UNIVERSITY OF SOUTHAMPTON

FACULTY OF MEDICINE

Human Development and Health

Applying a whole systems approach to improve the health behaviours of Royal Naval personnel

by

Anneliese Marie Shaw

Thesis for the degree of Doctor of Philosophy

December 2020

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF MEDICINE

Human Development and Health

Thesis for the degree of Doctor of Philosophy

APPLYING A WHOLE SYSTEMS APPROACH TO IMPROVE THE HEALTH BEHAVIOURS OF ROYAL NAVAL PERSONNEL

by Anneliese M. Shaw

The Royal Navy (RN) is not immune to the global obesity epidemic. This poses considerable health, economic and occupational risks, and in due course will impact on operational capability; thus counteracting action needs to be taken. Due to the complex and multifaceted determinants of obesity, recent government guidance directs that obesity should be tackled at a community level using a whole systems approach (WSA). This thesis presents a programme of research that aimed to evaluate whether a WSA could be taken to create a healthier environment onboard a RN ship, which facilitates RN personnel to adopt or maintain prudent health behaviours, and whether such an approach could reduce the prevalence of obesity amongst personnel. Six studies were undertaken to confirm the need for, inform the development and implementation of, and to rigorously evaluate a healthy lifestyle intervention. The studies confirmed that there was a need for a healthy lifestyle intervention. A cross-sectional study of 600 RN personnel indicated that 29% were classified as being at any risk of obesity related ill health. Furthermore, personnel were typically consuming unhealthy diets and 13% of personnel were not being active enough to stay healthy. Moreover, a cross-sectional study undertaken onboard eight RN vessels indicated that although the physical activity environment supported healthy choices, the nutrition environment did not. The studies suggested that the intervention should take a multi-component, multi-level WSA. The evaluation of the intervention highlighted that a WSA can be applied to successfully improve the healthiness of the nutrition and physical activity environment onboard a RN ship. Strong leadership buy-in across all levels of the system, community involvement and sufficient financial support and resource were essential components contributing to intervention feasibility and sustainability. The research provides originality and presents recommendations to support the future delivery of WSA in a military context. The recommendations are also relevant to other non-military institutional settings.

Contents

List of tables

List of figures

Declaration Of Authorship

I, Anneliese Marie Shaw, declare that this thesis entitled “Applying a whole systems approach to improve the health behaviours of Royal Naval personnel” and the work presented in it are my own, and have been generated by me as the result of my own original research.

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. Parts of this work have been published as:

Shaw AM, Wootton SA, Fallowfield JL, Allsopp AJ, Parsons EL. Environmental interventions to promote healthier eating and physical activity behaviours in institutions: a systematic review. *Public Health Nutrition*. 2019; doi: 10.017/S1368980018003683.

Shaw AM, Davey T, Allsopp AJ, Parsons EL, Wootton SA, Fallowfield JL. Food choice motives of Royal Navy personnel. *Proceedings of the Nutrition Society*. 2018;77:E221.

Shaw AM, Simpson D, Davey T, Fallowfield JL. Body mass index and waist circumference: implications for classifying the prevalence of overweight and obesity in the Royal Navy. *Proceedings of the Nutrition Society*. 2013;72(OCE4).

Shaw AM, Morrow L, Abrams C, Downie SE, Allsopp AJ, Parsons EL, Wootton SA, Fallowfield JL. Evaluation of a weight management programme delivered onboard a warship. *Proceedings of the Nutrition Society*. 2018;77:E148.

Shaw AM, Downie SE, Gunner F, Morrow L, Davey T, Fallowfield JL. Second Sea Lord's Feeding the Fleet Initiative: the health of Royal Navy personnel aboard Type-45 destroyers – an executive summary. *Journal of the Royal Navy Medical Service*. 2017;103(1): 2-4.

8. Parts of this work have been published as Institute of Naval Medicine technical reports:

Shaw AM, Surg Lt Cottey L, Sgt Abrams C, Wootton SA, Nestel P, Downie SE, Davey T, Gunner F, Fallowfield JL. *Second Sea Lord's Feeding the Fleet Initiative: Evaluation of a Healthy Lifestyle Intervention Delivered Onboard a Royal Navy Warship.* Institute of Naval Medicine. Report number: 2020.002, 2020.

Shaw AM, Surg Lt Morrow L, Sgt Abrams C, Downie SE, Davey T, Gunner F, Fallowfield JL. *Second Sea Lord's Feeding the Fleet Initiative: Evaluation of a Weight Management Programme Aboard a Royal Navy Ship During a 9-month Deployment.* Institute of Naval Medicine. Report number: 2018.013, 2018.

Shaw AM, Wootton SA, Fallowfield JL, Allsopp AJ, Parsons EL. *Environmental interventions to promote healthier eating and physical activity behaviours in the Armed Forces: a systematic review.* Institute of Naval Medicine. Report number: 2018.003, 2018.

Shaw AM, Gunner F, Fallowfield JL. *Second Sea Lord's Feeding the Fleet Initiative: Report 2 – The Nutrition and Physical Activity Environment Aboard Royal Navy Ships and Submarines.* Institute of Naval Medicine. Report number: 2016.021, 2016.

Shaw AM, Britland SE, Gunner F, Surg Lt Morrow L, Davey T, Fallowfield JL. *Second Sea Lord's Feeding the Fleet Initiative: Report 1 – The Health of Royal Navy Personnel Aboard Type-45 Destroyers.* Institute of Naval Medicine. Report number: 2016.015, 2016.

Shaw AM, Simpson D, Davey T, Fallowfield JL. *Surgeon General's Armed Forces Feeding Project: The Royal Navy – obesity, eating behaviours and factors influencing food choices.* Institute of Naval Medicine. Report number: 2013.022, 2013.

Signed: ....

Date:

Acknowledgements

I would firstly like to thank Navy Command for funding my PhD and my supervisory team: Assoc Prof Steve Wootton, Dr Jo Fallowfield, Dr Penny Nestel and Dr Emma Parsons. Steve, it has been an immense privilege to have worked with you over the past 5 years. I am sincerely grateful to you for sharing your knowledge with me, for your insightful comments during our many meetings, and for your patience whilst I found my way. Jo, thank you for your on-going support, for our many conversations, and for being a constant inspiration striving me to achieve my best. None of this could have been possible without you. Penny, thank you for agreeing to be a late addition to my supervisory team. The support that you have provided has been invaluable and you have truly helped to bring the thesis together. Emma, thank you for your support throughout.

I would also like to thank Prof Alan Jackson for his guidance and initial supervision in getting the PhD started and for his enduring support throughout. A big thank you also goes to Dr Adrian Allsopp for his continued support and encouragement in helping me complete this journey.

I would also like to thank WO1 (Retd) Trevor Llewellyn without whose support and passion this research programme would not have been possible. I am also indebted to Surg Lt Cdr Laura Cottey and Capt Chris Abrams the Medical Officer and Physical Training Instructor onboard the intervention ship and to my fellow team members at the Institute of Naval Medicine, in particular Dr Frances Gunner, Dr Trish Davey, Sophie Downie and Lt (Retd) Dean Simpson. Furthermore, I would like to thank all the Royal Navy personnel, Medical Officers, Physical Training Instructors and Chefs who were involved in the studies. This thesis would not have been possible without their contribution.

Last but not least I would like to thank my family for their continued support, love and patience. In particular to Ian, thank you and apologies for having to endure far too many conversations about my research!

Abbreviations

AFFBS	Armed Forced Food Based Standards
ANOVA	Analysis of Variance
AS	Anneliese Shaw
BA	Before-and-After
BCT	Behaviour Change Technique
BMI	Body Mass Index
BMR	Basal Metabolic Rate
BRNC	Britannia Royal Naval College
CDC	Centers for Disease Control
Center TRT	Center of Excellence for Training and Research Translation
CI	Confidence Intervals
CPL	Core Provisions List
DMR	Daily Messing Rate
EI	Energy Intake
EP	Emma Parsons
ETL	Endurance Training Leader
FAO	Food and Agriculture Organization
FCQ	Food Choice Questionnaire
FFQ	Food Frequency Questionnaire
FSA	Food Standards Agency
GBSF	Government Buying Standards for Food and Catering Services
GNKQ	General Nutrition Knowledge Questionnaire
HMNB	Her Majesty's Naval Base
HMS	Her Majesty's Ship
HSE	Health Survey for England
HWES	Health at Work Employee Survey
INM	Institute of Naval Medicine
IQR	Inter-Quartile Range
JR	Junior Rate
LO	Logistics Officer
m-NEAT	Military-Nutrition Environment Assessment Tool
MeSH	Medical Subject Heading
MLS	Multinational Logistics Service
MO	Medical Officer
MOD	Ministry of Defence
MODREC	Ministry of Defence Research Ethics Committee
MDRV	Military Dietary Reference Values

NAAFI	Navy Army Air Force Institutes
NHWB	Naval Health and Wellbeing Board
NICE	National Institute for Health and Care Excellence
OR	Odds Ratio
PAL	Physical Activity Level
PANEAT	Physical Activity and Nutrition Environment Assessment Tool
PAR	Physical Activity Ratio
PCA	Principal Components Analysis
PFS	Personnel Functional Standards
PHE	Public Health England
PTI	Physical Training Instructor
RM	Royal Marines
RN	Royal Navy
RNAS	Royal Naval Air Station
RNFT	Royal Navy Fitness Test
ROBINS-I	Risk Of Bias In Non-randomised Studies of Interventions
RQ	Research Question
S-O	Strengths-Opportunities
S-T	Strengths-Threats
SACN	Scientific Advisory Committee on Nutrition
SD	Standard Deviation
SEM	Socio-Ecological Model
SES	Socioeconomic Status
SR	Senior Rate
SW	Steve Wootton
SWOT	Strengths, Weaknesses, Opportunities, Threats
TEE	Total Energy Expenditure
TIDieR	Template for Intervention Description and Replication checklist
UHC	Unit Health Committee
UK	United Kingdom
US	United States of America
VIF	Variance Inflation Factor
W-O	Weaknesses-Opportunities
W-T	Weaknesses-Threats
WHO	World Health Organization
WMP	Weight Management Programme
WO	Warrant Officer
WSA	Whole Systems Approach
WSO	Whole Systems Approach to Obesity

Context of the PhD

After graduating from Loughborough University with a BSc in Sport and Exercise Science and an MSc in Sport and Exercise Nutrition, I started working as a Scientific Officer in the Applied Physiology Department at the Institute of Naval Medicine (INM) in 2008. The majority of the research projects in which I was involved focused on nutrition, predominantly public health nutrition. In 2010, I noticed a major gap in the knowledge and skill set of the department and requested to enrol part-time on the MSc in Public Health Nutrition at the University of Southampton. After successfully completing the Masters in 2012, I became a practitioner with the United Kingdom (UK) Public Health Register and a Registered Public Health Nutritionist with the Association for Nutrition. I currently work as a Public Health Analyst at the INM, where part of my role involves working as a Public Health Nutritionist.

In 2008, the Ministry of Defence (MOD) recognised that obesity was a significant problem for the UK Armed Forces. It was postulated that the health, economic and occupational implications of obesity were reducing operational readiness and capability. As such, the MOD directed that it was imperative that measures were taken to improve the health of Service personnel.

In 2012, I acted as the principal investigator for a study undertaken for the Surgeon General that examined the prevalence of overweight and obesity, and the health behaviours of Royal Navy (RN) personnel. It was anticipated that the findings from the study would provide an evidence-base to inform interventions to modify personnel's health behaviours, thus reducing the prevalence of obesity. In 2013 the results from the study prompted Navy Command Logistics and Infrastructure to task the INM to undertake a programme of work to develop, implement and evaluate a healthy lifestyle intervention onboard a RN ship. During the planning stages of this project, I was presented with the opportunity to undertake a PhD with the University of Southampton. I registered as a part-time PhD student in the Human Development and Health unit in June 2014. My research sets out to address how best to improve the health behaviours of RN personnel, to reduce the prevalence of obesity, and ultimately increase the numbers of personnel who are fit to deploy.

1. Introduction and thesis outline

1.1 Chapter overview

This thesis presents a programme of research that was conducted to investigate whether a whole systems approach[a] (WSA) could be undertaken to create a healthier environment onboard a Royal Navy (RN) ship, which facilitates RN personnel to adopt or maintain prudent health behaviours, and whether such an approach could reduce the prevalence of obesity amongst personnel. This chapter will begin by introducing the context within which the research was undertaken. This will be followed by an explanation of the problem of obesity in the RN and a brief overview of the recent literature on the effectiveness of strategies to tackle obesity in the United Kingdom (UK). Thus, the rationale for the research undertaken in the thesis will be presented. The chapter concludes with an outline of the empirical chapters.

1.2 The Royal Navy

The RN is the UK's principal maritime warfare force. Its role is to protect British interests at home and abroad, through preventing conflict, providing security at sea, fostering alliances with other nations, protecting the economy, providing humanitarian assistance and maintaining a state of readiness[1]. Civilians enlisting in the RN either join as a Rating or Officer Cadet. Initial Naval training for Ratings and Officer Cadets occurs at Her Majesty's Ship (HMS) Raleigh and the Britannia Royal Naval College (BRNC) Dartmouth, respectively. On entry, Ratings are aged between 16 and 37 years old and Officer Cadets are aged between 18 and 31 years old. Upon completing training Ratings and Officers join one of six branches (aviation, chaplaincy, engineering, logistics, medical and warfare) and are classified as being full-time trained strength.

Full-time trained strength personnel join either one of Her Majesty's Naval Bases (HMNB, Clyde, Devonport or Portsmouth); one of six Royal Marines (RM) bases; one of the RN training establishments (BRNC Dartmouth, HMS Collingwood, Institute of Naval Medicine (INM), Commando Training Centre RM Lympstone, HMS Excellent, HMS Raleigh, HMS Sultan or HMS Temeraire); Navy Command Head Quarters; one of the RN Air Stations (RNAS, Culdrose or Yeovilton) as part of the Fleet Air Arm; or one of the ships, boats or submarines in the Surface Fleet or Submarine Service. As at 20 August 2016, the RN Surface Fleet and Submarine Service consisted of 76 commissioned

---

[a] See section 1.4 for a full explanation of a WSA.

vessels, including: one amphibious assault ship, one static ship, two landing platform dock ships, five survey vessels, six Type 45 destroyers, 13 Type 23 frigates, 15 mine-countermeasure vessels, 22 patrol vessels, four ballistic missile submarines and seven nuclear fleet submarines[2]. Personnel are typically based at an establishment (or unit) or on a vessel[b] for a period of two years, after which they are posted to a different unit. If based on a vessel, or as a member of the Fleet Air Arm, personnel can be deployed on extended periods of duty at sea in either home or international waters. Deployments typically last between three and nine months duration, and are usually separated by at least 12 months, depending on the national operational tempo.

As at 1 October 2017, the full-time trained strength of the UK RN was 22,700[3]. Of which 5,110 (23%) were Officers and 17,590 (77%) were Ratings[3]. Sixty-two percent were General Service, and 18% and 20% belonged to the Submarine Service and Fleet Air Arm, respectively[3]. The average age of Ratings and Officers was 30 and 37 years old, respectively[4]. Nine percent of personnel were females and 4% came under the category black, Asian and minority ethnic[4]. Thus, the majority of RN personnel are young, white males.

Ratings can be further subdivided into non-commissioned Officers (Senior Rates; SR) and other ranks (Junior Rates; JR), where SR are Ratings who have succeeded in progressing their military career. The rank structure in the RN is hierarchical, with the average length of time between promotions typically ranging between 2-9 years[5]. It is expected that the average length of service for Ratings ranges between 6-30 years and for Officers ranges between 4-37 years[5]. Officers hold the Queen’s Commission to lead and command elements of the RN, and form the middle and senior management of the Service. As such, Officers have normally gained either a qualification at degree level or have achieved ‘good’ A level grades. Education standards for SR and JR are typically lower than for officers. In terms of income, personnel with a higher rank achieve higher wages[6]. Thus, military rank can be used as a proxy measure for socioeconomic status (SES).

RN personnel live and work in closed (e.g., onboard a deployed ship), semi-closed (e.g., living and working in a shore establishment) and open (e.g., living in private accommodation offsite whilst working in a shore establishment) environments. The type and location of the unit at which they are based will have a variable impact on their health behaviours. For example, personnel based onboard ship and submarines are a captive audience whose food and physical activity choices are constrained by the environment; whereas, the environment will have less of an impact on the health behaviours of

[b] The term vessel includes both ships and submarines.

personnel who work at a shore establishment and live off-site. Due to the hierarchical structure of the RN, all units have three messes (Officers', SR and JR), which are areas where personnel socialise, eat, and in some cases live. Additionally, all units have a breadth of sport and fitness facilities, which are freely available to all personnel.

To be able to join the RN, individuals have to pass a pre-joining fitness test and pre-Service medical. The pre-joining fitness test is an age and gender fair test consisting of a 2.4 km treadmill run. The test aims to assess an individual's level of aerobic fitness to ascertain whether they will be able to meet the physical demands of Naval life. Specifically, this refers to onboard generic tasks such as fire fighting, damage control and casualty evacuation[7]. As part of the pre-Service medical personnel are required to have their height and body weight, from which body mass index (BMI) is calculated, and waist circumference measured. These measures are used to identify whether individuals are at risk of obesity related ill health[8]. Personnel failing to meet the guidelines detailed at Table 1.1 are deemed not suitable for Service.

Table 1.1: BMI and waist circumference limits for entry to the RN[9].

Age (years)	BMI (kg/m^2)			
	Male and female minimum	**Male and female maximum**	**Male maximum if WC is <94 cm**	**Female maximum if WC is <80 cm**
18+	18	28	32	30
16 to <18	17	27	27	27

Note: BMI, body mass index; WC, waist circumference.

Once personnel have passed out of initial military training they are required to pass the annual RN fitness test (RNFT). Exemptions are granted for personnel over the age of 55 years and for those who are medically downgraded. The RNFT consists of an age and gender fair fitness test to assess aerobic fitness (either a multi-stage fitness test, 2.4 km run or Rockport Walk test) and a functional performance test[7]. Failure to achieve the pass standard for the functional performance test is not considered as a failure, as such there is no resultant disciplinary action[7]. However, personnel who fail the aerobic element of the RNFT are placed on a 3-month remedial training programme with a Physical Training Instructor (PTI). If personnel continue to fail the test after completing nine months of remedial training they are referred to the INM where aerobic fitness is measured using indirect calorimetry. If an individual fails this assessment they may be discharged from the Service[7]. Moreover, annual appraisal reports consider whether personnel are 'in date' for their RNFT. Hence, RNFT failure may impact an individual's chances of promotion.

Full-time trained strength personnel are also expected to complete a minimum of three hours of vigorous physical activity (defined as organised, structured and supervised physical fitness programmes including sports) per week programmed as part of their working day. Additionally, it is expected that at least 20% of unit personnel participate in five working days of adventurous training or challenging activities each year. These standards are part of the ‘Second Sea Lord’s Personnel Functional Standards’ (PFS)[10]. At present there is no mechanism in place to ascertain whether these standards are successfully implemented at a unit level. Thus, there is no resultant disciplinary action for non-compliance.

Full-time trained strength personnel are also required to have their BMI and waist circumference assessed regularly to identify their risk of obesity related ill health[11]. Risk is classified according to the National Institute for Health and Care Excellence (NICE) guidelines[8]. Following the measurements personnel are made aware of their level of health risk and offered health promotion advice and education. Personnel classified at ‘any increased risk’ (i.e. increased risk, high risk and very high risk) are provided with further support to assist them to achieve a healthy body weight[11]. Individuals classified at risk do not experience any disciplinary action. Moreover, an individual’s risk classification does not influence promotional opportunities.

1.3 The problem of obesity in the Royal Navy

The lifestyle and behaviour choices that individuals make play an important role in influencing health, wellbeing and the risk of chronic diseases. Numerous factors interact to determine these choices including biological, economic, social, psychological and physical determinants, and attitudes, beliefs and knowledge[12-15]. Data gathered from national surveys in England and the wider UK reveal that there is a large gap between the dietary and physical activity behaviours of adults and the government recommendations for maintaining good health[16,17]. These imprudent health behaviours are also mirrored in the RN[18-21], which is of concern as unhealthy diets and physical inactivity have been identified as major risk factors for obesity[22,23].

The prevalence of obesity among adults in the UK is increasing[24]. In the most recent Health Survey for England (HSE) report, 27% of men and 30% of women had a BMI which placed them in the obese category (i.e. a BMI of 30 kg/m^2 or more)[24]. Furthermore, 55% of men and 61% of women were classified as being at risk of obesity related ill health[24]. It is projected that overweight and obesity in adults will reach 70% by 2034[25]. This is worrying as being overweight or obese can increase the risk of developing a number of serious diseases and health conditions, including cardiovascular disease, type 2 diabetes and certain cancers[26-29]. The combined effect can shorten life expectancy[27].

Over the past two decades evidence has been presented to Naval Command demonstrating that the RN is not immune to the obesity epidemic[30-37]. In 2007, Wood[36] reported that the prevalence of obesity in the RN was 17%, where 40% of personnel were classified at risk of obesity related ill health according to the NICE risk classifications. Furthermore, in a randomised study of RN and RM personnel undertaken in 2007[34], the combined prevalence of overweight and obesity according to self-reported measures of height and body weight was 66% and 38% for males and females, respectively. In a follow-up study in 2011[31], the prevalence of overweight and obesity was 13% and 15% higher in male and female participants, respectively. Although caution should be taken when interpreting these results, due to the limitations of using self-reported measures of height and weight[38], and the use of BMI to classify obesity[39], the findings highlight that individuals gained weight over time. It is not known whether this increase in weight can be attributed solely to the positive relationship between age and obesity[31,34,40] or due to other reasons. In summary, due to limitations in the design and data collection methods of previous studies, the full scale of the problem of obesity in the RN is presently unknown.

The health, economic and occupational implications of obesity to the RN are considerable, where a higher BMI in military personnel has been associated with a higher risk of being medically downgraded[c] [41,42], the development of self-reported back problems[43], musculoskeletal disorders[43], high blood pressure[31,43], depressive symptoms[44] and increased sickness absence[45]. These factors are likely to result in reduced operational readiness[42] and deployability[46], potentially contributing to the decreased retention of personnel, and specifically the loss of highly valued military expertise[47]. In addition to the potential loss of personnel to the Service, those who are classified as being 'medically unfit' are provided with medical treatment and access to rehabilitation services, all of which may incur significant financial costs[48].

As at 1 April 2012, prior to the collation of the data reported in Chapter 3 of this thesis, the full-time trained strength of the RN was 25,970[49]. As detailed before, the full-time trained strength of the RN as at 1 October 2017 was 22,700[3]. Thus, as a result of the 2010 Strategic Defence and Security Review[50], manning figures reduced by 13% over the five year period. In addition to this reduction in manning levels, as at 1 October 2017, there was a deficit of 4.7% against the number of personnel needed[51]. Combined, the reduction and deficit in manning levels make it necessary that all RN personnel are both healthy and occupationally fit to deploy. However, between 1 April 2017 and 31 March 2018 there were a total of 486 medical discharges in the RN, of which 56% were due to musculoskeletal disorders and injuries[52]. Moreover, as at 1 April 2017, 17% of RN personnel were medically downgraded, of which approximately 49% had a principal cause

---

[c] Service personnel with medical conditions that affect their ability to perform their duties are referred to a medical board for a medical examination and review of their medical grading. The individual may be 'medically downgraded', to allow for treatment, recovery and rehabilitation. Personnel who are medically downgraded are unable to deploy on operations.

of musculoskeletal disorders and injuries[5]. Due to the numerous personal and organisational implications of obesity to the RN, in particular the adverse impact that it has on risk of musculoskeletal disorders and injuries and deployability, these figures further highlight the importance that action is taken to tackle the problem of obesity in the RN. Tackling the problem offers the potential to ease current manpower challenges and maximise deployability.

1.4 Strategies to tackle obesity

To develop strategies to tackle obesity, it is necessary to understand the key determinants of obesity. Obesity, in simple terms, occurs when an individual's energy intake (EI) exceeds their energy expenditure over a prolonged period of time. This leads to an accumulation of excess body fat[53], which impacts an individual's physical, psycho-social and functional health. It has been argued that this simplistic view fails to recognise the complexity of how individuals acquire and use energy and it has been postulated that the determinants of obesity are extremely complex and multifaceted[54]. In 2007, the Foresight programme reviewed the variables that directly or indirectly determine an individual's energy balance[55]. A fundamental part of the programme was the creation of an obesity systems map that provided a conceptual representation of the variables and the interactions between them[55]. The variables included: physiology; physical activity; activity environment; food consumption; food environment; individual psychology; and, societal influences[54,55]. The Foresight report recognised that the environment plays an important role in determining an individual's energy balance[54,56]. It noted that in recent decades food, in particular energy-dense food, has become readily available and accessible in multiple settings throughout the day[15,56]. At the same time, technological development has worked to engineer physical effort out of the environment[54,56,57]. The resultant effect is that the environment in combination with individual factors have broadly acted to increase energy consumption and reduce physical activity levels, thus promoting obesity[12].

The findings from the Foresight programme suggested that to successfully tackle obesity a socio-ecological approach must be taken that first establishes and maintains policies and an environment that support and facilitate healthy food and activity choices, and, second, encourages individuals to make healthy choices, recognising that these choices are cued by the behaviours of others including families, communities, workplaces and the government[54,56]. The Foresight programme outlined five core values to tackle obesity at a population level: (i) a system-wide approach; (ii) higher priority for the prevention of health problems, with clearer leadership, accountability, strategy and management structures; (iii) engagement of stakeholders within and outside government;

(iv) long term, sustained interventions; and, (v) on-going evaluation and a focus on continuous improvement[54].

In response to the Foresight report, in 2008, the UK government published ‘Healthy weight, healthy lives’[58], which was a cross-government strategy to tackle obesity. The strategy emphasised the importance of changing the environment to increase the likelihood that individuals, in particular families, would adopt healthier dietary and physical activity behaviours. The strategy neither promoted action across all government departments and sectors nor built in a monitoring, evaluation and learning system. Nevertheless, national and local stakeholders perceived that the strategy had increased the priority of obesity, engaged more stakeholders, stimulated and facilitated action, and changed attitudes[59].

In 2011, following the election of a new coalition government, the strategy ‘Healthy lives, healthy people: a call to action on obesity in England’ was published[60]. This adopted a life course approach and aimed to improve the health of the nation by empowering individuals and local government to take responsibility and action to tackle obesity. The change in responsibility from central to local government, which would result in interventions and services focusing on the needs of the local population, was viewed positively[61]. The strategy aimed to nudge individuals in the right direction by focusing on less intrusive interventions according to the Nuffield Council on Bioethics ‘intervention ladder’[62] (e.g., voluntary responsibility deals in the business sector) instead of a mandated approach (e.g., applying regulations). Although this libertarian paternalism approach was considered to be a positive of the strategy it was also viewed as a negative[63] as non-regulatory measures, when used in isolation, have been reported as being less likely to be effective[64]. It is unclear what impact the strategy had on the nation’s health[65].

In 2012, in support of the government’s ‘Healthy lives, healthy people: a call to action on obesity in England’ strategy, NICE distributed guidance to tackle obesity at a community level using a WSA[66]. This is a ‘Health in All Policies’ approach[67]. WSAs draw on complexity science and complex adaptive systems to examine how the system works as a whole[68] through taking a socio-ecological approach. They are typically used to tackle complex or ‘wicked’ problems that are inherently unpredictable, difficult to assess, and therefore difficult to manage[69]. They recognise that tackling a single driver in isolation cannot work as the system contains heterogeneous interacting components. These can lead to emergent behaviours that can change, evolve or adapt and are difficult to predict by looking at the effects of the individual components. Moreover, WSAs acknowledge the need for both individual and organisational level action, adopting a top-down bottom-up approach through employing cross-disciplinary, multi-agency and multi-level activities[66]. Thus, a benefit of adopting a WSA is that, due to collaborative working across departments, negative unintended consequences of individual actions are more likely to be anticipated and avoided. It has been hypothesised that a WSA can be applied to tackle obesity, as obesity is a systems problem[70]; it affects everyone, has heterogeneous patterns, has wide-ranging impacts, lacks a single cause, and traditional approaches that focus on single remedial actions have consistently failed.

To inform the development of the NICE guidance, a series of evidence reviews were commissioned[68,71,72]. The review by Garside et al.[68] identified ten features of a WSA to tackle obesity (Table 1.2).

Table 1.2: Ten features of a systems approach to tackle public health problems[68].

Feature	Explanation
Identifying a system	Explicit recognition of the public health system with the interacting, self-regulating and evolving elements of a complex adaptive system. Recognition given that a wide range of bodies with no overt interest or objectives referring to public health may have a role in the system and therefore that the boundaries of the system may be broad.
Capacity building	An explicit goal to support communities and organisations within the system.
Creativity and innovation	Mechanisms to support and encourage local creativity and/or innovation to address obesity.
Relationships	Methods of working and specific activities to develop and maintain effective relationships within and between organisations.
Engagement	Clear methods to enhance the ability of people, organisations and sectors to engage community members in programme development and delivery.
Communication	Mechanisms to support communication between actors and organisations within the system.
Embedded actions and policies	Practices explicitly set out for obesity prevention within organisations within the system.
Robust and sustainable	Clear strategies to resource existing and new projects and staff.
Facilitative leadership	Strong strategic support and appropriate resourcing developed at all levels.
Monitoring and evaluation	Well-articulated methods to provide ongoing feedback into the system, to drive change to enhance effectiveness and acceptability.

The review by Hunt et al.[71], which aimed to determine the effectiveness of community-wide programmes displaying features of a WSA to prevent obesity, reported a paucity of evidence. The review synthesised the findings from eight programmes, none of which were undertaken in the UK, and all of which targeted children below 14 years of age. The findings generally favoured using a WSA to tackle obesity, but improvements in anthropometric, and diet and physical activity outcomes tended to be relatively small and not always statistically significant. Furthermore, there was no clear evidence of an association between the presence of the ten features of system working, identified by Garside et al.[68], and programme effectiveness. These findings were supported by a more recent systematic review undertaken by Bagnall et al.[73] that aimed to obtain a greater insight of the effectiveness of WSAs and how they could be implemented in practice. The review, which included 33 studies about obesity, concluded that systems approaches could have some benefit on a range of health outcomes, but stated that evidence of how to operationalise them was still in its infancy. Reinforcing the ten features identified by Garside et al.[68], the review reported that features of successful approaches included: full engagement of relevant stakeholders and the community; time to build relationships, trust and capacity; good governance; being embedded within a broader policy context; local evaluation; and, finance[73]. In addition to these features the Pearson et al.[72] review described the importance of strategic leadership and enabling stakeholders to feel actively involved and have some ownership of the strategy.

In 2015, Public Health England (PHE) commissioned the Whole Systems Approach to Obesity (WSO) programme, which aimed to develop a practical guide to support local authorities in implementing a WSA to tackle obesity[74]. The programme built on the foundations articulated in the Foresight obesity report and research commissioned by NICE. It placed considerable emphasis on creating the right environment for change in the local area, collaborative working across the local system and the dynamic nature of the local system. Following working closely with 11 local authorities, the WSO co-produced a definitive guide to support other local authorities in tackling obesity[75]. One component of the guide was a step-by-step process (termed ‘the route map’), which takes stakeholders through six phases[76] (Table 1.3). Stages one and two focus on preparation to create the environment for change; stages three and four are about collective working; and, stages five and six focus on taking actions forward as a group, continuously monitoring, revising and reflecting on how things can be improved.

To date, key lessons that have emerged from the WSO programme include: taking a WSA requires the right mind set across the council; local level practitioners need support to think, adapt and work in a way that enables them to work in a whole systems way; and the importance of senior and political leadership cannot be underestimated[75,76]. Although the outcomes of the programme are yet to be published, at the time of writing this chapter, common areas of activity to tackle obesity identified in the pilot programmes included: planning a healthier food environment; the school and childcare setting; increasing healthy food consumption; planning and creating an environment that promotes activity including active transport; providing access to weight management support; creating healthy workplaces; educating people about the benefits of healthy eating and exercise and promoting opportunities in the local community[75].

Table 1.3: Whole systems approach to obesity programme route map[75].

Phase	Name	Detail
1	Set-up	Includes securing senior leadership support and developing relationships with key stakeholders
2	Building the local picture	Building an understanding of the local obesity picture
3	Mapping the reality	Bringing stakeholders from across the system together to create a map of the causes of obesity in their area
4	Action	Identify and prioritise areas of action
5	Creating a dynamic local system	Taking actions forward as a group. Continuously monitoring and revising them
6	Reflection	Reflecting on how things can be improved

When considering the action that the RN could take to tackle obesity, it was essential to identify existing mechanisms that aim to promote the health and wellbeing of personnel. According to the socio-ecological model (SEM) of health behaviour[77] – the theory-based framework that forms the basis of a WSA – an individual’s health behaviours affect and are affected by multiple levels of influence, namely: intrapersonal factors (biological, psychological); interpersonal processes and primary groups (social, cultural); organisational/ institutional factors; community factors; the physical environment; and public policy factors. At the policy level, three existing policies aim to support RN personnel to make healthy dietary and physical activity choices and maintain a healthy weight, namely: ‘Joint Services Publication 456’[78], ‘Second Sea Lord’s PFS’[10] and the ‘Armed Forces Weight Management Policy’[11].

The first policy document describes the MOD’s catering and dining policy[78]. It provides direction to contract caterers and military food providers to ensure that Service personnel receive the energy and nutrients required to fulfil their military roles. It stipulates that the catering service must meet the ‘Military Dietary Reference Values’[79] (MDRV), which are energy and nutrient-based guidelines; and is consistent with the ‘Armed Forces Food Based Standards’ (AFFBS), which are food-based guidelines based on the government’s advice on what constitutes a healthy balanced diet[80]. It may be assumed that if these requirements were complied with, the nutritional provision would offer healthy choices. However, at present there is no research investigating whether the feeding provision in RN shore establishments or onboard RN vessels conforms to these requirements.

The second policy document stipulates that RN personnel should complete a minimum of three hours of vigorous physical activity each week and this should be programmed as part of the working day[10]; thus providing direction to the individual to undertake the activity, and to Command to allocate time for individuals to be able to undertake the activity as part of their working day. There is presently no mechanism to evaluate the effectiveness of this policy.

Finally, the third policy document combines education with behavioural strategies to both encourage individuals to take responsibility for their health, and to support organisational and environmental change[11]. The policy recommends regular monitoring of height, weight and waist circumference measurements for all personnel to identify individuals who are at an increased health risk and who may require additional weight management support. Again, there is no research evaluating the effectiveness of this policy.

At the institutional level, the Naval Health and Wellbeing Board (NHWB) aims to promote the health and wellbeing of personnel, and therefore maximise the number of RN personnel fit to meet Defence outputs. This is done by supporting the development and implementation of the 'Naval Health and Wellbeing Plan' that sets out the Naval Service's health objectives and priorities, including six strategic objectives that are based around each life-stage of personnel: *Join Well*, *Train Well*, *Live Well*, *Work Well*, *Leave Well* and *Re-join Well*. To ensure the targets are met, four working groups sit under the NHWB: Lifestyles, Mental Health, Injury Prevention and Preventive Health. These working groups identify priority areas, initiate research, undertake data surveillance, facilitate access to resources and develop policies. The board and four working groups are comprised of representatives from multiple disciplines including personnel from the Executive, Logistics, Medical and Physical Training departments.

At a community (or establishment) level, Unit Health Committees (UHC) have an important role in achieving the Naval Health and Wellbeing Plan targets through delivering health promotion across nine health topics: fitness, nutrition, alcohol consumption and substance misuse, smoking cessation, mental health, sexual health, oral health, injury prevention and maternity health. It is a requirement for all units, including ships and submarines, to have an active UHC that formally meet on a termly basis (i.e. three times a year). The UHC is required to plan, deliver and evaluate activities promoting the health and wellbeing of their unit, and advocate for unit policies and environments that support prudent behaviours. Onboard a ship, a UHC represents all members of a Ship's Company and is comprised of representatives from the Executive, Medical, Physical Training and Catering Services departments. Thus, exemplifying a cross-disciplinary, multi-agency team.

When considering action that could be taken by the RN to tackle obesity, the environment onboard a warship provides an ideal opportunity to improve the dietary and physical activity behaviours of personnel using a WSA. This is particularly the case during a deployment, where the ship's company are a captive audience, and individual food and physical activity choices are constrained by the ship's environment. Ensuring the healthiness of a ship’s environment is a strategy that could reach the whole ship’s company and thus have a wider reaching impact compared with individual level behaviour change strategies alone[81]. Furthermore, the organisational culture of the RN would naturally be supportive of the adoption of a comprehensive WSA to tackle obesity that incorporates the ten key features identified by Garside et al.[68]. Onboard a RN ship a WSA could be adopted through stakeholder collaboration with the UHC to create an environment and policies that make healthy choices convenient, attractive and economical, produces strong social norms and social support for healthy choices, and both motivates and educates personnel to make these choices.

At present no research has been undertaken to evaluate the effectiveness of a WSA to tackle obesity in a closed environment, such as onboard a ship. Lessons identified from developing a WSA in such an environment could help to inform obesity programmes being delivered in other military settings, institutions and in the wider community setting.

1.5 Research aim and questions

Given the problem of overweight and obesity in the RN (section 1.3) and the evidence that supports taking a systems approach to tackle obesity (section 1.4), this thesis presents a programme of research to evaluate whether a WSA could be undertaken to create a healthier environment onboard a RN ship, which facilitates RN personnel to adopt or maintain prudent health behaviours, and whether such an approach could reduce the prevalence of obesity amongst personnel. The research was tasked by Navy Command Logistics and Infrastructure[82]. It targeted ship-level as opposed to unit-level or the RN as a whole because it represented a smaller system. Lessons learned could then be considered and applied in scaling up to larger more complex systems.

Based on the research aim, four research questions (RQ) were derived:

- RQ1: Is there a need for a healthy lifestyle intervention in the RN?
- RQ2: What should the integral components and theoretical approach of the healthy lifestyle intervention be?
- RQ3: What is the impact of the healthy lifestyle intervention on the healthiness of the physical environment onboard the intervention ship?
- RQ4: What is the impact of the healthy lifestyle intervention on RN personnel’s dietary and physical activity behaviours, and obesity classification?

Each question will be explored through six studies described below.

1.6 Thesis outline

The thesis comprises three sections. Section 1 presents a health needs assessment, identifying the health priorities of the RN and determining effective and acceptable intervention strategies and activities. Section 2 clarifies the aims of the healthy lifestyle intervention that was delivered onboard the ship, and describes the components of the intervention and the monitoring and evaluation strategy. Section 3 evaluates the effectiveness of the intervention and presents the general discussion of the findings of the research programme.

1.6.1 Health needs assessment

Chapter 2 uses systematic review methods to identify current knowledge concerning interventions to improve the dietary and physical activity behaviours of adults in institutional settings through modifying the environment. Specifically, the review aimed to determine which policy and environmental strategies were associated with improvements in diet, physical activity and body composition indices. The findings of the review were used to inform the development of the healthy lifestyle intervention.

Chapter 3 presents a cross-sectional study that assessed the health status of RN personnel in order to identify the need for a healthy lifestyle intervention and where actions should be targeted. The objectives of the study were to: determine the prevalence of overweight and obesity of RN personnel and assess dietary intake, physical activity levels, alcohol intake, smoking behaviours and the motives for food choice of personnel.

Chapter 4 presents a mixed methods study that informed the development of the healthy lifestyle intervention. The objectives of the study were to use focus groups and a quantitative survey to: determine levels of selected mediator variables of health behaviour change of intervention target users; identify the likelihood of intervention target users taking part or using a pre-defined list of initiatives; and explore barriers and enablers to prudent health behaviours and the needs, ideas and preferences of a sub-group of the intervention ship’s company for the healthy lifestyle intervention.

Chapter 5 presents a cross-sectional study that evaluated whether the nutrition and physical activity environments onboard RN vessels support healthy dietary and physical activity choices by: analysing the vessel menus against the MOD nutrient and food-based guidelines; assessing the Navy, Army and Air Force Institutes (NAAFI) shop and vending machine provision onboard the vessels against food-based guidelines; assessing the physical activity environment onboard the vessels; and assessing the health promotion and education activities delivered onboard the vessels. The findings of the study were used to inform the development of the healthy lifestyle intervention.

1.6.2 Healthy lifestyle intervention

Chapter 6 clarifies the aims of the healthy lifestyle intervention, presents a conceptual model for the intervention, and describes the components of the intervention and the monitoring and evaluation strategy. Specifically the chapter presents a: strengths, weaknesses, opportunities and threats analysis using the data gathered in Chapters 3, 4 and 5 to develop strategies designed to create a healthier environment on the intervention ship; an outcomes hierarchy that provides a two-dimensional representation of all the outcomes required to bring about the overall goal of the intervention; a logframe matrix for the intervention that displays the intervention resources, activities, intended results and underlying risks and assumptions; and an evaluation framework to evaluate the effectiveness of the healthy lifestyle intervention.

1.6.3 Intervention evaluation

Chapter 7 presents a repeated measures study to further consolidate the need for a healthy lifestyle intervention onboard a RN ship and to identify what happens to RN personnel ordinarily at sea. This was done by determining changes in the physical measurements, health-related behaviours and psychosocial variables of RN personnel onboard a control ship, which did not receive the healthy lifestyle intervention, over a deployment.

Chapter 8 presents a formative, process and outcome evaluation of the healthy lifestyle intervention that was delivered onboard a RN ship, based on the evaluation framework presented in Chapter 6.

1.6.4 General discussion

Chapter 9 presents a general discussion of the findings of the programme of research in the context of the research question and the thesis objectives. It also discusses the public health relevance of the findings with respect to the RN Fleet (i.e. all vessels), the RN as a whole, the UK Armed Forces and the civilian population.

Section 1: Needs analysis

2. Environmental interventions to promote healthier eating and physical activity behaviours in institutions: a systematic review

2.1 Introduction

This Chapter presents a systematic review of the literature on environmental interventions to improve the dietary and physical activity behaviours of adults in institutions. The identified papers were critically appraised and a narrative summary is presented. The findings were used to inform the development of the healthy lifestyle intervention outlined in Chapter 6.

The RN is not immune to the global obesity epidemic[30-37]. This is of concern due to the inherent health risks[41], and the occupational[43,47] and economic risks[48] that this poses to both the individual and the RN. These factors are likely to result in reduced operational readiness[42] and deployability[46], potentially contributing to the decreased retention of personnel, and specifically the loss of highly valued military expertise[47]. Although the causes of overweight and obesity are complex and multifaceted, unhealthy diets and physical inactivity have been identified as major risk factors[22,23], and need to be targeted in interventions to reduce the prevalence of obesity among RN personnel. To successfully tackle obesity a socio-ecological approach must be adopted which, first, establishes and maintains policies and an environment that support and facilitate healthy food and activity choices and, second encourages individuals to make healthy choices, recognising that these choices are cued by the behaviours of others including families, communities and workplaces[54,56].

Workplaces have been recognised as important settings for health promotion and disease prevention[83-86]. Interventions delivered in the workplace can offer an effective means of influencing the health behaviours of a broad captive audience through multiple levels of influence by means of direct (e.g., health education and increasing opportunities for physical activity) or indirect efforts (e.g., changing social norms to promote healthier behaviours)[83]. This was further emphasised by Hollands et al.[87] who proposed that environmental interventions are…

> *"Interventions that involve altering the properties or placement of objects or stimuli within micro-environments with the intention of changing health-related behaviour… implemented within the same micro-environment as that in which the target behaviour is performed, typically requiring minimal conscious engagement, can in*

principle influence the behaviour of many people simultaneously, and are not targeted or tailored to specific individuals."

There is a lack of clarity about the effectiveness of workplace dietary and physical activity interventions to improve dietary and physical activity behaviours and body composition indices. Seven systematic reviews concluded that workplace interventions involving dietary modification or nutrition education alone, or combined, have a positive effect on dietary behaviours[88-95]. Furthermore, some of these and others concluded that workplace physical activity interventions are effective at promoting physical activity levels[93,94,96-99] and health and work-related outcomes[98]. Moreover, a number of reviews concluded that there is moderate to strong evidence supporting a positive effect of multi-component interventions[d] in achieving improvements in dietary and/or physical activity behaviours[93,94,100-102] and body weight[93,103-105]. In contrast, others concluded that evidence to support workplace dietary, physical activity and multi-component interventions for improving dietary and/or physical activity behaviours is either limited or inconclusive[92,102,106-113].

After reviewing the evidence it was evident there is no consensus as to which levels of the social system workplace dietary and physical activity interventions should be targeted at. Allan et al.[112] and Kahn-Marshall and Gallant[101] suggested that the evidence supporting interventions that include only environmental and policy changes is questionable. Conversely, Matson-Koffman et al.[94] concluded that environmental and policy changes can improve dietary and physical activity behaviours. Grech and Allman-Farinelli[95] suggested that interventions targeting pricing and availability are effective at improving the nutritional quality of foods and beverages purchased from vending machines. Three reviews concluded that interventions that combine environmental and policy changes with interventions targeted at the individual-level are more likely to be effective at improving dietary and/or physical activity behaviours than interventions targeted to one level of the social system[99,101,102]. A number of reviews concluded that modest improvements in measures of adiposity can be achieved through multi-component workplace interventions including individual-level intervention activities alone[103] and individual-level intervention activities combined with environmental changes[93,100,104,105].

The conflicting findings presented above may be due to the use of different inclusion and exclusion criteria. Also, many were narrative reviews rather than meta-analyses. Nevertheless, the majority of authors agree that the literature suffers from a lack of quality evaluation studies and further well-designed studies are needed[88,89,94-98,101,102,106-109,111,112].

---

[d] Multi-component interventions target both dietary and physical activity behaviours simultaneously.

Effective intervention strategies and activities described in the systematic reviews included: targeting multiple levels of influence through ensuring organisational support, targeting workers' broader social context, and worker involvement during planning and implementation[114]; offering structured programmes[103]; comprehensive work-site approaches (i.e. education, counselling, health-promotion classes and on-site exercise facilities)[94]; and addressing multiple health behaviours[93,114]. Effective environmental modifications included: point-of-purchase nutrition labelling[90,94,102,104]; prompts to increase stair use[94]; use of promotional materials[102]; increasing the availability of healthy products in canteens and vending machines [94,95,100,102]; reducing the price of healthy products in vending machines [95]; efficient food placement[102]; team competitions[104]; walking routes and maps[104]; and family involvement[104]. Effective behaviour change techniques (BCT) included: goal setting[96,97]; self-monitoring[96,97,99]; combining educational approaches with counselling[103]; and motivational enhancement[113].

In summary, there is a lack of clarity about the effectiveness of workplace dietary and physical activity interventions. Furthermore, the majority of reviews have focused on the effects of individual-level interventions (e.g., education), with few evaluating the effects of policy and environmental changes. As such, the effectiveness of interventions that target multiple levels of the social system remain untested, where it is recognised that interventions targeting behaviour change are only successful and sustainable if the physical and social environments in which they are embedded are supportive[77,115-117].

RN personnel live and work in closed, semi-closed and open environments where the level of constraint on their health behaviours is dependent upon the type and location of the establishment in which they are based. In a number of military establishments (e.g., onboard a warship) the environment is distinct from a traditional workplace, with RN personnel being a captive audience whose food and physical activity choices are constrained by the environment (i.e. a closed environment). A systematic review that evaluates environmental-based strategies and interventions targeted at improving the health behaviours of adults in such closed environments is lacking. Thus, to inform the development of the healthy lifestyle intervention the present systematic review aimed to evaluate the effectiveness of interventions, which included environmental-based strategies and intervention activities, to improve the dietary and physical activity behaviours of adults in institutions. Specifically, it sought to determine which strategies and activities were associated with improvements in diet, physical activity and body composition indices. The research questions were as follows:

1. How effective are environmental interventions that are delivered in institutional settings at improving the dietary intake and physical activity behaviours of adults?

2. Do environmental interventions delivered in institutional settings have an effect on measures of body composition indices?
3. Is the type of environmental intervention associated with intervention effectiveness?

2.2 Methods

2.2.1. PROSPERO registration

The protocol for the present systematic review was registered on PROSPERO (registration number CRD42017076709) on 13 October 2017.

2.2.2. Literature search

This systematic review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement[118]. Using Medical Subject Heading (MeSH) terms and text words, the following databases were searched for studies from database inception to October 2017: MEDLINE; Embase; PsycINFO; CINAHL; The Cochrane Library; Web of Science; ProQuest Dissertation and Theses and Scopus. The reference lists of all identified reports and articles were searched for additional studies. To identify grey literature an advanced search was conducted in Athena. Searches were limited to literature published in English. The search strategy included a search for the following terms: Institutional Setting: (); AND Health Behaviour/Health Outcome: (); AND Intervention: (). The MeSH terms and full search strategies for each database are provided at Appendix 1. Three librarians based in the Faculty of Medicine at the University of Southampton reviewed the search strategy.

2.2.3. Study inclusion/ exclusion criteria

For a study to be included it needed to evaluate an intervention, comprising environmental changes, aimed at improving dietary intake and/or physical activity behaviours. Thus, complying with Hollands et al.'s[87] definition of an environmental intervention. Additionally, the intervention had to have been conducted within an institutional setting (e.g., military, ship, prison or oil rig), in a high-income economy as defined by the World Bank Group[119] and have targeted adults aged 18-64 years. Eligible interventions could include adults of any body composition, with or without identified risk factors or conditions. Interventions undertaken in universities were excluded as it was deemed that the nature of the environment and the population were dissimilar to that in the military.

2.2.4. Outcomes

Studies were included if they reported the effects of the intervention on behavioural measures of physical activity and dietary intake, or physiological measures associated with these behaviours. Primary outcomes were objective and subjective measures of physical activity and dietary intake behaviour (e.g., accelerometers and point of purchase analysis of food content; and self-reported physical activity and food diaries). Secondary outcomes were objective and subjective measures of changes in body composition indices (e.g., body weight, body mass index and body fat percentage).

2.2.5. Study selection process

All potentially relevant abstracts were imported into Endnote and duplicates were removed. The titles and abstracts of the remaining studies were screened by one review author (AS) and were scored as follows: 'positive' (if inclusion and exclusion criteria were certainly met); 'negative' (if inclusion and exclusion criteria were certainly not met); or 'unclear' (if the author was unsure, or if insufficient detail was provided in the abstract). The full text of articles scored as 'positive' or 'unclear' were retrieved and assessed for eligibility by two review authors (AS and EP). Discrepancies between the two authors were resolved through discussion with a third review author (SW). The reference lists of the included articles were manually searched for additional articles.

2.2.6. Study design

Data were included from controlled trials (with or without randomisation), before-and-after (BA) studies and cohort studies, where comparators could be other interventions or no treatment. Studies were categorised by study design using NICE guidelines[120].

2.2.7. Data extraction and risk of bias assessment

A standardised data extraction form was completed for all eligible studies. Data were recorded on study design, setting, intervention type, participant and intervention characteristics, study outcome measures and reported results. Depending on the study design, either the Cochrane Collaboration's risk of bias tool[121] or the risk of bias in non-randomised studies of interventions (ROBINS-I) tool[122] was used to assess potential biases in the included studies. The tools enabled the reviewers to systematically assess specified elements of the design, conduct, analysis and reporting of the studies in order to quantify the level of risk of bias that was present and may have affected the accuracy of the reported outcomes (see Tables 2.1 and 2.2 for an overview).

The template for intervention description and replication checklist (TIDieR)[123] was used to evaluate the quality of reporting of the interventions. The checklist has 12 items: (i) intervention name; (ii) intervention rationale; (iii) what was delivered; (iv) what procedures were used to deliver the intervention; (v) who provided the intervention; (vi) how the intervention was delivered; (vii) where the intervention occurred; (viii) when and how much of the intervention people were exposed to; (ix) planned tailoring of the intervention; (x) modifications to the intervention during the study; (xi) what the intended intervention delivery was; and (xii) intervention adherence and fidelity.

The typology of choice architecture interventions[87] was used to classify the types of environmental intervention. The typology summarises nine different types of environmental interventions according to those that alter the properties of objects or stimuli (ambience, functional design, labelling, presentation and sizing), those that alter the placement of objects or stimuli (availability and proximity), and those that alter both the properties and placement of objects or stimuli (priming and prompting) (Table 2.3).

The BCT taxonomy v1[124] was used to classify the types of BCTs that were employed in the interventions. The taxonomy comprises 93 distinct BCTs clustered into 16 groups: (i) goals and planning; (ii) feedback and monitoring; (iii) social support; (iv) shaping knowledge; (v) natural consequences; (vi) comparison of behaviour; (vii) associations; (viii) repetition and substitution; (ix) comparison of outcomes; (x) reward and threat; (xi) regulation; (xii) antecedents; (xiii) identity; (xiv) scheduled consequences; (xv) self-belief; and, (xvi) covert learning.

Table 2.1: Cochrane Collaboration's tool for assessing risk of bias[121].

Bias domain	Source of bias	Explanation
Selection bias	Random sequence generation	Selection bias due to inadequate generation of a randomised sequence
	Allocation concealment	Selection bias due to inadequate concealment of allocations before assignment
Performance bias	Blinding of participants and personnel	Performance bias due to knowledge of the allocated interventions by participants and personnel during the study
Detection bias	Blinding of outcome assessment	Detection bias due to knowledge of the allocated interventions by outcome assessment
Attrition bias	Incomplete outcome data	Attrition bias due to amount, nature, or handling of incomplete data
Reporting bias	Selective reporting	Reporting bias due to selective outcome reporting
Other bias	Anything else	Bias due to problems not covered elsewhere

Table 2.2: ROBINS-I tool for assessing risk of bias[122].

Bias domain	Source of bias	Explanation
Pre-Intervention: Bias due to confounding	Selection bias	When factors that predict the outcome of interest also predict the intervention received at baseline
Pre-Intervention: Bias in selection of participants into the study	Selection bias	When exclusion of some eligible participants, or the initial follow up time of some participants or some outcome events, is related to both intervention and outcome
At intervention: Bias in classification of interventions	Misclassification bias	Bias introduced by misclassification of intervention status
Post intervention: Bias due to deviations from intended interventions	Performance bias	Biases that arises when there are systematic differences between experimental intervention and comparator groups in the care provided, which represent a deviation from the intended intervention(s)
Post intervention: Bias due to missing data	Attrition bias	Biases that arises when later follow up is missing for individuals initially included and followed
Post intervention: Bias in measurement of outcomes	Detection bias	Bias introduced by either differential or non-differential errors in measurement of outcome data

Table 2.3: Typology of choice architecture interventions in micro-environments, adapted from Hollands et al.[87].

Intervention class	Intervention type
Primarily alter **properties** of objects or stimuli	**Ambience** – alter aesthetic or atmospheric aspects of the surrounding environment
	Functional design – design or adapt equipment or function of the environment
	Labelling – apply labeling or endorsement information to product or at point-of-choice
	Presentation – alter sensory qualities or visual design of the product
	Sizing – change size or quantity of the product
Primarily alter **placement** of objects or stimuli	**Availability** – add behavioural options within a given micro-environment
	Proximity – make behavioural options easier (or harder) to engage with, requiring reduced (or increased) effort
Alter both **properties and placement** of objects or stimuli	**Priming** – place incidental cues in the environment to influence a non-conscious behavioural response
	Prompting – use non-personalised information to promote or raise awareness of a behaviour

2.2.8. Data analysis

Meta-analysis was not possible due to the considerable heterogeneity in the design and quality of the studies, the types of interventions and outcomes measured. As such, a narrative summary is presented. Where possible, data were used to calculate and report standardised effect sizes for mean differences using a Campbell Collaboration calculator[125]. Effect sizes were used to quantify the size of the difference between two groups, such that the effectiveness of an intervention could be determined.

2.3 Results

2.3.1. Literature search

The search identified 27,842 potentially relevant articles. After the removal of duplicates, 24,130 articles remained. Of these 24,111 were excluded following screening the titles, abstracts or both against the study inclusion and exclusion criteria. After full-text assessment of the 19 remaining articles, eight articles were excluded because they did not meet one or more of the inclusion criteria. Checking the references of the 11 remaining articles produced no additional articles. Nine studies (reported in 11 articles) were included in the systematic review[126-136]. Figure 2.1 presents a flowchart of the study selection process.

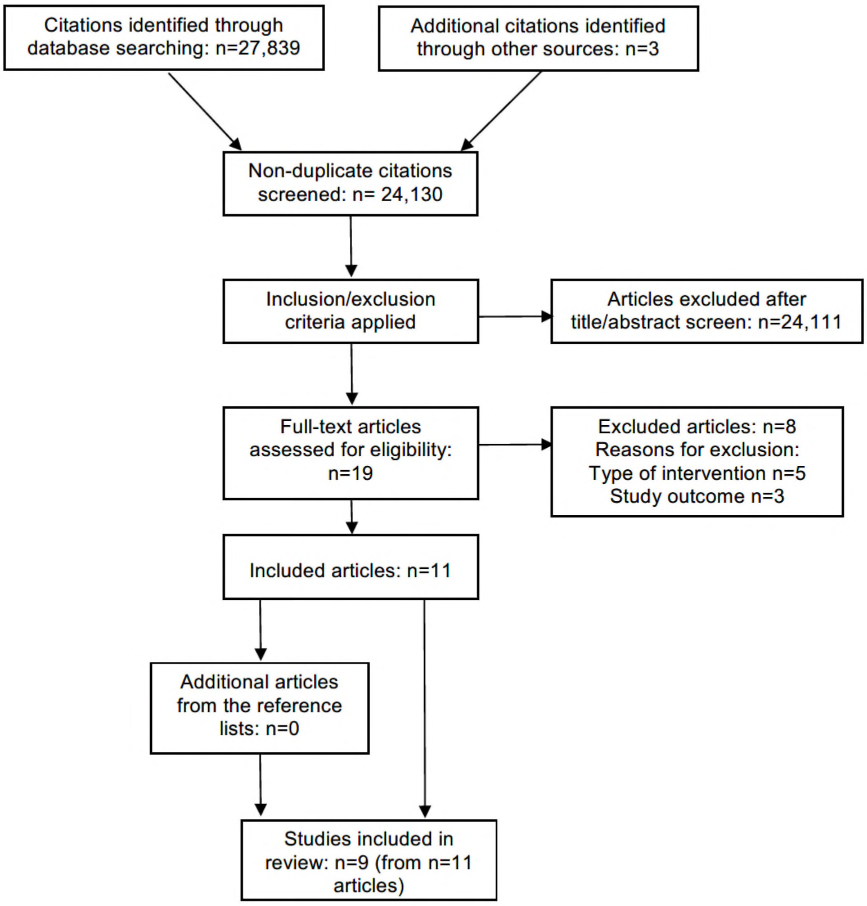

Figure 2.1: Flow chart of study selection process.

2.3.2. Study characteristics

Descriptions of the included studies are provided in Table 2.4. Studies were published between 1995 and 2016. Five studies were conducted in the United States of America (US)[126,128,129,132,136], two in Denmark[130,131,133], and one in both Finland[127] and Norway[134,135]. Eight settings were military bases[126-129,131-136] and one was a shipping company[130]. Study sizes ranged from 148 to 606 participants and from one to ten settings. Study designs ranged from one randomised controlled trial (RCT)[136], one cluster RCT[128], four non-RCT[126,127,129,134,135] and three BA studies[130-133].

2.3.3. Risk of bias

The risk of bias due to confounding of intervention effects (see Table 2.5 for an overview) was considered serious in two articles, moderate in four and low in three. Selection bias was considered moderate in four articles, low in five and unclear in two due to incomplete reporting. Allocation concealment, performance and detection bias were considered unclear due to incomplete reporting in the two articles assessed for these types of bias. Classification of interventions bias was considered low in the nine articles assessed. Deviation from intended intervention bias was considered serious in one article and low in eight. Attrition bias was considered serious in one article, moderate in five, low in four and unclear in one due to incomplete reporting. Outcome measurement bias was considered moderate in the nine articles assessed. Reporting bias, reflecting on whether the outcomes reported were pre-planned, was considered low in all of the articles. Risk of other bias not covered elsewhere was considered low in the two articles assessed.

2.3.4. Descriptions of the interventions

Of the nine interventions described in the 11 included articles, five were multi-level[127,128,130,131,133-135] and four included environmental changes only[126,129,132,136]. The most commonly used interventions were: making healthy changes to food content and/or options (n=7)[126-129,131,133-136]; introducing health promotion information and/or education (n=4)[127,128,132,134,135]; labelling food items (n=3)[126,128,132]; and introducing cooking courses for canteen staff (n=2)[130,131,133]. Only one intervention[130] attempted to improve fitness facilities, offer individual exercise guidance and offer individual health check-ups. Duration of follow-up ranged from three weeks to ten years across all studies.

According to Hollands et al's. typology (Table 2.6), eight interventions primarily altered the placement of objects or stimuli (n=8 availability (i.e. adding behavioural options within an environment[126-131,133-136])), four primarily altered the properties of objects or stimuli (n=3 labelling (i.e. applying labelling or endorsements information to product or at point of choice)[126,128,132] and n=1 presentation (i.e. altering sensory qualities or visual design of the product[131,133])) and one altered both the properties and placement of objects or stimuli through prompting (i.e. using non-personalised information to promote or raise awareness of a behaviour)[134,135].

The most frequently used BCT was restructuring the physical environment (n=8 (e.g., healthy changes to food options))[126-131,133-136], followed by using prompts/cues (n=3)[126,128,132] and using information about health consequences (n=2)[130,134,135]. Only one intervention used feedback on behaviour, biofeedback, feedback on outcome(s) of behaviour, social support, information on how to perform a behaviour and demonstration of behaviour[130].

2.3.5. Intervention reporting

According to the TIDieR checklist[123] (Table 2.7), all included articles: specified the name of the intervention; described the rationale; reported the procedures applied; described the mode of delivery; described the location in which the intervention occurred; and described the period over which the intervention was delivered, or the dose or intensity of the intervention. All articles except one described the materials used. Four out of the 11 articles did not adequately report who had delivered the intervention. Only one article reported whether the intervention was modified during the study, whether the intervention was tailored and the actual adherence/fidelity. None of the articles reported the planned strategies for ensuring adherence/fidelity.

2.3.6. Outcomes: effects of interventions

All nine interventions reported measures of dietary intake and one reported measures of physical activity. Dietary intake was measured objectively through sales data, digital photography/plate waste methods and weighed food intake in four interventions[126,128,131-133], and was based on self-reported data in five interventions[127,129,130,134-136]. Physical activity level was based on self-reported data[130]. Three of the nine interventions reported measures of body composition indices[129,130,136]. Two of these reported metabolic factors[129,130]. Other outcome measures reported included self-reported acceptability and satisfaction of changes (n=4)[126,128,135,136], physical fitness (n=2)[130,136] and nutrition knowledge (n=1)[134,135].

For the primary outcomes, the four interventions that measured energy and nutrient intake, reported significant positive effects. Effect sizes could be calculated for three interventions; Cohen's *d* ranged from 0.05 to 1.10 (no effect to a large-sized effect). Of the eight interventions that measured food intake and/or food selection quality, seven reported significant positive effects. Of these seven interventions one reported no effects on some measures[128] and one reported negative effects on some measures, including fruit intake[127]. Effect sizes could be calculated for three interventions; Cohen's *d* ranged from 0.11 to 1.42 (no effect to a large-sized effect). No significant effects were reported for the intervention that measured physical activity levels. For the secondary outcomes, none of the three interventions that measured body composition indices reported significant effects. Of the two interventions that measured metabolic factors, one reported a trend to support a more favourable lipid profile and one reported a significant reduction in participants with metabolic syndrome.

For the other outcomes, of the four interventions that measured self-reported satisfaction, two reported significant positive effects. Effect sizes could be calculated for one intervention; Cohen's *d* was 0.19 (no effect). One out of the two interventions that measured physical fitness reported a significant positive effect, and a significant positive effect was reported in the one intervention that measured nutrition knowledge. Effect sizes could not be calculated for these measures.

Of the three interventions that applied labelling to foods at the point of choice[126,128,132], two reported significant positive effects on energy and nutrient intakes (effect sizes d = 0.05-0.65, no effect to medium sized effect), food intake and/or food selection quality (effect sizes d = 0.11-1.42, no effect to large-sized effect) and self-reported satisfaction (effect size d = 0.19 (one intervention), no effect). One of the three interventions reported no significant effects on some measures of food intake[128]. There were no differences in the sales of targeted entrees in the intervention by Sproul et al.[132], with 79% of respondents reporting that the materials did not influence their food selection.

The one intervention that improved the presentation of healthier food options[131,133] reported significant positive effects on food intake (effect size d = 1.40, large-sized effect). The one intervention that used prompting[134,135] reported significant positive effects on food intake and nutrition knowledge (no effect size calculated), but no changes in self-reported satisfaction.

Table 2.4: Summary of included studies.

Study	Design	Setting	Sample	Intervention type	Intervention	Follow-up time	Main outcome measure(s)	Major findings
Belanger and Kwon (2016)[126]	Non-RCT	1 DFAC at 1 Army base, US	CTL: $n_{surveys}$=154, n_{photos}135 INT: $n_{surveys}$=131, n_{photos}=124	Environmental	Healthy changes to food content and options; food items labelled	3 weeks	Energy and nutrient intakes	Decreased: EI (*P*<0.001, *d*=-0.65), % energy from fat (*P*<0.001, *d* = -0.46), % energy from saturated fat (*P*<0.01, *d* = -0.44) Increased: % energy from CHO (*P*<0.05, *d* = 0.26), Na intake (*P*<0.001, *d* = -0.58)
							Food selection quality	Decreased: number of red-labelled items selected (*P*<0.001, *d* = -1.42) Increased: number of green-labelled items selected (*P*<0.001, *d* = 1.02)
							Number of healthy options	22% less meals labelled red, 20% more meals labelled green
							Self-reported satisfaction and meal acceptability	Increase in food appeal (*P*<0.05, *d* = -0.19)
Fiedler et al. (1999)[136]	RCT	1 Air Force base, US	INT, n=402; CTL n=422	Environmental	Healthy changes to food content	6 weeks	Self-reported: food and nutrient intake; DQI	At FU: larger improvement in DQI for INT *v.* CTL, % energy from fat was lower for INT *v.* CTL, daily servings of CHO increased for INT and decreased for CTL, F&V intake decreased for both groups, no change in protein intake for INT but a 20% reduction for CTL
							Cost-effectiveness	New menus were 20% more expensive and not within allowance
							Self-reported satisfaction	No differences between groups
							Body weight	No differences between groups
							Physical fitness	No differences between groups
Friedl et al. (1995)[129]	Non-RCT	1 military academy, US	INT, n=205; CTL n=190	Environmental	Healthy changes to food content and options	10 years	Self-reported: energy and nutrient intakes	Decreased: EI in male cadets (*P*<0.05, *d* = 0.25); fat intake (*P*<0.01, *d* = 1.1); % energy from fat and alcohol Increased: CHO intake (*P*<0.01, *d* = -0.50 males, *d* = -0.57 females); % energy from CHO; number of cadets deriving <35% of their EI from fat No change: protein intake
							Metabolic factors	Trend to support a more favourable lipid profile
							Body fat	No changes
Sproul et al. (2003)[132]	BA	1 Army base, US	n=149	Environmental	Food items labelled; health promotion information	5 weeks	Sales data	No differences in sales of targeted entrees; 60% of respondents reported noticing the promotional materials
							Meal selection decisions and attitudes towards nutrition	79% of respondents reported that the materials did not influence their meal selection decisions; 75% reported that the materials did not influence their attitude about nutrition for the better

Note: INT, intervention; CTL, control; B, baseline; 6M, 6 months; 12M, 12 months; FU, follow-up; DFAC, Dining facility; DQI, dietary quality index; EI, energy intake; CHO, carbohydrates; Na, sodium; F&V, fruit and vegetables.

Table 2.4: Summary of included studies continued.

Study	Design	Setting	Sample	Intervention type	Intervention	Follow-up time	Main outcome measure(s)	Major findings
Bingham et al. (2012)[127]	Non-RCT	2 garrisons, Finland	INT n=362; CTL n=242	Multi-level	Healthy changes to food content and options; health promotion information introduced	8 weeks	Self-reported food intake	At FU: INT had a lower F&V index (IE: *P*<0.01, *d* = 0.48, TE: *P*<0.01), fruit and berries intake (IE: *P*<0.001, *d* = 0.51) and fat index (IE: *P*<0.01, *d* = 0.39) *v.* CTL At FU: INT had a higher porridge and cereal intake (IE: *P*<0.01, *d* = 0.11) *v.* CTL At FU *v.* B: increase in potato chip (IE: *P*<0.05, *d* = 0.30, TE: *P*<0.001), soft drink (IE: *P*<0.05, *d* = 0.25, TE: *P*<0.05) and dessert (IE: *P*<0.01, *d* = 0.54, TE: *P*<0.01) intake was higher in CTL *v.* INT
Crombie et al. (2013)[128]	Cluster RCT	10 DFACs at 1 Army base, US	INT: B n=341; 6M n=254; 12M n=276 CTL: B n=296; 6M n=301; 12M n=286	Multi-level	Healthy changes to food content and options; food items labelled; health promotion information and education introduced	12 months	Energy and nutrient intake	At 6M FU: INT had lower EI (*P*<0.01, *d* = 0.32), total fat (*P*<0.01, *d* = 0.40), % energy from fat (*P*<0.01, *d* = 0.38) and saturated fat (*P*<0.01, *d* = 0.44) and higher % energy from CHO (*P*<0.01, *d* = 0.41) *v.* CTL At 12M FU: INT had higher intakes of % energy from CHO (*P*<0.01, *d* = 0.05) and lower % energy from protein (*P*<0.01, *d* = 0.46) *v.* CTL INT at 6M and 12M FU *v.* B: EI, total fat and % energy from fat were lower and % energy from CHO was higher (*P*<0.01)
							Food selection quality	At FU: INT had lower intake of refined grains (*P*<0.01, *d* = 0.11) *v.* CTL, no differences in intakes of whole grains or F&V, INT had lower refined grains intake *v.* B
							Self-reported satisfaction and meal acceptability	Customer satisfaction significantly higher for INT *v.* CTL
Hjarnoe and Leppin (2013)[130]	BA	2 shipping companies, Denmark	n=606	Multi-level	Cooking course for chefs; improved fitness facilities; individual exercise guidance; individual health check ups	1 year	Self-reported exercise level	No changes
							Self-reported overeating frequency	No changes
							Self-reported high sugar product intake	Decreased % of participants reporting frequent intake of high-sugar products (*P*<0.05)
							Waist circumference	No changes
							Physical fitness	Increase in % of participants with a high fitness score (*P*<0.001)
							Metabolic syndrome	Reduction in participants with metabolic syndrome (*P*<0.05)
							Fidelity	30% received exercise guidance (37% received FU guidance); 54% received extra health check; 75% of chefs attended cooking course; 64% of ships requested fitness facility upgrade (70% reported improvements)

Note: INT, intervention; CTL, control; B, baseline; 6M, 6 months; 12M, 12 months; FU, follow-up; DFAC, Dining facility; F&V, fruit and vegetables; EI, energy intake; CHO, carbohydrates; IE, intervention effect; TE, time effect.

Table 2.4: Summary of included studies continued.

Study	Design	Setting	Sample	Intervention type	Intervention	Follow-up time	Main outcome measure(s)	Major findings
Lassen et al. (2004)[131]	BA	1 military base, Denmark	n=190	Multi-level	Cooking and health promotion course for canteen staff; healthy changes to food content and options	8 months	F&V consumption	Increase in daily consumption of F&V (*P*<0.001, *d* = -1.4)
							F&V content of meals	Increase in F&V content of the hot meal (*P*<0.001, *d* = -1.97)
Thorsen et al. (2010)[133]	BA	1 military base, Denmark	n=148	Multi-level	Cooking and health promotion course for canteen staff; healthy changes to food content and options	5 years	F&V consumption	Compared with 8 month FU: decrease in daily consumption of F&V (*P*<0.05) Compared with B: no changes
Uglem et al. (2014)[134]	Non-RCT	2 military camps, Norway	INT, n=374; CTL, n=105	Multi-level	Healthy changes to food content and options; health promotion materials and information introduced	5 months	Self-reported food intake	At FU: higher intake of vegetables, fruits and semi-wholegrain bread for INT *v.* CTL (*P*<0.05) INT at FU: groups with a low and medium intake at B had a higher intake of vegetables, fruits and semi-wholegrain bread (*P*<0.001); the lowest group had the highest % increase; no change in high intake group CTL at FU: group with a low intake at B had a higher intake of vegetables, fruits and semi-wholegrain bread (*P*<0.05); no change in medium intake group; reduction in high intake group (*P*<0.001)
							Nutritional knowledge	At FU: INT increased knowledge (*P*<0.001); INT had higher knowledge *v.* CTL (*P*<0.001)
Uglem et al. (2013)[135]	Non-RCT	2 military camps, Norway	INT, n=374; CTL, n=105	Multi-level	Healthy changes to food content and options; health promotion materials and information introduced	5 months	Self-reported food intake	At FU in INT group: increase in vegetable (*P*<0.001), fruit (*P*<0.05) and semi-wholegrain bread (*P*<0.001) and decrease in potato (*P*<0.001) intake; reduction of recruits consuming <150 g vegetables (*P*<0.001) At FU in CTL group: no change in vegetable or semi-wholegrain bread intake, decrease in fruit (*P*<0.05) and potato (*P*<0.001) intake; no change in frequency of recruits consuming <150 g vegetables At FU INT *v.* CTL: vegetable, fruit and semi-wholegrain bread intakes were higher (*P*<0.001); potato intake was lower (*P*<0.001)
							Nutritional knowledge	At FU: INT increased knowledge (*P*<0.001); CTL no change
							Self-reported satisfaction	No significant differences between groups

Note: INT, intervention; CTL, control; B, baseline; 6M, 6 months; 12M, 12 months; FU, follow-up; F&V, fruit and vegetables.

Table 2.5: Risk of bias in included studies.

Study	Confounding bias	Selection bias	Allocation concealment bias	Classification of interventions bias	Deviations from intended interventions bias	Performance bias	Detection bias	Attrition bias	Outcome measurement bias	Reporting bias	Other bias
Belanger and Kwon (2016)[126]	Moderate	Low	n/a	Low	Low	n/a	n/a	Moderate	Moderate	Low	n/a
Fiedler et al. (1999)[136]*	n/a	Unclear	Unclear	n/a	n/a	Unclear	Unclear	Low	n/a	Low	Low
Friedl et al. (1995)[129]	Moderate	Moderate	n/a	Low	Low	n/a	n/a	Moderate	Moderate	Low	n/a
Sproul et al. (2003)[132]	Moderate	Low	n/a	Low	Low	n/a	n/a	Moderate	Moderate	Low	n/a
Bingham et al. (2012)[127]	Low	Low	n/a	Low	Low	n/a	n/a	Unclear	Moderate	Low	n/a
Crombie et al. (2013)[128]*	n/a	Unclear	Unclear	n/a	n/a	Unclear	Unclear	Low	n/a	Low	Low
Hjarnoe and Leppin (2013)[130]	Serious	Moderate	n/a	Low	Serious	n/a	n/a	Serious	Moderate	Low	n/a
Lassen et al. (2004)[131,133]	Serious	Low	n/a	Low	Low	n/a	n/a	Low	Moderate	Low	n/a
Thorsen et al. (2010)[131,133]	Moderate	Low	n/a	Low	Low	n/a	n/a	Low	Moderate	Low	n/a
Uglem et al. (2014)[134,135]	Low	Moderate	n/a	Low	Low	n/a	n/a	Moderate	Moderate	Low	n/a
Uglem et al. (2013)[134,135]	Low	Moderate	n/a	Low	Low	n/a	n/a	Moderate	Moderate	Low	n/a

Note: n/a, not applicable for type of study; risk of bias assessed using ROBINS-I tool, except where noted otherwise; * risk of bias assessed using Cochrane Collaboration's risk of bias tool.

Table 2.6: Classification of included studies according to the emergent typology of choice architecture interventions[87].

Study	Coding of included studies by intervention type								
	Alter properties					Alter placement		Alter both properties and placement	
	Ambience	Functional design	Labelling	Presentation	Sizing	Availability	Proximity	Priming	Prompting
Belanger and Kwon (2016)[126]	N	N	Y	N	N	Y	N	N	N
Fiedler et al. (1999)[136]	N	N	N	N	N	Y	N	N	N
Friedl et al. (1995)[129]	N	N	N	N	N	Y	N	N	N
Sproul et al. (2003) [132]	N	N	Y	N	N	N	N	N	N
Bingham et al. (2012)[127]	N	N	N	N	N	Y	N	N	N
Crombie et al. (2013)[128]	N	N	Y	N	N	Y	N	N	N
Hjarnoe and Leppin (2013)[130]	N	N	N	N	N	Y	N	N	N
Lassen et al. (2004) and Thorsen et al. (2010)[131,133]	N	N	N	Y	N	Y	N	N	N
Uglem et al. (2013 and 2014)[134,135]	N	N	N	N	N	Y	N	N	Y

Note: N, absence of intervention type; Y, presence of intervention type.

Table 2.7: Coding of included articles against TIDieR criteria[123].

Study	Brief name	Why	What: Materials	What: Procedures	Who provided	How	Where	When and how much	Tailoring	Modifications	How well: Planned	How well: Actual
Belanger and Kwon (2016)[126]	82	83	84	84	84	84	83	84	X	X	X	X
Fiedler et al. (1999)[136]	155	155	156	156, 158	156, 158	156,158	155-6	156	X	158	X	X
Friedl et al. (1995)[129]	527	527	527	527	X	527	527	527	X	X	X	X
Sproul et al. (2003)[132]	557	557	557	557	557	557	557	557	X	X	X	X
Bingham et al. (2012)[127]	2	2	4	3-4	X	3-4	2	4	X	X	X	X
Crombie et al. (2013)[128]	921	921	922-3	922-4	923	922-4	921	921	X	X	X	X
Hjarnoe and Leppin (2013)[130]	5	2	5	5	5	5	3	5	X	X	X	7, 8
Lassen et al. (2004)[131]	264	264	264, 267	264, 267	X	267	264	264	264	X	X	X
Thorsen et al. (2010)[133]	1647	1647	X	1648	X	1648	1648	1648	X	X	X	X
Uglem et al. (2014)[134]	1013	1013	1015	1015	1015	1015	1013	1014	X	X	X	X
Uglem et al. (2013)[135]	2	2	2-4	2-4	2, 3	2-4	2	2	X	X	X	X

Note: X, no information provided; number indicates article page number.

2.4 Discussion

The aim of this review was to systematically examine the effectiveness of interventions, which included environmental strategies and intervention activities, aimed at improving the dietary and physical activity behaviours of adults in institutions. The evidence base appears to be in favour of implementing environmental-based interventions in institutions to improve the dietary behaviours of adults. However, it was difficult to draw conclusions concerning the effectiveness of environmental-based interventions on improving physical activity behaviours or body composition indices, or to make clear recommendations about the content and delivery of interventions, due to the small number of studies and the variable methodological quality of the studies and interventions included in the review.

Across the nine interventions included, eight showed significant positive effects on dietary behaviours. Reported effects included: decreased EI; decreased percentage energy from fat and saturated fat, and increased percentage energy from carbohydrates; positive changes in the number of red- and green-labelled items purchased; reductions in the proportion of participants reporting frequent intakes of high-sugar products; and, increases in fruit and/or vegetable consumption. Effect sizes could not be calculated for all the studies. Where they could be calculated, there was considerable variation between and within studies, with effect sizes ranging from no effect to large-sized effects. Only one of the nine interventions used strategies to improve physical activity levels[130]. There was a significant positive effect on physical fitness but no effect on self-reported activity levels. A possible reason for the lack of effectiveness was poor fidelity: less than half of the ships included in the study reported actual improvements in fitness facilities; and less than a third of participants reporting receiving exercise guidance.

No evidence was identified that the interventions included in the review resulted in significant positive changes in body composition indices, although this was measured in only one-third of the studies. A possible explanation for this is that extensive lifestyle changes are required to affect body composition. Compensatory behaviours (e.g., dietary intake at the evening meal) were not measured in any of the included studies. Thus, although the interventions improved the dietary behaviours of participants during the meal times assessed, it was unknown whether this led to compensatory behaviours at other meals or between meals (e.g., snacking behaviour).

Similar to the findings reported by Allan et al.[112], the types of interventions most commonly employed were increasing the availability of healthier options and food labelling. Only one intervention altered the presentation of foods on offer, and one introduced prompts to the environment. The interventions in the review contained between one and five different components. Four interventions targeted the environment only, and five targeted multiple levels of the social system. This made it difficult to identify precisely what worked and for whom. As positive effects on dietary behaviours were reported in eight out of nine of the interventions, it could be assumed that all types of environmental-based strategies and interventions applied across the interventions were successful to some degree and that, potentially, it was the multi-level and multi-component nature of the interventions that was successful.

In the study that reported no significant positive effects[132], labelling and health promotion information focusing on health attributes were used unsuccessfully to increase sales of healthier meal options. The authors suggested that a better approach would have been to highlight the sensory attributes of healthier foods such as taste and quality. In contrast, two other interventions included in the review that used point-of-purchase labelling reported positive effects. These interventions used multiple environmental strategies. As such, it could not be determined whether food labelling *per se* was a successful intervention activity.

To determine the duration of beneficial effects after an intervention has ended, long-term follow-up studies are required[101,137]. The duration of follow-up in the studies included in the present review ranged from three weeks to ten years, with less than half of the studies incorporating follow-up times of one year or longer. In the studies by Thorsen et al.[133] and Lassen et al.[131] there was a failure to sustain the increase in fruit and vegetable intake that was achieved at the first follow-up point (five months) at the second follow-up point (five years). However, the study by Friedl et al.[129], which included a follow-up at ten years, reported improvements in EI and percentage EI from fat, carbohydrates and alcohol at the follow-up. This suggests that a long-term follow-up does not necessarily result in negative findings.

2.4.1. Comparison with other reviews

The findings from the present systematic review are broadly comparable with those of other reviews undertaken in a workplace setting. The present and previous reviews have reported that health promotion interventions that include environmental strategies have a positive effect on dietary behaviours[88,92-95,101,102,106,112]. As in the present review, Engbers et al.[102] reported inconclusive evidence for an effect on physical activity, whereas other reviews[93,94,101] have reported that multi-component interventions incorporating individual-level and environmental strategies improved physical activity behaviours. Similar to the present review, the reviews undertaken by Allan et al.[112] and Engbers et al.[102] reported little evidence that health promotion interventions have an effect on body composition indices. Conversely, other reviews have reported that interventions achieved modest improvements in weight status, which might be explained by these reviews including studies where change in weight was a primary outcome[93,103,104].

The most commonly used environmental strategies were increasing the availability of healthier options and food labelling. This was also the case in the review undertaken by Allan et al.[112]. Due to the numerous strategies that were employed by the interventions in the present review, it is difficult to identify precisely what worked and for whom. Previous reviews have also reported that it is difficult to determine the effective components of interventions and suggest that interventions should be multi-level and multi-component[88,93,101,102,104,112].

2.4.2. Methodological quality of studies

The quality assessment indicated several common methodological limitations across the studies, which were common to previous workplace reviews[88,92,101,102,106,112]. Only two out of the nine studies employed a randomised or cluster-randomised controlled design. A possible explanation is that the studies were conducted in institutions, where organisational and logistical issues may have compromised the strength of the research design. A particular cause for concern was the use of self-reported methods of outcome measurement, where five out of the nine studies used self-reported measures of behaviour. This may have caused recall or reporting bias and resulted in no blinding of the outcome assessment. Other issues with using self-report methods to measure dietary and physical activity behaviours are that it takes time and effort to complete diaries, which may be an intervention in itself (self-monitoring) and may therefore obscure the impact of the intervention. Although physical activity can be measured using objective methods (e.g., using accelerometers) it is difficult to objectively assess dietary behaviours in free-living individuals. Thus, it is important that future research uses valid and reliable methods to assess dietary and physical activity behaviours and, where possible, uses these in combination with objective measures.

Other limitations of the studies include the: lack of concealed intervention allocation; lack of assessment of compensatory behaviours; variable reporting quality including insufficient reporting of effect sizes (or data to allow their calculation); and, the absence of intention-to-treat analyses, which may have led to the under- or over-estimation of effects. There were also sampling limitations and the lack of use of validated questionnaires in some of the studies. Generalisation of the findings to a RN ship is limited by the fact that all the studies were conducted in the US or Northern European countries and only one was undertaken in the maritime environment. Thus, highlighting the need for further well-designed evaluation studies.

The impact of an intervention is maximised when attrition is low. In this review there was considerable variation in attrition bias between the included studies. It is important that strategies are identified to sustain participant involvement. This could be achieved by exploring the feasibility and acceptance of interventions and including some involvement from the target population during the development of the intervention, which was the case in three of the studies included in the review. In the study reported by Bingham et al.[127] guided workshops were undertaken with a purposive sample of target users and intervention deliverers during the intervention planning to develop an action plan for implementing the intervention and to assess feasibility. Furthermore, in the study reported by Lassen et al.[131] and Thorsen et al.[133] a purposive sample of target users and intervention deliverers were involved in the development and implementation of the intervention. However, neither of these studies reported the findings from this qualitative research. Finally, in the study reported by Friedl et al.[129] potential recipes were trialled by target users. The remainder of the studies included in the review did not report that intervention acceptability was assessed, nor did these studies identify the lack of this qualitative research as a limitation of the methods. Self-reported satisfaction was measured in two out of five of the studies that were classified as having a moderate to serious risk of attrition bias. In one study there was no effect of the intervention on satisfaction[134,135] and in the other study food appeal rating increased after the intervention[126], suggesting that attrition was not a result of the intervention itself.

One notable finding from the coding of the interventions against TIDieR guideline recommendations was that the majority of studies failed to report planned or actual strategies to assess adherence or fidelity. Fidelity is an important component of programme evaluation, which enables researchers and practitioners to understand how and why an intervention works, and the extent to which outcomes can be improved. This finding further highlights the need for additional well-designed intervention studies.

2.4.3. Limitations of the review

Limitations of the present review should be taken into account when interpreting the findings. First, the literature search was limited to articles published in the English language, which might have resulted in relevant studies published in other languages being missed. Second, it is possible that the search did not identify all published studies, which might have resulted in selection bias. However, this was minimised by reviewing the reference lists of the articles retrieved in the search. Third, the search strategy focused on a defined list of institutions (military, prisons, ships and offshore). Thus, studies from other institutions not included in the search strategy (e.g., universities) might have been relevant. A fourth issue that should be considered is publication bias due to selective publishing of studies demonstrating positive outcomes. A funnel plot could not be used to assess the potential role of publication bias due to the studies either not reporting effect sizes or providing enough information to allow for them to be calculated for all measured variables. A further limitation of the present review was that the heterogeneity of design, interventions and outcome measures negated a quantitative synthesis of results by meta-analysis. Finally, due to the inclusion of the search term "marine" a considerable number of citations were identified which focused on ocean life. However, it was decided to keep the search term in so not to introduce bias into the search strategy by potentially not identifying interventions targeting amphibious fighting forces (e.g., RM).

2.4.4. Conclusion

In conclusion, the evidence presented in this systematic review appears to be in favour of implementing environmental-based interventions in institutions to improve the dietary behaviours of adults. However, due to the multi-level and multi-component nature of the intervention studies, it was difficult to determine which strategies and intervention activities were successful and which were not. Environmental-based strategies that were typically employed targeted: reducing barriers; increasing opportunities for and accessibility of healthy choices; restricting the availability of less healthy options; and increasing cues to healthy behaviour.

It was difficult to draw conclusions concerning the effectiveness of environmental-based interventions at improving the physical activity behaviours or the body composition indices in institutions, or to make clear recommendations about the content and delivery of environmental-based interventions. This was due to the small number of studies included in the review and the variable methodological quality of the studies and intervention reporting. The findings highlight that further well-designed evaluation studies are required.

The findings suggest that the "healthy lifestyle intervention" should combine multi-level and multi-component strategies through taking a socio-ecological approach. Although none of the studies included in the present review fully adopted a WSA (see section 1.4), five of the nine studies followed a socio-ecological approach, which is the theory-based framework forming the basis of a WSA. Furthermore, several of the studies included some of the key features of a WSA[68] including: capacity building[126-128,130,131,133-136]; creativity and innovation[127,136]; engagement[127,128,130]; and, communication[127,131,133]. Thus, reinforcing the aims of the present research programme to evaluate whether a WSA could be taken to create a healthier environment onboard a RN ship.

To improve the effectiveness of the intervention it will be necessary to: determine the specific need for a healthy lifestyle intervention in the RN and where actions should be targeted; explore the feasibility and acceptance of intervention strategies by including involvement from the target population during the development phase; and to ascertain whether the nutrition and physical activity environments onboard RN vessels are conducive to healthy living and identify where improvements can be made. These factors will be considered in Chapters 3, 4 and 5, respectively. Finally, the findings from the present review highlight the importance that robust methods are used to evaluate the intervention, the methods of which will be discussed in Chapter 6.

3. Prevalence of obesity, health behaviours and motives for food choice in the Royal Navy

3.1 Introduction

This Chapter presents a cross-sectional study to assess the prevalence of overweight and obesity and the health behaviours of RN personnel to identify the need for a healthy lifestyle intervention and where actions should be targeted. The findings were used to inform the development of the healthy lifestyle intervention outlined in Chapter 6.

In the maritime setting the problem of overweight and obesity is not unique to the UK RN. Studies have reported that the prevalence of overweight and obesity of seafarers working onboard merchant Italian, Filipino, Indian, Danish and UK ships was over 50%, 37%, 52%, 75% and 75%, respectively[138,139]. Furthermore, overweight and obesity are also of concern to other nation's military Naval populations, including the US and Malaysia where the combined prevalence of overweight and obesity has been reported to be 65% and 36%, respectively[140,141]. Moreover, overweight and obesity are also a problem to the other UK Armed Forces Services, where in 2011 the combined prevalence of overweight and obesity in the British Army was reported to be 57%[142], and in 2007 the combined prevalence in the UK Royal Air Force was reported to be 56%[36].

A limitation to the assessment of obesity based on BMI is that it is not able to differentiate between fat mass and fat-free mass[39]. In the military a high BMI may correspond to an increase in fat-free mass, but not fat mass, which may lead to the misclassification of non-obese individuals[143,144]. As such, NICE recommend that the assessment of the health risks associated with overweight and obesity in adults should be based on BMI in combination with waist circumference[145], where waist circumference provides an indication of abdominal obesity. In 2011, Bennett et al., reported that 25% and 33% of male and female RN personnel, respectively, were classified as being at risk of obesity-related diseases according to the NICE guidelines (see Table 3.1)[31]; however, as described previously this study used self-report data. In summary, due to limitations in the design and data collection methods of previous studies the full scale of the obesity problem in the RN is presently unknown.

The health[41], economic[48] and occupational[43,47] risks that obesity poses to the RN are of concern. These factors will likely result in a reduction in the numbers of RN personnel fit to deploy[42], which may impact on operational capability. Thus, it is imperative that measures are taken to reduce the prevalence of overweight and obesity among RN personnel. To develop strategies to tackle obesity, it is necessary to understand the key determinants of obesity. Unhealthy diets and physical inactivity have been identified as major contributing factors for overweight and obesity[22,23]. Dietary risk factors include: diets high in fat and low in fibre; diets high in energy dense foods; and the consumption of drinks that are high in sugar[146]. Similar to national surveys[16,17], data gathered on operations at sea highlighted that the nutritional intakes of RN personnel were less than optimal in terms of macro-nutrient proportions and were not consistent with the government's healthy eating guidelines[18,19]. The mean fat and salt intakes of study participants were higher[18,19], and the mean carbohydrate, fruit and vegetable, and milk and dairy product intakes were lower than national guidelines[18-21]. Furthermore, there was considerable variation in the self-reported frequency of structured physical training amongst participants, ranging between 0 to 15 sessions per week[18,19]. There is currently no research that has explored the sedentary behaviours of RN personnel.

Numerous factors interact to influence an individual's food choice decisions, including: sensory, physiological, psychological, economic, social, cultural and environmental determinants[13,147,148]. Understanding these factors may help inform interventions to improve dietary behaviours and hence tackle obesity. There is presently no contemporary research investigating dietary behaviours and motives for food choice in the UK Armed Forces. Research from the US Army has described that environmental variables, such as time and food availability, may have a disproportionately greater effect on food choices and food consumption when in a military setting[149]. Food accessibility and availability in the UK RN is different compared with the civilian population, especially during training and whilst deployed at sea, when both food accessibility and availability are constrained by the environment. Thus, it is likely that the motives for food choice of RN personnel are different to the civilian population.

3.1.1 Aims

To inform interventions to address the issue of obesity in the RN this study aimed to assess the health status of RN personnel to identify the need for a healthy lifestyle intervention and where actions should be targeted.

The objectives of the study were to:

i. Determine the prevalence of overweight and obesity among RN personnel;
ii. Investigate differences in obesity prevalence based on demographic characteristics;
iii. Assess dietary intake, physical activity levels, alcohol intake, smoking behaviours and the motives for food choice of RN personnel; and
iv. Investigate differences in health behaviours and food choice motives based on demographic characteristics and NICE risk classification.

The study was part of a wider programme of work commissioned by the Surgeon General to examine nutrition for the UK Armed Forces[150].

3.2 Methods

3.2.1. Study design

This cross-sectional study was approved by the MOD Research Ethics Committee (MODREC, 281/GEN/11) and complied with the Declaration of Helsinki[151].

3.2.2. Recruitment

The study intended to be representative of the whole of the RN. It was advertised at all RN land establishments and air stations in the South and South West of England and onboard two ships using daily and weekly orders between May 2012 and January 2013. On the day of data collection a project brief was delivered to the volunteers, which included a full description of the study. It was explained that participation was voluntary and personnel did not need to provide a reason if they chose not to participate. There was an opportunity for personnel to ask questions of the project team, either in the group or in private. Written informed consent was obtained from all participants before data collection commenced.

3.2.3. Participants

A stratified convenience sample of 600 RN personnel (males 52%, females 48%), median (interquartile range, IQR) age 27 (23-35) years volunteered to participate in the study. The study sample was stratified for rank and age according to the Armed Forces manning report[152], and consisted of 132 Officers (22%), 111 SR (19%) and 357 JR (60%). The sample size was determined according to the equation proposed by Green[153], where a minimum of 530 participants were required to be measured to contribute to a regression model consisting of 60 variables, with an alpha value of 0.05 and a power of 0.80. Participants were recruited from 13 land bases, two ships and two air stations: BRNC Dartmouth, Commando Training Centre RM Lympstone, HMNB Devonport, HMNB Portsmouth, HMS Collingwood, HMS Drake, HMS Excellent, HMS Nelson, HMS Raleigh, HMS Sultan, HMS Temeraire, the INM, MOD Hospital Unit Derriford, HMS Daring, HMS Illustrious, RNAS Culdrose and RNAS Yeovilton.

3.2.4. Procedures

Participants had their height, body weight and waist circumference measured by the author at one time point:

- *Height*: Participants removed their shoes/boots before standing on the stadiometer (Invicta, Leicester, England) with feet together. Feet, buttocks and scapulae were in contact with the back of the stadiometer with the head positioned in the Frankfort plane. One measurement was taken with participants stretching to the maximum height. Height was measured to the nearest 0.1 cm.

- *Body Weight*: Participants were weighed in shorts and t-shirt (Seca, Hamburg, Germany). The measurement was taken twice and was recorded to the nearest 0.1 kg. The mean of the two measurements was used for analysis.
- *BMI*: This was calculated by dividing body weight (kg) by height (m) squared: BMI = (body weight, kg) ÷ (height, m^2).
- *Waist Circumference*: Girth was measured at the mid-point between the upper margin of the iliac crest and the lower rib using a Lufkin metal tape (Rabone Chesterman, England). The measurement was taken twice, using the same tape, and was recorded to the nearest 0.1 cm. A third measurement was taken if the difference between the first two measurements was greater than 1 cm. The mean of the two closest measurements was used for analysis.
- *NICE Risk Classification:* Risk of obesity related ill health, as determined by BMI and waist circumference measurement, was classified according to the NICE classifications[145] (Table 3.1). Participants were classified into one of four categories: no increased risk, increased risk, high risk or very high risk.

Table 3.1: NICE obesity risk classifications[145].

BMI		**Waist circumference**		
kg/m^2	**Classification[39]**	**Low** Men <94 cm Women <80 cm	**High** Men 94-101.9 cm Women 80-87.9 cm	**Very high** Men ≥102 cm Women ≥88 cm
<18.5	Underweight	Increased risk		
18.5-24.9	Healthy weight	No increased risk		
25.0-29.9	Overweight	No increased risk	Increased risk	High risk
30.0-34.9	Obese class I	Increased risk	High risk	Very High risk
≥35.0	Obese class II and III	Very high risk		

In previously published work[154], the intra-rater test-retest reliability of the author's measurement of height and waist circumference was determined. Using a non-randomised repeated measures within subjects design the height and waist circumference of 10 participants (n=5 males; n=5 females) was measured on two occasions at the same time of day. The participants were selected from a subset of the main study participant population. The findings from the study demonstrated that the author measured height and waist circumference reliably. The intraclass correlation coefficient values were very high (height 1.00; waist circumference 1.00) and the standard error of the measurement values were small, indicating minimal random error and high precision of the measurements.

Participants completed a short demographics questionnaire (Appendix 2), a food frequency questionnaire (FFQ, Appendix 3), and questionnaires to assess physical activity levels (Appendix 4)[155], smoking and drinking behaviours (Appendix 5)[156], and motives for food choice (FCQ, Appendix 6)[157].

The FFQ was developed specifically for the study (see Appendix 7) and asked individuals to consider their average use of 40 food items over the past six months. There were also additional dietary questions concerning milk and added sugar consumption. The average number of servings for the 40 different foods consumed per day was calculated by converting the reported frequencies according to the following formula[158]: never or less than once per month = 0, 1-3 per month = 0.07, once a week = 0.14, 2-4 per week = 0.43, 5-6 per week = 0.80, once a day = 1.0, 2-3 per day = 2.5, 4-6 per day = 4.5, six or more per day = 6.0. The results from the study described in Appendix 7 suggest that the FFQ has good reproducibility. However, the questionnaire was not validated against a different dietary assessment method (e.g., weighed food intake).

The FCQ assessed the relative importance of a range of motivating factors on an individual's food choice. The questionnaire asked participants to endorse the statement *"it is important to me that the food that I eat on a typical day..."* for 36-items by choosing between four responses scored one to four: (i) not at all important, (ii) a little important, (iii) moderately important, and (iv) very important (Appendix 6). The questionnaire was found to have satisfactory test-retest reliability over a two to three week period and the internal consistency of factors was high (Cronbach's alpha values: 0.72-0.84)[157]. The FCQ consists of nine scales, measuring the importance of: (i) health concern; (ii) mood or use of food to improve mood and cope with stress; (iii) convenience of preparation and purchase; (iv) sensory appeal in terms of taste, smell and texture; (v) natural content and the absence of additives and artificial ingredients; (vi) price and concern about value for money; (vii) weight control; (viii) familiarity of food; and, (xi) ethical concern about country of origin and packaging[157]. Participant's scores on each factor were computed by summing the individual items relating to each of the nine factors and then dividing by the number of items relating to each factor to give a score on each factor ranging between one and four. Following a study that was undertaken to test the applicability of the FCQ to the context of the RN (Appendix 7), two of the questions in the FCQ (items 11 and 35) were altered slightly to make them more relevant.

3.2.5. Data analyses

All analyses were conducted using the statistical package SPSS (Version 24, IBM Chicago, US). Data were checked for normality using the Kolmogorov-Smirnov test. Where data were found to be not normally distributed the equivalent non-parametric statistical analyses were applied. Parametric and non-parametric data are presented as mean (standard deviation, SD) and median (IQR), respectively. P values <0.05 were considered statistically significant.

Descriptive statistics were performed to generate a demographic profile of the study population's characteristics. Differences in physical measurements, health behaviours and motives for food choice based on gender, age group (18-24, 25-34 and ≥35 years old), rank (Officer, SR and JR), NICE risk classification (no increased risk and any risk) and educational attainment (GCSE and below and A Level and above) were tested using Independent samples t-tests and One-way Analysis of Variance (ANOVA) with Bonferroni post-hoc comparisons tests. Differences in NICE risk classification based on gender, age group and rank; and differences in educational attainment based on rank; were tested using Pearson's Chi-Square tests. Kendall's tau tests were used to determine associations between motives for food choice and dietary intake. Participants were grouped according to the number of four lifestyle risk factors (smoking, low consumption of fruit and vegetables, consumption of alcohol in excess of government guidelines and physical inactivity) they engaged in. Differences in the prevalence of these multiple risk factors based on gender, age group, rank and NICE risk classification were tested using Pearson's Chi-Square tests.

Principal components analysis (PCA) was used to identify common patterns of food consumption (i.e. food patterns) from the FFQ food intake data. PCA is a statistical technique that reduces data into patterns based upon inter-correlations between dietary items in order to account for the largest amount of variation in diet. The frequency of food item consumption of 39 food items from the FFQ was entered as the number of servings per week. Factors were rotated with an orthogonal (varimax) rotation to derive optimal non-correlated components (food patterns). The correlation matrix of the standardised variables was examined to decide the number of components to retain based on eigenvalue and interpretability. Labelling of the factors was primarily descriptive and based on the author's interpretation of the pattern structures. Cases were assigned pattern-specific factor scores. Scores were calculated as the sum of the products of the factor loading coefficient and standardised weekly frequency of use of each food associated with that pattern. Only foods with factor loadings ≥0.30 and ≤-0.20 were included in calculation of pattern scores because these items represent the foods most strongly related to the identified factor. Associations between dietary patterns and gender, age, rank, level of educational attainment, NICE risk classification, motives for food choice, physical activity levels, smoking and drinking habits were explored using Spearman's correlation tests and Kendall's tau tests.

Binary logistic regression was used to predict the likelihood that an individual was classified at any risk of obesity related ill health according to NICE risk classification. After deleting cases with missing values, data on 523 participants were retained for regression analyses, representing 87% of the original cases[e]. The greatest amount of missing cases for an individual variable was ten. Data were analysed in three stages. First, associations between the dependent variable NICE risk classification and the independent variables (gender, age, rank, educational attainment, motives for food choice, dietary intake [three categories: 0-0.14, 0.43-0.80 and 1.0+ servings per day], PCA food patterns, physical activity levels, smoking and drinking habits) were assessed by generating univariate models. P values <0.1 were considered statistically significant during the univariate analysis. Second, binary logistic regression was performed, using stepwise backward likelihood ratio elimination, on the independent variables that were identified as being statistically significant during stage one. Third, a fully adjusted model was built by including all of the variables identified as being statistically significant during stage two. A Box-Tidwell test was used to check for linearity between the continuous independent variables and the logit (log odds) of the dependent variable. The model included the following variables: age; rank; level of educational attainment; processed meat intake; biscuit intake; nut intake; whether participants consumed five portions of fruit and vegetables per day; and whether individuals had ever been on a slimming diet. Diagnostic tests were used to determine model accuracy through assessing: sensitivity; specificity; positive and negative predictive values; and multicollinearity using the variance inflation factor (VIF). Outliers were detected using standardised residuals. Odds ratios (OR) and 95% confidence intervals (CI) are reported.

3.3 Results

3.3.1. Participant demographics

The median age of the study sample was 27 (23-35) years. Male participants were older compared with female participants (P<0.01; Table 3.2). SRs were older compared with Officers and JRs (P<0.05; Table 3.2), and Officers were older compared with JRs (P<0.001; Table 3.2). There was limited ethnic diversity, where only 27 participants (4.5%) described themselves as 'other' than 'White British'. Educational levels of participants varied, with 32% of participants receiving education up to GCSE level only and 68% to A Level and above. There was an association between rank and educational attainment (X^2 (2)=68.7, P<0.001), whereby Officers were more likely to be educated to above GCSE level compared with SRs and JRs (98% vs. 65% and 59%, respectively).

[e] There were no differences in gender, rank, age group or NICE risk classification between participants with and without complete data (data not shown).

Table 3.2: Age of participants based on gender and rank[145].

Gender (n)	Median age (IQR)	Rank (n)	Median age (IQR)
Male (313)	28 (23-37) ‡	Officer (74)	33 (26-41) *†
		SR (69)	37 (32-41)
		JR (170)	25 (22-28) **
Female (287)	26 (23-33)	Officer (58)	32 (26-36) *†
		SR (42)	35 (31-41)
		JR (187)	24 (22-27) **

Note: * P<0.05, ** P<0.001 One-way ANOVA difference to SR; † P<0.001 One-way ANOVA difference to JR; ‡ P<0.01 Mann Whitney U-test difference to females.

3.3.2. Height, weight, waist circumference and BMI

Male participants were taller, heavier, and had a higher BMI and larger waist circumference compared with female participants (P<0.01; Table 3.3). Participants in the 18-24 and 25-34 year age groups had a lower weight, BMI and waist circumference compared with older participants (P<0.05; Table 3.3). Differences between age groups were similar based on gender. In the male participants, SRs were heavier, and had a higher BMI and larger waist circumference compared with their Officer and JR counterparts (P<0.05; Table 3.4). In the female participants, Officers were taller compared with JRs, but had a lower BMI compared with SRs (P<0.05; Table 3.4). There were no differences in height, weight, waist circumference or BMI based on educational attainment.

3.3.3. NICE risk classification

Twenty-nine percent of male and 30% of female participants were classified as being at ‘any risk’ of obesity related ill health (Table 3.5). There was an association between NICE risk classification and age group (X^2 (2)=94.3, P<0.001), whereby participants in the ≥35 year age group were more likely to be classified at ‘any risk’ compared with younger participants (Table 3.5). There was also an association between NICE risk classification and rank (X^2 (2)=12.8, P<0.01), whereby SRs were more likely to be classified at ‘any risk’ compared with Officers and JRs (Table 3.5). There were no associations between NICE risk classification and level of educational attainment.

Table 3.3: Height, weight, BMI and waist circumference of participants based on gender and age group.

Variable	Descriptive Statistic	All (n=600)	Males (n=313)	Females (n=287)	Age 18-24 years (n=201)	Age 25-34 years (n=246)	Age ≥35 years (n=153)
Height (m)	Mean (SD)	**1.72 (0.09)**	**1.78 (0.07) ***	**1.65 (0.07)**	**1.71 (0.10)**	**1.72 (0.09)**	**1.74 (0.09)**
	Median (IQR)	1.72 (1.65-1.79)	1.78 (1.74-1.83)	1.65 (1.61-1.69)	1.72 (1.64-1.79)	1.72 (1.65-1.78)	1.74 (1.67-1.79)
	Minimum	1.52	1.62	1.52	1.52	1.53	1.53
	Maximum	2.01	2.01	1.86	1.97	2.01	1.94
	95% CI Range	0.01	0.01	0.01	0.01	0.01	0.01
Weight (kg)	Mean (SD)	76.8 (13.8)	84.3 (12.3)	68.6 (10.4)	**73.4 (11.9) §**	**75.8 (13.7) §**	**83.0 (14.5)**
	Median (IQR)	**76.3 (66.0-85.6)**	**82.5 (76.5-91.8) †**	**66.6 (61.0-74.5)**	72.3 (63.5-81.2)	74.7 (64.8-84.0)	83.1 (72.8-93.1)
	Minimum	45.5	54.0	45.5	52.1	49.9	45.5
	Maximum	132.4	132.4	104.1	114.8	125.8	132.4
	95% CI Range	74.2-77.4	80.8-84.6	65.3-68.5	1.7	1.7	2.3
BMI (kg/m²)	Mean (SD)	25.8 (3.5)	26.5 (3.4)	25.1 (3.4)	25.0 (3.2)	25.5 (3.2)	27.4 (3.7)
	Median (IQR)	**25.4 (23.3-27.9)**	**26.1 (24.0-28.8) †**	**24.5 (22.8-27.1)**	**24.4 (22.7-26.5) ‡**	**25.2 (23.2-27.3) ‡**	**27.4 (25.0-29.6)**
	Minimum	19.2	19.2	19.2	19.9	19.2	19.2
	Maximum	41.6	41.6	32.4	35.3	40.5	41.6
	95% CI Range	25.1-25.7	25.6-26.6	24.0-24.9	23.9-24.7	24.8-25.7	26.5-28.2
Waist circumference (cm)	Mean (SD)	83.8 (10.5)	88.9 (9.7)	78.2 (8.3)	**80.4 (8.4) §**	**82.6 (9.8) §**	**90.1 (11.5)**
	Median (IQR)	**82.3 (75.8-90.6)**	**87.8 (81.7-95.2) †**	**76.7 (72.4-82.5)**	79.8 (74.1-85.5)	81.1 (75.0-88.9)	89.8 (82.7-97.8)
	Minimum	62.4	70.2	62.4	64.6	64.4	62.4
	Maximum	130.5	130.5	108.8	107.9	115.5	130.5
	95% CI Range	81.3-83.6	86.2-88.9	75.7-77.9	1.2	1.2	1.8

Note: * P<0.001 Independent Samples t-test difference to females; † P<0.01 Mann Whitney U-test difference to females; ‡ P<0.001 Kruskal-Wallis H test bonferroni correction difference to ≥35 year age group; § P<0.001 One way ANOVA difference to ≥35 year age group; bold text signifies if data is parametric/non-parametric.

Table 3.4: Height, weight, BMI and waist circumference of participants based on gender and rank.

Variable	Descriptive Statistic	Males			Females		
		Officers (n=74)	SRs (n=69)	JRs (n=170)	Officers (n=58)	SRs (n=42)	JRs (n=187)
Height (m)	Mean (SD)	**1.79 (0.07)**	**1.78 (0.07)**	**1.78 (0.06)**	**1.68 (0.06)**	**1.65 (0.05)**	**1.64 (0.07) ΨΨ**
	Median (IQR)	1.79 (1.74-1.87)	1.78 (1.73-1.82)	1.78 (1.74-1.83)	1.67 (1.63-1.72)	1.65 (1.62-1.70)	1.64 (1.60-1.68)
	Minimum	1.68	1.62	1.64	1.57	1.53	1.52
	Maximum	2.01	1.94	2.00	1.86	1.75	1.83
	95% CI Range	0.02	0.02	0.01	0.02	0.02	0.01
Weight (kg)	Mean (SD)	**83.7 (10.0) ***	**88.9 (13.2)**	**82.7 (12.4) ****	**69.4 (11.8)**	**71.5 (11.0)**	**67.6 (9.7)**
	Median (IQR)	82.5 (77.0-89.3)	88.5 (79.1-99.5)	80.7 (74.5-90.0)	68.0 (61.2-73.5)	69.9 (63.0-78.7)	65.5 (60.7-74.0)
	Minimum	65.2	60.4	54.0	50.3	45.4	49.9
	Maximum	109.2	132.4	125.8	104.1	95.3	100.7
	95% CI Range	2.3	3.1	1.9	3.0	3.3	1.4
BMI (kg/m^2)	Mean (SD)	**26.0 (3.1) ****	**28.0 (3.4)**	**26.1 (3.4) *****	**24.5 (3.2)**	**26.2 (3.8) Ψ**	**25.1 (3.4)**
	Median (IQR)	25.4 (23.9-30.4)	28.2 (26.0-29.7)	25.6 (23.5-28.0)	24.2 (22.4-26.5)	25.3 (23.4-27.6)	24.5 (22.8-27.2)
	Minimum	20.9	19.2	19.3	19.2	19.4	19.2
	Maximum	34.4	41.6	40.5	34.2	36.4	36.4
	95% CI Range	0.7	0.8	0.5	0.8	1.1	0.5
Waist circumference (cm)	Mean (SD)	**88.5 (8.6) ****	**93.6 (10.1)**	**87.3 (9.4) *****	**76.8 (8.3)**	**80.0 (8.3)**	**78.2 (8.3)**
	Median (IQR)	86.2 (82.3-94.0)	92.2 (86.5-99.2)	86.2 (80.1-92.5)	76.7 (70.9-81.7)	78.7 (74.3-84.8)	76.3 (72.5-82.5)
	Minimum	72.6	74.7	70.2	62.4	62.4	64.4
	Maximum	115.8	130.5	115.5	104.4	98.0	108.8
	95% CI Range	2.0	2.4	1.4	73.2-78.3	75.2-83.8	75.3-78.0

Note: * P<0.05, ** P<0.01, *** P<0.001 One way ANOVA difference to SR; Ψ P<0.05, ΨΨ P<0.001 One way ANOVA difference to Officers; † P<0.05, †† P<0.001 Kruskal-Wallis H test bonferroni correction difference to SR; ‡ P<0.001 Kruskal-Wallis H test bonferroni correction difference to JR; bold text signifies if data is parametric/non-parametric.

Table 3.5: NICE risk classification of participants based on gender, age group and rank.

NICE Risk Classification	All (n=600) % (n)	Males (n=313) % (n)	Females (n=287) % (n)	Age 18-24 years (n=201) % (n)	Age 25-34 years (n=346) % (n)	Age ≥35 years (n=153) % (n)	Officers (n=132) % (n)	SRs (n=111) % (n)	JRs (n=357) % (n)
No increased risk	71 (424)	71 (222)	70 (202)	80 (160) *	79 (295) *	45 (69)	75 (99) †	57 (63)	73 (262) †
Increased risk	15 (90)	15 (48)	15 (42)	11 (22)	10 (25)	28 (43)	14 (19)	23 (26)	13 (45)
High risk	6 (35)	5 (15)	7 (20)	4 (8)	5 (12)	10 (15)	3 (4)	6 (7)	7 (24)
Very high risk	8 (51)	9 (28)	8 (23)	6 (11)	6 (14)	17 (26)	8 (10)	14 (15)	7 (26)

Note: * P<0.001 Pearson chi-square test difference to ≥35 year age group; † P<0.01 Pearson chi-square test difference to SR; shaded cells signify at any risk of obesity related ill health.

3.3.5. Food choice motives

The highest rated motives for food choice factors for all participants were sensory appeal, health and price. The lowest rated factors were familiarity and ethical concern (Table 3.6). Figure 3.1 demonstrates the number of participants scoring one to four for each scale.

Female participants were more likely to be motivated by the factors of sensory appeal, weight control, convenience and mood compared with male participants (P<0.05; Table 3.6). Participants aged 18-24 years old rated mood higher and sensory appeal, ethical concern and natural content lower compared with participants aged ≥35 years old (P<0.05; Table 3.6). Participants in the 25-34 year age group rated sensory appeal lower and natural content higher compared with participants in the ≥35 and 18-24 year age groups, respectively (P<0.05; Table 3.6). Officers were more likely to be motivated by natural content and ethical concern, and less likely to be motivated by price, compared with JRs (P<0.001; Table 3.7). Officers and JRs were more likely to be motivated by mood compared with SRs (P<0.05; Table 3.7). Officers rated the factor of natural content higher compared with SRs (P<0.05; Table 3.7). Participants classified as being at 'any risk' of obesity related ill health rated health lower compared with participants at no risk (P<0.05; Table 3.8).

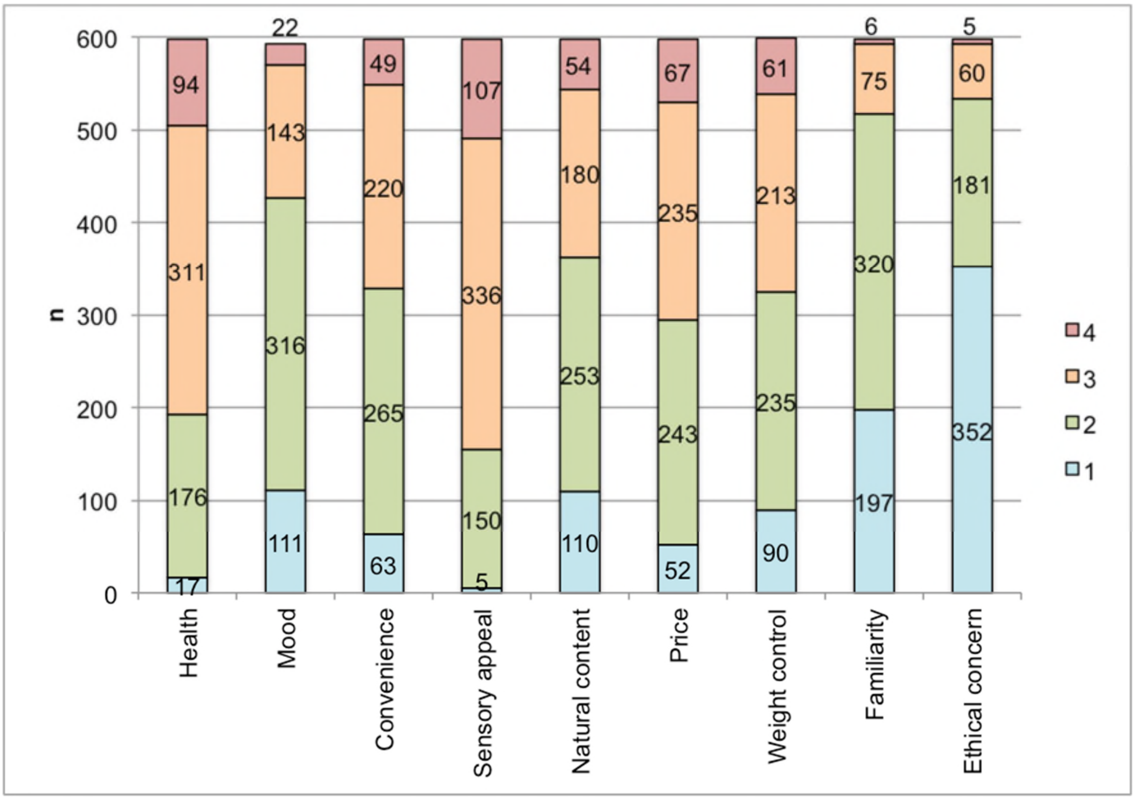

Figure 3.1: Food choice motives of all participants, n=592-599.
Note: 1, not at all important; 2, a little important; 3, moderately important; 4, very important.

Table 3.6: Food choice motives of participants based on gender and age group.

Scale	All (n=592-599)[1] Mean (SD)	Males (n=307-313)[1] Mean (SD)	Females (n=285-287)[1] Mean (SD)	Age 18-24 years (n=200-201)[1] Mean (SD)	Age 25-34 years (n=243-246)[1] Mean (SD)	Age ≥35 years (n=148-153)[1] Mean (SD)
Health	2.7 (0.7)	2.7 (0.7)	2.8 (0.6)	2.7 (0.7)	2.7 (0.7)	2.7 (0.6)
Mood	2.1 (0.7)	2.0 (0.7) *	2.1 (0.6)	2.1 (0.7) †	2.0 (0.6)	1.9 (0.6)
Convenience	2.4 (0.7)	2.3 (0.7) **	2.6 (0.7)	2.5 (0.8)	2.4 (0.7)	2.4 (0.7)
Sensory appeal	2.8 (0.6)	2.7 (0.6) *	2.9 (0.6)	2.7 (0.6) †	2.7 (0.6) †	2.9 (0.6)
Natural content	2.3 (0.8)	2.3 (0.8)	2.4 (0.8)	2.1 (0.8) ††	2.4 (0.8) ‡	2.5 (0.8)
Price	2.5 (0.7)	2.6 (0.7)	2.5 (0.8)	2.6 (0.8)	2.5 (0.7)	2.5 (0.7)
Weight control	2.4 (0.8)	2.2 (0.8) **	2.6 (0.8)	2.4 (0.9)	2.4 (0.8)	2.5 (0.7)
Familiarity	1.8 (0.6)	1.8 (0.6)	1.8 (0.6)	1.9 (0.6)	1.8 (0.6)	1.8 (0.6)
Ethical concern	1.3 (1.0-2.0)	1.3 (1.0-2.0)	1.3 (1.0-2.0)	1.0 (1.0-1.7) §	1.3 (1.0-2.0)	1.3 (1.0-2.0)

Note: * P<0.05, ** P<0.001 Independent Samples t-test difference to females; † P<0.05, †† P<0.01 One way ANOVA difference to ≥35 year age group; ‡ P<0.01 One way ANOVA difference to 18-24 year age group; § P<0.01 Kruskal-Wallis H test bonferroni correction difference to 35-44 year age group; [1] presents range for n.

Table 3.7: Food choice motives of participants based on rank and NICE risk classification.

Scale	Officers (n=130-132)[1] Mean (SD)	SRs (n=109-111)[1] Mean (SD)	JRs (n=354-356)[1] Mean (SD)	No increased risk (n=419-423)[1] Mean (SD)	Any increased risk (n=173-176)[1] Mean (SD)
Health	2.8 (0.6)	2.7 (0.7)	2.7 (0.7)	2.8 (0.7)	2.6 (0.7) §
Mood	2.1 (0.6)	1.9 (0.7) *	2.1 (0.7) †	2.1 (0.7)	2.0 (0.7)
Convenience	2.4 (0.7)	2.3 (0.7)	2.5 (0.7)	2.4 (0.7)	2.4 (0.7)
Sensory appeal	2.8 (0.5)	2.8 (0.7)	2.8 (0.6)	2.8 (0.6)	2.8 (0.6)
Natural content	2.6 (0.7)	2.4 (0.7) *	2.2 (0.8) **	2.4 (0.8)	2.3 (0.8)
Price	2.3 (0.7)	2.5 (0.7)	2.6 (0.8) **	2.6 (0.8)	2.5 (0.7)
Weight control	2.4 (0.7)	2.4 (0.8)	2.4 (0.9)	2.4 (0.8)	2.5 (0.8)
Familiarity	1.7 (0.5)	1.7 (0.6)	1.9 (0.6)	1.8 (0.6)	1.8 (0.7)
Ethical concern	1.7 (1.0-2.0)	1.3 (1.0-2.0)	1.3 (1.0-1.7) ‡	1.3 (1.0-2.0)	1.3 (1.0-2.0)

Note: * P<0.05, ** P<0.001 One way ANOVA difference to Officers; † P<0.01 One way ANOVA difference to SR; ‡ P<0.001 Kruskal-Wallis H test bonferroni correction difference to Officers; § P<0.05 One way ANOVA difference to no increased risk group; [1] presents range for n.

3.3.6. Dietary intake and dieting history

Male participants consumed more portions of 23 food items, and fewer portions of chocolate and fresh fruit compared with female participants (P<0.05; Table 3.8). More female participants were likely to be on a slimming diet compared with male participants (X^2 (1)=8.8, P<0.01, 23% vs. 14%). Furthermore, more female participants reported having been on a slimming diet than male participants (P<0.001).

Table 3.8: Food items consumed in greater frequencies based on gender.

Food items consumed in greater frequencies by males (n=288)			Food-items consumed in greater frequencies by females (n=260)
Chips ***	Cakes **	White rice ***	Chocolate **
Pizza **	High-fat dairy desserts **	Potatoes *	Fresh fruit **
Fried breakfast ***	Non-diet dizzy drinks **	Pasta **	
Red meat ***	Non-diet squash *	Wholegrains *	
Processed meat ***	Energy drinks ***	Beans ***	
Salty snacks *	Bottled milkshake ***	Nuts **	
Savoury pastries ***	Alcohol ***	Eggs ***	
Gravy **	White bread ***		

Note: * P<0.05, ** P<0.01, *** P<0.001 Mann-Whitney U test difference to other gender.

Participants aged 18-24 years old consumed more portions of ‘unhealthy’ food items and less portions of fruit, vegetables, high-fibre breakfast cereals and reduced-fat dairy products compared with older participants (P<0.05; Table 3.9). Participants aged 25-34 years old consumed more portions of high-energy drinks, chocolate and cereal bars, and fewer portions of alcohol compared with older participants (P<0.05; Table 3.9). More participants aged 18-24 years old were likely to add sugar to hot drinks or breakfast cereals compared with participants aged ≥35 years old (X^2 (2)=13.9, P<0.01, 54% vs. 34%).

SRs consumed fewer portions of ‘unhealthy’ food items and more portions of ‘healthy’ food items compared with JRs (P<0.05; Table 3.9). JRs consumed more portions of fast food and high-energy drinks and fewer portions of sweet baked goods, biscuits, alcohol and ‘healthy’ food items (P<0.05; Table 3.9), and more added sugar to hot drinks or breakfast cereals (X^2 (2)=22.0, P<0.001, 51% vs. 28%) compared with Officers. SRs consumed more portions of fast food and fewer portions of food items including fried breakfast, sweet baked goods, biscuits, fruit juice, vegetables and salad, compared with Officers (P<0.05; Table 3.9).

Participants classified at no increased risk of obesity related ill health consumed more portions of six of the ‘unhealthy’ food items and fewer portions of reduced fat dairy products compared with participants at any risk (P<0.05; Table 3.9). Participants classified at ‘any risk’ were likely to be on a slimming diet compared with participants at no risk (X^2 (2)=16.9, P<0.001, 29% vs. 14%).

Table 3.9: Food items consumed in greater frequencies based on age group, rank and NICE risk classification.

Comparison	Group	Food items consumed in greater frequencies		
Age 18-24 vs. 25-34 years	**18-24 (n=178)**	Chips †† Fast food † Chocolate †† Sweets †	Non-diet fizzy drinks † Energy drinks ††† Bottled milkshake ††† Savoury pastries †††	Cereal bars † Cake †
	25-34 (n=227)	Fresh fruit †† Vegetables †	High-fibre breakfast †† Reduced-fat dairy ††	Nuts †† Seeds †
Age 18-24 vs. ≥35 years	**18-24 (n=178)**	Chips † Fast food †† Fried breakfast †† Savoury pastries †† Cereal bars †††	Non-diet fizzy drinks ††† Non-diet squash ††† Energy drinks ††† Bottled milkshake ††† White bread †	Beans † Chocolate †† Sweets ††† Cake †
	≥35 (n=143)	Biscuits † Fresh fruit †††	High-fibre breakfast †† Reduced-fat dairy †††	Vegetables †
Age 25-34 vs. ≥35 years	**25-34 (n=227)**	Non-diet squash ††† Energy drinks †††	Bottled milkshake † Non-diet fizzy drinks ††	Chocolate † Cereal bars †
	≥35 (n=143)	Alcohol †		
JRs vs. SRs	**JRs (n=325)**	Chips † Fried breakfast † Savoury pastries † Cereal bars ††	Non-diet fizzy drinks †† Energy drinks ††† Bottled milkshake †††	White bread † Sweets † Fast food ††
	SRs (n=103)	Fruit ††† Reduced-fat dairy ††	Vegetables ††	Fruit juice †
JRs vs. Officers	**JRs (n=325)**	Non-diet squash † Energy drinks ††	Bottle milkshake ††† Non-diet fizzy drinks †	Fast food ††† Lentils †
	Officers (n=120)	Alcohol ††† Fresh fruit ††† Fruit juice ††† Vegetables †††	Sweet baked goods † Biscuits ††† Salad ††† Reduced-fat dairy ††	Nuts † Seeds †† Eggs †† Fish ††
SRs vs. Officers	**SRs (n=325)**	Fast food †		
	Officers (n=120)	Fried breakfast † Biscuits †† Lentils †	Sweet baked goods †† Cereal bars †† Fruit juice †††	Vegetables † Salad †
NICE risk	**No risk (n=383)**	Pizza * Chocolate * Biscuits * Cakes **	Sweet baked goods * High-fat dairy desserts * Bottled milkshake * Cereal bars **	Nuts *** Seeds *
	Any risk (n=165)	Reduced-fat dairy **		

Note: † P<0.05, †† P<0.01, ††† P<0.001 Kruskal-Wallis H test bonferroni correction difference to other group; * P<0.05, ** P<0.01, *** P<0.001 Mann-Whitney U test difference to other group.

Participants who placed more importance on the food choice motive health consumed less ‘unhealthy’ and more ‘healthy’ food items (Appendix 8). Participants who rated natural content, weight control and ethical concern higher also displayed this healthier pattern of eating. Participants who placed more importance on the food choice motive mood consumed more portions of ‘sugary’ foods (e.g., baked goods, chocolate and biscuits). Participants who rated familiarity, convenience and price higher consumed more portions of fast food items, and fewer portions of fresh fruit and vegetables.

After removal of variables that did not have any correlations above $r = 0.3$ or which had a sampling adequacy below 0.5 according to the Kaiser-Meyer-Olkin measure, a PCA was performed on 27 food items. Four major dietary patterns were identified, which combined explained 41.4% of the variation in dietary intake. The factor loadings for the food items associated with each pattern are shown in Table 3.10. The higher the factor loading for a food, the stronger the association of the food with that pattern.

Component 1, which explained 12.3% of the variation, was characterised by high intakes of high-fat dairy desserts, red meat, cakes, fried breakfasts, beans, gravy/ sauces, chips, potatoes, processed meat and white rice. This component was termed the ‘high-fat’ pattern. Component 2, which explained 10.3% of the variation, was characterised by high intakes of fast food, savoury pastries, salty snacks, energy drinks, bottled milkshakes, chips, processed meat and gravy/ sauces, and low intakes of fresh fruit, vegetables and white rice. This component was termed the ‘processed’ pattern. Component 3, which explained 10.0% of the variation, was characterised by high intakes of salad, fish, vegetables, eggs, whole grains and fresh fruit, and low intakes of chips. This component was termed the ‘healthy’ pattern. Component 4, which explained 8.8% of the variation, was characterised by high intakes of chocolate, sweet baked goods, sweets, pasta, salty snacks, cakes, white rice and pizza, and low intakes of eggs. This component was termed the ‘refined carbohydrates’ pattern.

The strength of associations between the dietary patterns and the measured variables ranged between very weak to weak (Table 3.11). The ‘high-fat’ dietary pattern was positively associated with being male, being more physically active and consuming higher intakes of alcohol; and was negatively associated with the food choice motives convenience, natural content and weight control. The ‘processed’ dietary pattern was positively associated with being male, being a current smoker, consuming higher intakes of alcohol, and a decrease in rank from Officer to JR; and was negatively associated with age, a higher level of educational attainment, the food choice motives health, sensory appeal, natural content, weight control and ethical concern, and being more physically active. The ‘healthy’ dietary pattern was positively associated with age, the food choice motives health, natural content, weight control and ethical concern, and being more physically active; and was negatively associated with a decrease in rank from Officer to JR, and the food choice motives convenience, sensory appeal, price and familiarity. The ‘refined carbohydrates’ dietary pattern was positively associated with the food choice motives mood, convenience and sensory appeal; and was negatively associated with being male, being classified at risk of obesity related ill health, the food choice motive health, and being a current smoker.

Table 3.10: Principal components analysis coefficients.

Food-item	**Component 1 'High-fat'**	**Component 2 'Processed'**	**Component 3 'Healthy'**	**Component 4 'Refined carbohydrates'**
High-fat dairy desserts	**0.70**	0.10	-0.01	0.10
Red meat	**0.64**	0.27	0.09	-0.10
Cakes	**0.63**	-0.03	-0.16	**0.34**
Fried breakfast	**0.61**	0.12	-0.06	-0.02
Beans	**0.55**	0.15	0.17	0.05
Gravy/ sauces	**0.54**	**0.31**	0.06	0.02
Chips	**0.50**	**0.46**	**-0.26**	0.04
Potatoes	**0.44**	-0.08	0.27	0.08
Processed meat	**0.42**	**0.37**	-0.18	0.13
White rice	**0.41**	**-0.23**	-0.05	**0.33**
Fast food	0.12	**0.67**	-0.11	0.18
Savoury pastries	0.23	**0.63**	-0.06	0.13
Salty snacks	-0.05	**0.55**	-0.11	**0.40**
Energy drinks	0.05	**0.48**	0.08	-0.09
Bottled milkshake	0.09	**0.47**	-0.04	0.04
Pizza	0.15	**0.45**	-0.07	**0.32**
Salad	-0.01	-0.12	**0.73**	0.04
Fish	0.10	0.14	**0.66**	-0.16
Vegetables	0.14	**-0.24**	**0.66**	0.16
Eggs	0.23	0.14	**0.57**	**-0.21**
Whole grains	-0.03	-0.07	**0.56**	0.06
Fresh fruit	-0.08	**-0.25**	**0.53**	0.10
Seeds	-0.05	0.02	0.29	-0.04
Chocolate	0.05	0.13	-0.05	**0.73**
Sweet baked goods	0.11	0.23	0.03	**0.71**
Sweets	-0.00	0.23	0.01	**0.68**
Pasta	0.26	-0.17	0.08	**0.42**
Percentage of variance explained	12.3	10.3	10.0	8.8

Note: coefficients 0.30 or greater or below -0.20 are highlighted in bold.

Table 3.11: Correlation coefficients for dietary patterns and other variables.

Variable	'High-fat'	'Processed'	'Healthy'	'Refined carbohydrates'
Gender[2]	0.26***	0.13***	-0.05	-0.10**
Age[1]	-0.08	-0.24***	0.14**	-0.04
Rank[2]	-0.05	0.21***	-0.17***	-0.05
Level of educational attainment[2]	0.06	-0.10**	0.04	0.05
NICE risk classification[2]	-0.02	0.01	-0.02	-0.08*
Food choice motives[1]				
Health	-0.05	-0.25***	0.34***	-0.11**
Mood	0.02	-0.03	-0.01	0.11**
Convenience	-0.09*	0.07	-0.10*	0.10*
Sensory appeal	0.02	-0.12**	-0.11**	0.14**
Natural content	-0.09*	-0.28***	0.39***	-0.05
Price	-0.01	0.06	-0.16***	0.07
Weight control	-0.22***	-0.26***	0.16***	-0.07
Familiarity	-0.03	0.07	-0.11**	0.08
Ethical concern	-0.07	-0.17***	0.11**	0.05
Physical activity levels[2]	0.07*	-0.07*	0.16***	-0.02
Smoking status[2]	-0.01	0.18***	-0.06	-0.08*
Alcohol consumption[2]	0.19***	0.08**	-0.01	-0.06

Note: 1, Spearman's correlation test; 2, Kendall's tau test; * P<0.05, **P<0.01, ***P<0.001.

3.3.7. Physical activity levels

Thirteen percent of participants reported that they were either inactive or moderately inactive. More male participants were likely to be active and fewer to be moderately active compared with female participants (X^2 (3)=8.2, P<0.05; Table 3.12). There were no differences in physical activity levels based on age group, rank or NICE risk classification (Appendix 9).

Table 3.12: Physical activity levels of participants based on gender, n=599.

Physical activity level	All % (n)	Males % (n)	Females % (n)
Inactive	7 (39)	6 (18)	7 (21)
Moderately inactive	6 (33)	4 (13)	7 (20)
Moderately active	18 (108)	15 (47)	21 (61) *
Active	70 (419)	75 (234)	64 (185) *

Note: * P<0.05 Pearson chi-square test difference to males.

3.3.8. Smoking behaviours

The majority of participants reported that they had never smoked (60%). More Officers were likely to have never smoked and less likely to be current smokers compared with both SRs and JRs, and more SRs were likely to be ex-smokers and fewer to be current smokers compared with JRs (X^2 (4)=39.1, P<0.001; Table 3.13). There were no differences in smoking history based on gender, age group or NICE risk classification (Appendix 9).

Table 3.13: Smoking history of participants based on rank, n=598.

Smoking history	All % (n)	Officers % (n)	SR % (n)	JR % (n)
Never smoked	60 (359)	76 (100)	54 (60) *	56 (199) *
Ex-smoker	21 (125)	20 (26)	32 (35)	18 (64) †
Current smoker	19 (114)	5 (6)	14 (16) *	26 (92) *†

Note: * P<0.001 Pearson chi-square test difference to Officers; † P<0.001 Pearson chi-square test difference to SR.

3.3.9. Alcohol consumption

The majority of participants (64%) typically consumed between 1 and 10 units of alcohol per week, with only a small minority (10%) reporting a consumption of more than 15 units per week. More male participants consumed 11-15 and 21+ units of alcohol per week, and fewer consumed 1-5 units of alcohol per week compared with female participants (X^2 (5)=36.5, P<0.001; Table 3.14). There were no differences in alcohol history based on age group, rank or NICE risk classification (Appendix 9).

Table 3.14: Alcohol history of participants based on gender, n=590.

Units of alcohol consumed per week	All % (n)	Males % (n)	Females % (n)
None	14 (85)	12 (38)	17 (47)
1-5	40 (236)	32 (100) *	48 (136)
6-10	24 (139)	25 (76)	22 (63)
11-15	12 (71)	17 (51) *	7 (20)
16-20	6 (36)	8 (24)	4 (12)
21+	4 (23)	6 (20) *	1 (3)

Note: * P<0.001 Pearson chi-square test difference to females.

3.3.10. Multiple lifestyle risk factors

Twenty four percent of participants were engaged in no risk factors, 52% engaged in one risk factor, 22% engaged in two risk factors, 2% engaged in three risk factors and 0% engaged in all four risk factors. The pattern of multiple lifestyle risk factors was similar between participants based on gender and age group (Appendix 9). More Officers were engaged in no risk factors compared with JRs and SRs, and more JRs engaged in two or more risk factors compared with Officers (X^2 (6)=38.5, P<0.001; Figure 3.2). Fewer participants who were classified at 'any risk' of obesity related ill health engaged in no risk factors and more engaged in two or more risk factors compared with individuals at no risk (X^2 (3)=9.8, P<0.05; Figure 3.2).

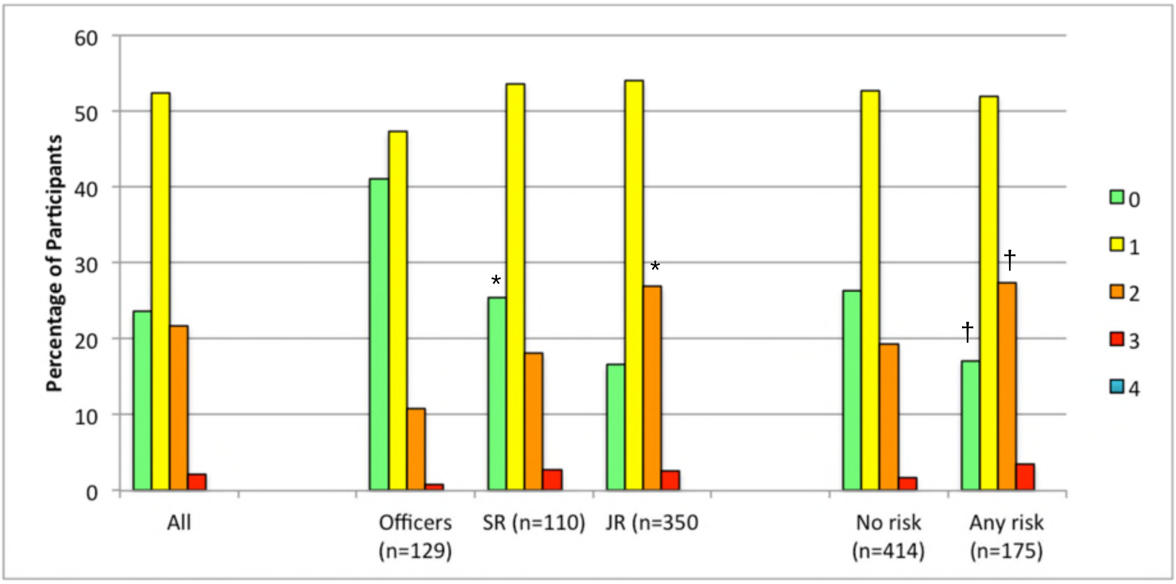

Figure 3.2: Multiple lifestyle risk factors of participants based on rank and NICE risk classification, n=589.

Note: * P<0.001 Pearson chi-square test difference to Officers; † P<0.001 Pearson chi-square test difference to no risk group; risk factors: smoking, low consumption of fruit and vegetables, consumption of alcohol in excess of government guidelines and physical inactivity.

3.3.11. Multivariable analysis

Of the 64 variables included in the univariate models to test associations with NICE risk classification, 19 had a P value <0.1. Variables included: age, rank, level of educational attainment, dietary intake (pizza, processed meat, sweet baked goods, biscuits, cakes, high-fat dairy desserts, cereal bars, nuts, reduced fat dairy, added sugar, five portions of fruit and vegetables a day), whether individuals had ever been on a slimming diet, current dieting history, motives for food choice (health), alcohol consumption compared with government guidelines and engagement in multiple lifestyle risk factors (see subsection 3.3.10). The continuous variables age and the food choice motive health were found to be linearly related to the logit of the dependent variable.

After the elimination of variables using a stepwise backward likelihood method, binary logistic regression analysis showed that eight variables were associated with NICE risk classification, that is: age; rank; level of educational attainment; processed meat intake; biscuit intake; nut intake; whether participants consumed five portions of fruit and vegetables per day; and whether individuals had ever been on a slimming diet (Table 3.15).

Increasing age was associated with an increased likelihood of being at any risk of obesity related ill health (P<0.001). JRs were 2.63 times more likely to be at any risk of obesity related ill health than Officers (CI=1.23-5.41). Participants who had an educational attainment level of GCSE or below were 1.8 times more likely to be classified at any risk compared with individuals with a higher level of educational attainment (CI=1.14-2.99).

Participants who consumed processed meats, biscuits and nuts 1 to 6 times per week were 2.17 times more likely, 0.57 times less likely and 0.56 times less likely, respectively, to be at any risk compared with individuals who consumed these food items less frequently (CI=1.35-3.47; CI=0.36-0.92; CI=0.34-0.92, respectively). Participants who did not achieve the government guidelines for portions of fruit and vegetables per day were 1.73 times more likely to be at any risk compared with individuals who achieved the guidelines (CI=1.00-3.00). Finally, participants who had ever been on a slimming diet were 2.85 times more likely to be at any risk of obesity related ill health compared with individuals who had never been on a slimming diet (CI=1.72-4.73).

The model was statistically significant, X^2 (13)=130.1, P<0.001 and explained 31.3% (Nagelkerke R^2) of the variance in NICE risk classification. In terms of the model's accuracy in predicting the likelihood of participants being classified at risk of obesity related ill health, it correctly classified 77.8% of cases; sensitivity was 47.1%; specificity was 90.8%; positive predictive value was 68.2%; negative predictive value was 80.3% and a low level of multicollinearity was present, where the highest VIF was 1.5. There were sixteen standardised residuals with a value over 2.5 SD, which were kept in the analysis. The final model had an adjustment of 0.435 according to the Homer-Lemeshow Test.

Table 3.15: Multivariable logistic regression predicting likelihood of participants being classified at risk of obesity related ill health, n=523.

Variable/ category	OR	95% CI	P
Age	1.15	1.11-1.19	<0.001
Rank			
Officers	1.00	-	-
SR	1.12	0.55-2.28	0.75
JR	2.63	1.23-5.41	0.01
Educational attainment			
A Levels and above	1.00	-	-
Up to GCSE	1.84	1.14-2.99	0.01
Processed meat intake			
3 times per month or less	1.00	-	-
1 – 6 times per week	2.17	1.35-3.47	<0.01
Daily or more frequently	1.44	0.38-5.42	0.59
Biscuit intake			
3 times per month or less	1.00	-	-
1 – 6 times per week	0.57	0.36-0.92	0.02
Daily or more frequently	1.55	0.67-3.57	0.31
Nut intake			
3 times per month or less	1.00	-	-
1 – 6 times per week	0.56	0.34-0.92	0.02
Daily or more frequently	0.42	0.12-1.43	0.16
5 portions of fruit and vegetables			
Achieving 5 a day	1.00	-	-
Not achieving 5 a day	1.73	1.00-3.00	0.05
Times on a diet			
Never	1.00	-	-
Ever	2.85	1.72-4.73	<0.001

3.4. Discussion

The present study aimed to assess the health status of RN personnel in order to identify the need for a healthy lifestyle intervention and where actions should be targeted.

3.4.1. NICE risk classification and demographic factors

The study indicated that 29% of male and 30% of female participants were classified as being at ‘any risk’ of obesity related ill health, which was higher (male) and lower (female) than has previously been reported for RN personnel[31]. These differences may be partly explained due to the use of self-report measures of height, weight and waist circumference in the study by Bennett et al.[31]. Self-report data may incur reporting bias[38], which may have subsequently affected the proportions of personnel being classified at risk. The 2017 HSE reported a higher prevalence of risk in adults, with 55% of males and

61% of females being classified at risk[24]. However, it is difficult to make comparisons between the present study and the HSE findings, as the data were not partitioned into comparable age groups.

In accordance with the well-documented positive association between age and obesity[31,34,40], older participants were more likely to be classified at 'any risk' compared with their younger counterparts. This association was observed in both the univariate and multivariable analyses. Although the univariate analysis indicated that SRs were more likely to be classified at 'any risk' compared with Officers and JRs, this association was not demonstrated in the multivariable analysis. It is likely that this was due to age being a confounder, as the mean age of the SR group was higher compared with that of the Officers and JRs, with age being included as an independent variable in the model. Previous research that investigated differences in the prevalence of overweight and obesity in the RN and in a tri-Service cohort, based on BMI demonstrated a similar trend whereby more Ratings (SRs and JRs combined) were overweight or obese compared with Officers[31,35]. However, no previous research has examined differences using the NICE risk classifications in the RN based on rank.

As discussed in Chapter 1 military rank can be used as a proxy measure for SES. Within the UK civilian adult population obesity prevalence is correlated with SES, with prevalence being higher among individuals with a lower SES[159]. In the multivariable analysis JRs, who would be considered to have a lower SES, were 2.63 times more likely to be classified at 'any risk' of obesity related ill health compared with Officers. Furthermore, when considering educational attainment, which is also an indicator of SES, the multivariable analysis indicated that participants who had an educational attainment level of GCSE or below were 1.84 times more likely to be classified at 'any risk' compared with individuals with a higher level of educational attainment. Thus, confirming the relationship between SES and obesity prevalence.

3.4.2. Motives for food choice, dietary intake and dietary patterns

In agreement with previous findings, sensory appeal, health and price were reported as the strongest determinants of food choice in RN personnel[157,160-162]. Similarly, familiarity of food and ethical concern were reported as the weakest determinants[157,163,164]. Anecdotal observations collected by the project team suggested that the majority of RN personnel eat at the dining facility on base at least once a day, and regularly source snack foods from the on-site shop. As such, familiar foods are readily available and personnel can exert little influence on the ethical issues concerning the country of origin and packaging of foods and drinks that these outlets provide. Familiarity of food and ethical concern about the country of origin and packaging may therefore have been rated lower due to this lack of control, rather than being considered as unimportant. In contrast to research findings from the US Army, which described that environmental factors may have a disproportionately large effect on food choices when in a military setting[149], in the present study convenience of preparation and purchase of food were not the highest rated determinants of food choice.

In terms of differences based on gender, female participants placed greater importance on sensory appeal, weight control, convenience and mood or use of food to improve mood and cope with stress, as determinants of food choice. These findings are supported by numerous studies that have reported that women place more importance on convenience and sensory appeal[165,166], affect regulation (management of emotion)[167], coping motivations[168] and weight control[160,165-167] as factors influencing food choices compared with men. Female participants in the present study tended to place greater importance on the majority of the food choice motives, which along with previous research suggests that they are more preoccupied with food in general[169].

An individual's life course experience is an important factor influencing food choice decisions[170]. In agreement with previous research, positive associations between age and sensory appeal[157], natural content[157,167] and ethical concern[157,167] were observed. Previous research has demonstrated an association between high natural content and ethical concern ratings with a healthier pattern of eating[161]. This pattern of food consumption was also observed in the present study, whereby older participants consumed more portions of 'healthy' food items compared with younger participants, who generally consumed more portions of 'unhealthy' food items.

Although no other research has been undertaken examining differences in determinants of food choice in military populations based on rank, research has been undertaken in civilian populations based on indicators of SES, including income and educational attainment. Thus, comparisons can be made with the findings of the present study. In the present study price and concern about value for money was a much more important factor for JRs compared with Officers, which was not surprising considering Officers are paid more than JRs[171]. This was further supported by the findings of Konttinen et al.[172], Steptoe et al.[157], Steenhuis et al.[173]; and Steptoe and Wardle[174] who reported a negative association between the food choice motive price, and income and educational status, respectively. However, unlike the latter studies, this study found differences in the factors natural content and ethical concern based on rank. Thus, while these differences might reflect SES, age might also be an influencing factor.

As discussed previously, a high natural content and ethical concern rating have been associated with a healthier pattern of eating, and a high price rating with a higher intake of the food item cake[161]. This was supported in the present study, whereby higher-ranking participants consumed more portions of ‘healthy’ food items and fewer portions of ‘unhealthy’ food items compared with participants of a lower rank. These findings suggest that healthy eating interventions in the RN should primarily target JRs, and focus on the price of foods.

In the present study participants categorised at ‘any risk’ of obesity related ill health placed less importance on health as a motive for food choice compared with participants at no increased risk. Similarly, Dressler and Smith[175] reported that lean/normal weight low-income women stated that health was influential in food choice compared with overweight/obese participants. Hebden et al.[176] found that factors perceived as being more important to participants in the increased health risk category included helping them cope with stress (i.e. mood) and controlling their weight (i.e. weight control). These differences may be consequential to the fact that the causes of overweight and obesity are complex and multifaceted. As such, motives for food choice may differ between obese populations and between individuals within these populations.

Previous research has shown an association between a high health rating with a healthier pattern of eating[161]. The univariate analysis indicated that participants classified at ‘any risk’ of obesity related ill health, who placed less importance on health as a motive for food choice, consumed fewer portions of a number of ‘unhealthy’ food items compared with those classified at no risk. The multivariable analysis, which adjusted for confounding variables, demonstrated that participants who consumed more portions of processed meat and who did not achieve the government fruit and vegetable consumption guidelines were more likely to be at any risk of obesity related ill health. Furthermore, the analysis indicated that participants who consumed more portions of nuts were less likely to be at any risk. These findings support the previously established links between processed meat, fruit and vegetables and nut intakes and obesity[177-179]. However, the multivariable analysis also found that participants who consumed more portions of biscuits were less likely to be at ‘any risk’, which is dissimilar to previously reported research[180].

PCA produced four dietary components with a clear interpretation. The first component termed the ‘high-fat’ pattern was similar to the ‘high-fat’ pattern described by McCann et al.[181]. Interestingly, the identification of this pattern as the first principal component is the opposite of other results from UK data, which typically report a healthier pattern as the first principal component[182-185]. The second component termed the ‘processed’ pattern was similar to the ‘processed’ pattern described by Northstone et al.[182]. The third component termed the ‘healthy’ pattern was similar to the ‘healthy foods’ pattern described by Hearty and Gibney[186]. Finally, the fourth component termed the ‘refined carbohydrate’ pattern has not been previously described in a UK adult population. Whilst the four component scores together explained 41.4% of the variation in dietary intake, direct comparisons of the proportion of variation explained cannot be made with other studies as the result is highly dependent on the number of variables included in the analysis and the number of components retained.

Associations were observed between the four identified dietary patterns and the other measured variables, including: gender; age; rank; level of educational attainment; motives for food choice; physical activity levels; smoking and drinking behaviours; and NICE risk classification. The findings suggest that dietary advice given to RN personnel should focus on getting individuals to consume healthier foods, where: males should be moved away from a ‘high-fat’ and ‘processed’ dietary pattern; females should be moved away from a ‘refined carbohydrates’ dietary pattern; and JRs and younger participants should be moved away from a ‘processed’ dietary pattern. Although the associations were statistically significant it must be noted that the strength of the associations ranged between weak to very weak. Furthermore, correlations do not infer causality.

3.4.3. Physical activity levels

The majority of participants were physically active (70%) and therefore assumed to be meeting the physical activity guidelines[187]. However, as 13% of participants reported to being either inactive or moderately inactive, the findings suggest that compliance to the recommendation stated in Second Sea Lord’s PFS[10], that personnel should complete a minimum of three hours of vigorous activity a week programmed as part of the working day, could be improved. Thus supporting previous research that found some personnel who intended to exercise did not feel empowered to do so despite the direction stated in the policy document[188].

In comparison with the general population the proportion of physically active male and female participants was 9% and 6% higher, respectively[189]. Although in the present study there was a higher proportion of males in the ‘active’ category compared with females and a higher proportion of females in the ‘moderately active’ category compared with males, there were no differences in the proportions of participants who were in the ‘inactive’ or ‘moderately inactive’ categories based on gender. While females in the ‘moderately active’ category could be targeted to be more active, a similar proportion of both males and females need to be targeted to undertake any form of exercise.

In the present study no differences were observed in physical activity levels based on age, rank or NICE risk classification. This was dissimilar to the findings reported in the 2016 HSE that found older individuals, individuals with a lower SES and individuals who were obese were less likely to meet physical activity guidelines[189]. Possible reasons for these differences include that in the RN there is equity in the availability and accessibility of physical activity opportunities regardless of demographic factors. Furthermore, participants who were classified at any risk of obesity related ill health were more likely to be on a slimming diet compared with those classified at no risk, as such it could be assumed that they were already engaged in physical activity. Overall, these findings suggest that all RN personnel should be targeted to be more active.

3.4.4. Smoking behaviour

Although the majority of participants reported that they had never smoked (60%), 19% reported that they were current smokers, which was a similar prevalence to that reported in the general population (15%)[190]. There were no differences in self-reported smoking history based on gender, age group or NICE risk classification. This was dissimilar to the findings reported in the 2017 HSE, that found males were more likely to be smokers compared with females, and that the prevalence of adults who currently smoke was highest among adults aged 25 to 34 and 45 to 54 years old[190]. In the present study, differences in smoking prevalence were observed based on rank. More JRs were current smokers compared with SRs and Officers, and more SRs were current smokers compared with Officers. This was similar to recently reported data in the UK adult population which reported that individuals with a lower SES were more likely to be smokers[191]. Further reinforcing that rank may be acting as a proxy for educational attainment and SES. Overall, these findings suggest that initiatives to reduce the prevalence of smoking in the RN should be targeted at Ratings, particularly JRs.

3.4.5. Alcohol consumption

Only a small minority of participants self-reported that they consumed more than the government guidelines of alcohol per week (males 6%, females 5%), with the majority of participants typically consuming between one and ten units per week. There were differences in alcohol consumption based on gender, with more males consuming higher intakes compared with females; but there were no differences based on age group, rank or NICE risk classification. Due to the structure of the questionnaire that was administered to assess alcohol consumption, comparisons cannot be made between participants in the present study and the general population. Furthermore, as the questionnaire did not ask participants to record the quantity of alcohol they consumed on their heaviest days drinking over the week, it cannot be ascertained whether a culture of binge drinking is present in the RN. It must be noted that previous research suggests that individual's commonly underreport alcohol consumption[192,193]; and that levels of underreporting may not be uniform across demographic subgroups of the population[192,194]. Given that alcohol intake may be a risk factor for obesity in some individuals[195]; and that data from this study suggests that obesity is a problem in the RN; the alcohol behaviours of RN personnel requires further exploration.

3.4.6. Multiple lifestyle risk factors

When participants were grouped according to the number of multiple lifestyle risk factors (smoking, excessive alcohol use, poor diet, and low levels of physical activity) in which they engaged, 2% reportedly engaged in three or more unhealthy behaviours. This was lower than has been previously reported in the general UK population (25%)[196]. There were no differences in the pattern of multiple lifestyle risk factors participants engaged in based on gender or age group, which supported previous research[196]. However, when comparisons were made based on rank, JRs engaged in more risk factors than Officers suggesting that healthy lifestyle interventions should primarily target JRs. This finding was supported by previous research that reported individuals with a lower SES were more likely to engage in all four poor health behaviours. More participants who were classified at any risk of obesity related ill health were engaged in two or more risk factors compared with individuals at no risk. However, as the study design was cross-sectional a causal relationship cannot be ascertained.

3.4.7. Multivariable analysis and NICE risk classification

The multivariable regression analysis showed that increasing age, lower military rank, lower levels of educational attainment, high dietary intakes of processed meat, low dietary intakes of biscuits and nuts, not achieving the fruit and vegetable dietary guidelines, and ever having been on a slimming diet, were independently associated with being classified at risk of obesity related ill health. With the exception of biscuit intake, all associations were in expected directions, and support previous literature. The model explained 31.3% of the variance in NICE risk classification, where some of the unexplained variance may be explained by other variables that were not measured in the study including genetics and environmental influences[197]. The findings from the model indicate that interventions to reduce the prevalence of overweight and obesity in the RN should target older and lower ranking personnel, the latter of which will inevitably have a lower level of educational attainment; and should encourage personnel to consume lower intakes of processed meat; and to achieve the government fruit and vegetable guidelines. Efforts to increase fruit and vegetable intakes need to be mindful not to inadvertently increase individuals' energy intakes due to food cooking and preparation methods (e.g., deep frying vegetables or serving vegetables in a cheese sauce). The model also supports advising personnel to consume more portions of biscuits and nuts; however because these food items are typically energy-dense this would not be advised.

3.4.8. Implications for the healthy lifestyle intervention

The present study indicates that it is essential that steps be taken to reduce the prevalence of overweight and obesity in the RN. There are two options that could be taken to achieve this, a population-based approach, or an individual level (high-risk) approach.

The results from the multivariable model suggest that obesity action in the RN should take a high-risk approach by targeting older and lower ranking personnel. Although this approach may help these individuals reduce their risk of obesity related ill health, the impact on the burden of obesity at the population level may be disappointing as problems may arise from individuals in the middle of the risk distribution[198]. As previous research has demonstrated that a targeted approach tailored to groups of individuals is more effective than a ‘one size fits all’ approach[13,199], it is recommended that the RN take a combined approach to tackle obesity. Due to logistical reasons it is highly unlikely that interventions that aim to improve the health behaviours of RN personnel would target individuals based on their gender or age. However, as RN personnel both access and consume food in different mess decks depending on their rank, multi-level interventions to improve dietary behaviours could feasibly target personnel based on rank. Additionally, interventions could feasibly target overweight and obese personnel and personnel who smoke through individual level strategies. The findings from the present study indicated that:

a. Healthy eating interventions should target sensory appeal, health and price and primarily be targeted at JRs;
b. Physical activity and alcohol interventions should be targeted at all personnel;
c. Smoking cessation interventions should primarily be targeted at Ratings, particularly JRs.

Since 2008 the MOD has placed emphasis on reducing the prevalence of obesity in UK Armed Forces personnel[200,201]. Due to the multifaceted aetiology of obesity and the complex relationships that exist between individuals, groups, and their environments, obesity must be tackled using a multifaceted approach, which addresses the whole system[54]. Such an approach should acknowledge that individually based risk factors must be contextualised[202] and that interventions targeting individual behaviour change are only achievable and sustainable if the physical and social environments in which they are embedded are supportive[77,101,115-117].

Previous health promotion activities that have been utilised by the RN have included nutrition education lectures and guides. Research indicates that the effectiveness of the briefs has been poor[32,33]. Furthermore, the effectiveness of the guides has not been formally evaluated. The findings from the present study suggest that nutrition education interventions to promote prudent health behaviours and to reduce the prevalence of obesity among personnel should encompass a multidimensional approach focusing not only on health, but also on the wider determinants governing food choice.

As described in Chapter 2, numerous interventions have been used in work-site and institutional settings to improve the eating behaviours of employees and personnel.

Pricing strategies have been effective at modifying food choices by increasing the cost of popular higher fat/energy-dense foods to generate revenues to subsidise the reductions of healthier food items[13,147,203]. The findings from the present study suggest that this may be a viable option to change the eating behaviours of RN personnel, as price was a strong determinant of food choice amongst all participants. Similarly, an approach that has been recommended by WHO to encourage healthy eating is the use of fiscal policy to influence food prices[85,204]. Where food taxes and subsidies have been shown to influence eating behaviours and improve health outcomes[205]. However, both of these approaches will impose a larger burden on the 'less-well off' (i.e. JRs) compared with the 'better-off' (i.e. Officers)[206].

It is also important to consider that RN personnel do not exclusively live in a military environment. As such, dietary behaviours may regress when personnel are exposed to the wider environment. Thus, the MOD has recognised that personnel need to be encouraged and empowered to take responsibility for their own health[11]. Using environmental strategies alone to modify dietary behaviours does not support this view. As discussed in Chapter 2 previous successful interventions to modify dietary behaviours and to control overweight and obesity in the work-site and institutional setting have focused on multi-level strategies that combine individual focused strategies (e.g., nutrition education) with making supportive changes to the environment[13,93,103,104].

3.4.9. Study strengths and limitations

The main strength of the present study was that the study sample was stratified for rank and age group as per the Armed Forces manning report, where participants were recruited from the majority of RN land bases across the UK and both RNAS. However, only two ships were included in the study, where these ships were based alongside. Thus, the nutrition environment in which these participants lived and worked was similar to a land base; meaning that the study findings may not accurately reflect RN personnel at sea. Furthermore, the study sample did not include individuals from the Submarine Service or personnel based at HMNB Clyde. A second strength was the methods used to measure participant's physical measurements. Previous studies that measured the height, weight and waist circumference of RN personnel have either relied on self-reported data or measurements taken by untrained individuals, who did not take these measurements following the NICE standardised methods.

Limitations of the present study should be taken into account when interpreting the findings. First, there is a risk of volunteer bias where although the sample was representative of the entire Service, in terms of rank and age, it was unknown whether the sample was representative in terms of the prevalence of overweight and obesity, motives for food choice or health behaviours. This might therefore limit the generalisability of the results. Furthermore, it needs to be considered whether the sample size was sufficient to accurately reflect the actual prevalence of obesity in the RN. Second, the study was cross-sectional and causal relationships cannot be determined between the measured variables and overweight and obesity. Third, after deleting cases with missing values, data on 523 participants were included in the regression analyses. This was lower than the required 530 participants detailed in section 3.2.3. This reduction in sample size will have reduced the power of the test (i.e. the probability of observing an effect in the sample) and may have increased the likelihood of a Type II error (i.e. a false-negative).

A further limitation of the study was the measurement tools used to collate data on participant's health behaviours and motives for food choice. They all used self-reported methods, which may have caused recall or reporting bias. The methods used to measure dietary behaviour, physical activity behaviour and alcohol consumption did not allow for a direct comparison with civilian population data or the limited military data available. However, at the time of the study the measurement methods used were the most appropriate self-reported questionnaires that were available for use in the circumstances. Although the FFQ developed specifically for the study had good test-retest reliability, its validity had not been assessed. Furthermore, the FFQ only measured the pattern of food consumption rather than actual intake. Thus, the questionnaire may not have accurately assessed the dietary intake of the study participants. However, the method was less burdensome for the participants in comparison with other methods of collecting dietary data. Additionally, the study to test the applicability of the FCQ to the context of the RN did not consist of any females. As the results presented in this chapter suggested that motives for food choice differ based on gender, potentially, the questionnaire might not have included all motives relevant to females. Finally, although differences in the motives for food choice between the participants were statistically significant, they ranged between 0.2 and 0.4 on a scale of 1 to 4 (i.e. 7% to 13%). These differences are modest and the extent to which they are sufficiently meaningful to justify targeting intervention strategies based on these factors is unclear.

3.4.10. Conclusion

This study determined the prevalence of obesity, the health behaviours and the determinants of food choice of a stratified sample of RN personnel. The findings indicated that nearly a third of participants were classified 'at risk' of obesity related ill health. Although the data highlighted differences in the prevalence of obesity based on age and rank, the findings suggest that it is essential that steps be taken to reduce the prevalence of overweight and obesity across the whole RN population. Thus, confirming the need for a healthy lifestyle intervention.

The findings suggested that the RN should take a combined approach to improve the health behaviours of personnel, where:

a. Healthy eating interventions should target sensory appeal, health and price and primarily be targeted at JRs;
b. Physical activity and alcohol interventions should be targeted at all personnel;
c. Smoking cessation interventions should primarily be targeted at Ratings, particularly JRs;
d. Interventions to reduce the prevalence of obesity should be targeted at all personnel, and encourage personnel to consume lower intakes of processed meat and to achieve the government fruit and vegetable guidelines.

To improve the effectiveness of a healthy lifestyle intervention it is important to determine the feasibility and acceptance of the intervention by involving the target population during the development phase; to ascertain whether the nutrition and physical activity environments onboard RN vessels are conducive to healthy living; and to identify where improvements can be made. These factors will be considered in Chapters 4 and 5, respectively.

4. Healthy lifestyle intervention needs analysis

4.1 Introduction

In developing any complex intervention to improve the health behaviours of individuals it is recommended first to identify the evidence base; second to develop a theoretical understanding of the likely process of change; and third to assess the feasibility of the intervention[207]. Chapter 2 presented the evidence base and systematically evaluated the effectiveness of environmental-based interventions to improve the dietary and/or physical activity behaviours of adults in institutions. The findings suggested a healthy lifestyle intervention should combine multi-level and multi-component strategies through a socio-ecological approach. In Chapter 1 the SEM of health behaviour,[77] in the context of the RN, was used to develop a theoretical understanding of the factors that influence the dietary and physical activity behaviours of RN personnel. This chapter looks at the feasibility of an intervention.

Inherent in most community-based interventions is the notion of community involvement, based on the view that behaviour change is more likely when the individuals affected by a specific problem are involved in both defining and finding solutions for the problem[208,209]. Previous research suggests that the successful implementation of an intervention, and indeed its effectiveness, is dependent upon levels of acceptability[210]. This includes its acceptability to the target users and the intervention deliverers.

The requirements of an intervention will vary between target users due to differences in a range of personal characteristics, including gender, age, SES, cultural background, knowledge, previous experiences and salient health-related behaviours[210]. Therefore, to ensure that an intervention designer has insight into all relevant perspectives, during the iterative qualitative research stage it is essential that a purposive sample is selected that represents a diverse range of target users[211]. In the studies included in the systematic review presented at Chapter 2; seven studies[126,128-130,132,134-136] did not assess intervention acceptability, usability and satisfaction or build an understanding of the psychosocial context of the target users and their views of the behavioural elements of the intervention, nor did these studies identify the lack of qualitative research as a limitation of the methods. However, in the study reported by Bingham et al.[127], guided workshops were undertaken with a purposive sample of target users during the intervention planning to develop an action plan for implementing the intervention and to assess feasibility. Furthermore, in the study reported by Lassen et al.[131] and Thorsen et al.[133] a purposive sample of target users and intervention deliverers were involved in the development and implementation of the intervention. However, neither of these studies reported the findings from this qualitative research.

One of the core values that underpins a WSA is the need to use local knowledge, held by individuals, communities and organisations, to generate locally created solutions[212]. This is complemented by a second core value of having an active appreciation of the personal qualities and experiences of the intervention target users and deliverers through engaging them in the intervention design process[212]. These actions will ultimately strengthen learning and build capacity[68,212]. Thus, further highlighting the importance of including the intervention target users and deliverers during the intervention planning process.

4.1.1 Mixed methods research

Health researchers are increasingly using mixed methods research designs[213]. Mixed methods research involves combining qualitative and quantitative paradigms (the consensual set of beliefs and practices that guide a field[214]) to produce converging findings to address complex research questions[215]. Qualitative research emphasises an induction subjective contextual approach[214], through typically using interviews or focus groups to provide rich and in-depth data about individual’s beliefs, values, feelings and motivations. Whereas, quantitative research emphasises a deductive objective generalising approach[214], to produce factual, reliable and objective data. Although combining these methods raises several problems due to differences in their values and processes, where qualitative research is underpinned by constructivism and quantitative research is underpinned by positivism, triangulating data gathered from mixed methods research using a pragmatic approach can produce greater insight than a single method[215]. Thus, the study presented in this Chapter employed a mixed methods research design to determine the feasibility of the intervention.

4.1.2 Aims

The present study aimed to explore the feasibility and acceptance of a proposed intervention with multiple activities with a ship’s company and intervention deliverers by: determining intentions and barriers to change; identifying the likelihood of intervention target users taking part in a pre-defined list of intervention activities; and, exploring barriers and enablers to prudent health behaviours and the needs, ideas and preferences of a sub-group of the intervention ship’s company for the healthy lifestyle intervention.

4.2 Methods

4.2.1 Study design and ship

This mixed methods study was approved by MODREC (527MODREC14) and complied with the Declaration of Helsinki[151]. In June 2014 Navy Command Logistics and Infrastructure selected HMS Dauntless to be the intervention ship. However, due to unforeseen circumstances the ship did not deploy and HMS Duncan became the intervention ship. Due to these logistical changes the ship's company on both HMS Dauntless and HMS Duncan were included in the present study.

4.2.2 Recruitment

The study was advertised on each ship using daily and weekly orders. On the day of data collection a project brief was delivered to each ship's company that included a full description of the study. It was explained that participation was voluntary and personnel did not need to provide a reason if they chose not to participate. An opportunity was given for personnel to ask questions of the project team, either in the group or in private. Written informed consent was obtained from all participants before data collection commenced.

4.2.3 Procedures and participants

Health at Work Employee Survey

A sample of 131 RN personnel completed the Health at Work Employee Survey (HWES)[216] (Appendix 10) on HMS Dauntless (n=9 (44% of ships company)) and HMS Duncan (n=2 (51% of ships company)). The HWES is a workplace environment audit tool developed by the British Heart Foundation to assess the facilities and challenges that exist in promoting health in the workplace, and to assess the interests and needs of the workforce. It includes questions on age range, gender and rank as well as questions to: determine intentions and barriers to change; identify the likelihood of the volunteers taking part or using a pre-defined list of intervention activities offered onboard the ship during her next deployment; and explore other ideas for intervention activities that the volunteers would like to be offered.

Focus groups

Four semi-structured focus groups were conducted onboard HMS Dauntless in June 2014 with a purposive sample of 20 RN personnel. The focus groups comprised between four and seven personnel and lasted between 35 and 60 minutes. Due to the hierarchical nature of the RN it was decided that separate focus groups would be undertaken with participants based on their rank (i.e. Officers (n=4), SRs (n=7) and JR (n=5)) and with potential intervention deliverers (i.e. the UHC, n=4) due to their possible differing views and opinions. The participants were selected as they represented the ship's company for which the healthy lifestyle intervention was being developed.

The focus groups explored the barriers and enablers to prudent health behaviours onboard ship and the needs, ideas and preferences of the participants for a healthy lifestyle intervention to be delivered onboard the ship during its next deployment. The author facilitated the focus groups by guiding the groups through a set of topics (healthy eating, physical activity and health promotion activities) and questions set out in a focus group discussion guide (Appendix 11). All focus groups were digitally recorded meaning the author could focus on the discussion and act as a facilitator. An additional member of the project team supported the focus groups and gathered field notes.

4.2.4 Data analyses

Quantitative data from the HWES was analysed using the statistical package SPSS (Version 25, IBM Chicago, US). Data for both ships was merged as neither ship had received an intervention. Data were checked for normality using the Kolmogorov-Smirnov test. Where data were not normally distributed the equivalent non-parametric statistical analyses were applied. Parametric and non-parametric data are presented as mean (SD) and median (IQR), respectively. P values <0.05 were considered statistically significant. Descriptive statistics were performed to generate a demographic profile of the study population's characteristics. Differences in the measured variables based on gender, age group (under 21-30 (U21-30), 31-40 and ≥41 years old) and rank (Officer, SR and JR) were analysed using Pearson's Chi-Square tests.

The focus groups and the qualitative data in the form of free text ideas for intervention activities from the HWES were transcribed verbatim into a Word document. Any identifiable information was removed and where applicable pseudonyms were given. The transcripts were then imported into the qualitative data analysis software NVivo Version 12 (QSR International Pty Ltd) and were read through to saturation. Transcripts were analysed using a deductive thematic analysis approach to categorise the data following the six phases of analysis described by Braun and Clarke[217]:

i. Familiarising yourself with the data;
ii. Generating initial codes;
iii. Searching for themes;
iv. Reviewing themes;
v. Defining and naming themes; and
vi. Producing the report.

Line by line coding was undertaken on the transcripts. All text in the transcripts was coded deductively for barriers and enablers to prudent health behaviours onboard ship, and the needs, ideas and preferences for a healthy lifestyle intervention. Semantic themes were identified, where themes were considered in relation to the SEM of health behaviour described in section 1.4 (i.e. the intrapersonal, interpersonal, organisational, physical environment and policy levels). A total of 95 lower level codes were identified (Appendix 12). Lower level codes that were related were clustered together to form themes, resulting in four major themes and 13 sub-themes.

Quantitative data from the HWES and qualitative data from the focus groups and HWES were analysed separately; findings are presented at section 4.3. These findings were then triangulated during the interpretation stage in section 4.4 using the triangulation methods described by O'Cathain et al.[213]. This involved considering where findings from each method converged, offered complementary information on the same issue, or appeared to contradict each other. Findings were interpreted in relation to the SEM of health behaviour.

4.3 Results

4.3.1 Quantitative Data: HWES

Participants

A sample of 131 RN personnel completed the HWES. Eighty-five percent of participants were male (n=110). Twenty-one percent of participants were Officers (n=27), 20% were SRs (n=26) and 59% were JRs (n=75). In terms of age, 56% of participants (n=72) were U21-30 years old, 34% (n=43) were between 31-40 years old and 11% (n=13) were over 40 years old. Two participants did not disclose their gender identity and three participants did not disclose their rank or age.

Weight management

Fifty-six percent of participants (n=73) stated they were currently trying to lose weight. This was similar for participants based on gender (56% males, 58% females) age group (57% U21-30, 49% 31-40, 69% ≥41 years old) and rank (48% Officers, 62% SRs, 56% JRs).

Barriers to being more physically active

The most frequently cited barrier to participants being more physically active onboard ship was *"I don't have time"* (59%), followed by *"I need to rest and relax in my spare time"* (30%), *"no motivation"* (24%) and *"injury"* (21%) (Table 4.1). There were no differences in barriers based on gender. Officers and participants age 31-40 years old were more likely to cite *"I don't have time"* as a barrier compared with SRs and JRs (χ^2 (2)=15.9, P<0.05; 93% vs. 46% and 52%, respectively), and participants age ≥41 years old (χ^2 (2)=6.4, P<0.05; 70% vs. 31%), respectively. Participants age ≥41 years old were more likely to cite *"too fat/overweight"* as a barrier compared with participants age U21-30 years old (χ^2 (2)=8.4, P<0.05; 23% vs. 3%).

Barriers to eating more healthily

The most frequently cited barrier to participants eating more healthily onboard ship was a *"lack of healthy eating choices in the Galley"* (74%), followed by a *"lack of healthy eating choices in the NAAFI"* (53%) and a *"lack of food storage/ preparation areas onboard"* (47%) (Table 4.2). There were no differences in barriers based on gender or age group. Officers were less likely to cite *"lack of food storage/ preparation areas onboard"* as a barrier to eating more healthily compared with SRs and JRs (χ^2 (2)=12.0, P<0.05; 19% vs. 58% and 56%, respectively).

Stage of change and physical activity

The majority of participants (53%) were either contemplating or preparing to increase the amount of time that they participate in physical activity. Where the remaining 47% were either already in the action or maintenance stage of change. There were no differences in readiness to change physical activity levels based on gender, age group or rank.

Stage of change and eating more healthily

The majority of participants (75%) were either contemplating or preparing to improve the healthiness of their diet. Of the remaining participants, 24% were either in the action or maintenance stage of change and a further 2% were in the pre-contemplation stage of change. Female participants were more likely to be in the action stage of change compared with male participants (χ^2 (4)=10.1, P<0.05; 28% vs. 8%). There were no differences in readiness to dietary change based on age group or rank.

Reasons for taking part in physical activity

The most frequently cited reason the participants gave for taking part in physical activity was *"to get fit"* (78%), followed by *"to improve my health"* (64%), *"to feel good"* (52%), *"to relieve stress"* (50%) and *"to lose weight"* (47%) (Table 4.3). There were no differences in reasons based on gender, age group or rank.

Interest in taking part or using proposed healthy lifestyle intervention activities

The most popular activities that participants stated they would be fairly or extremely likely to take part in or use during their next deployment were *"healthy meal choices available in the Galley/Wardroom"*, *"selection of healthy refreshments in meeting rooms"*, *"on ship activity classes"* and *"on ship taster sessions run by the ships PTI"* (Table 4.4). Of the twenty-four proposed activities there were only three where less than half of the participants stated that they would be fairly or extremely likely to take part in or use.

Interest in taking part or using the proposed activities did not differ by gender. Participants age ≥41 years old said they would be less likely to use *"on site facilities (e.g. food preparation and storage areas)"* or take part in a *"lunchtime activity group"* or *"on ship* *activity classes"* compared with participants age U21-30 years old (χ^2 (4)=10.1, P<0.05; 54% vs. 86%; χ^2 (4)=9.6, P<0.05; 54% vs. 85%; χ^2 (4)=10.3, P<0.05; 69% vs. 94%). More Officers cited that they would be unlikely to take part in *"nutrition courses or qualifications"* and *"access health promotion materials"* compared with JRs and SRs, respectively (χ^2 (4)=10.6, P<0.05; 52% vs. 20%; χ^2 (4)=9.7, P<0.05; 44% vs. 8%).

Interest in becoming involved in the healthy lifestyle intervention

Ninety-five percent of participants were interested in becoming involved in the healthy lifestyle intervention during their next deployment. There were no differences based on gender, age group or rank.

Table 4.1: Barriers to being more physically active, n=128.

Barriers	All (n=128) % (n)	Males (n=108) % (n)	Females (n=19) % (n)	Age U21-30 years (n=70) % (n)	Age 31-40 years (n=43) % (n)	Age ≥41 years (n=13) % (n)	Officers (n=27) % (n)	SRs (n=26) % (n)	JRs (n=73) % (n)
I don't have time	59 (76)	57 (61)	74 (14)	59 (41)	70 (30)†	31 (4)	93 (25)	46 (12)*	52 (38)*
I need to rest and relax in my spare time	30 (38)	32 (35)	16 (3)	35 (24)	28 (12)	15 (2)	33 (9)	19 (5)	33 (24)
No motivation	24 (31)	26 (28)	16 (3)	26 (18)	19 (8)	38 (5)	15 (4)	27 (7)	27 (20)
Injury[1]	21 (27)	21 (23)	17 (3)	19 (13)	21 (9)	23 (3)	4 (1)	35 (9)	21 (15)
Can't be bothered	12 (15)	14 (15)	0 (0)	12 (8)	12 (5)	15 (2)	15 (4)	8 (2)	12 (9)
There are no suitable facilities	11 (14)	10 (11)	11 (2)	14 (10)	0 (0)	23 (3)	7 (2)	8 (2)	12 (9)
I don't put priority on physical activity	11 (14)	12 (13)	5 (1)	12 (8)	14 (6)	0 (0)	4 (1)	12 (3)	14 (10)
Too fat/overweight	6 (7)	6 (6)	5 (1)	3 (2)†	5 (2)	23 (3)	0 (0)	12 (3)	6 (4)
I don't enjoy physical activity	6 (7)	7 (7)	0 (0)	6 (4)	5 (2)	8 (1)	0 (0)	4 (1)	8 (6)
There is no-one to do it with[1]	4 (5)	5 (5)	0 (0)	6 (4)	2 (1)	0 (0)	0 (0)	0 (0)	7 (5)
I might get injured or damage my health	3 (4)	2 (2)	5 (1)	1 (1)	5 (2)	0 (0)	0 (0)	0 (0)	4 (3)
My health is not good enough	2 (3)	3 (3)	0 (0)	3 (2)	2 (1)	0 (0)	0 (0)	0 (0)	4 (3)
I'm not the sporty type	2 (2)	2 (2)	0 (0)	3 (2)	0 (0)	0 (0)	0 (0)	0 (0)	3 (2)
I'm active enough	1 (1)	1 (1)	0 (0)	0 (0)	2 (1)	0 (0)	0 (0)	4 (1)	0 (0)
I'm too old	1 (1)	1 (1)	0 (0)	0 (0)	0 (0)	8 (1)	0 (0)	0 (0)	1 (1)
I can't afford it	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Note: [1] n=127 All, n=18 females, n=69 U21-30 years, n=72 JR; * P<0.05 Pearson chi-square test, difference to Officers; † P<0.05 Pearson chi-square test, difference to ≥41 years old.

Table 4.2: Barriers to eating more healthily, n=127.

Barriers	All (n=127) % (n)	Males (n=107) % (n)	Females (n=19) % (n)	Age U21-30 years (n=70) % (n)	Age 31-40 years (n=43) % (n)	Age ≥41 years (n=13) % (n)	Officers (n=27) % (n)	SRs (n=26) % (n)	JRs (n=73) % (n)
Lack of healthy eating choices in the Galley	74 (94)	74 (79)	79 (15)	74 (52)	71 (30)	85 (11)	70 (19)	73 (19)	76 (55)
Lack of healthy eating choices in the NAAFI	53 (67)	55 (59)	42 (8)	53 (37)	50 (21)	62 (8)	37 (10)	65 (17)	54 (39)
Lack of food storage/ preparation areas onboard	47 (60)	50 (53)	37 (7)	56 (39)	36 (15)	46 (6)	19 (5)	58 (15)*	56 (40)*
Cost of healthy foods	24 (31)	27 (29)	11 (2)	23 (16)	29 (12)	23 (3)	11 (3)	35 (9)	26 (19)
Work commitments	21 (27)	23 (25)	11 (2)	21 (15)	26 (11)	8 (1)	26 (7)	27 (7)	18 (13)
Lack of nutritional knowledge	19 (24)	21 (22)	11 (2)	17 (12)	14 (6)	38 (5)	7 (2)	23 (6)	21 (15)
Dislike of healthy foods	6 (8)	7 (7)	5 (1)	6 (4)	10 (4)	0 (0)	0 (0)	15 (4)	6 (4)
Special dietary needs	1 (1)	1 (1)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)
Poor health	1 (1)	1 (1)	0 (0)	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	1 (1)
Family dietary preferences	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Note: ‡ $P<0.05$ Pearson chi-square test, difference to DNTL; * $P<0.05$ Pearson chi-square test, difference to Officers; NAAFI, Navy Army Air Force Institutes shop.

Table 4.3: Reasons for undertaking physical activity, n=98.

Barriers	All (n=98) % (n)	Males (n=88) % (n)	Females (n=10) % (n)	Age U21-30 years (n=46) % (n)	Age 31-40 years (n=38) % (n)	Age ≥41 years (n=13) % (n)	Officers (n=25) % (n)	SR (n=26) % (n)	JR (n=46) % (n)
To get fit	78 (76)	78 (69)	70 (7)	76 (35)	76 (29)	85 (11)	76 (19)	73 (19)	80 (37)
To improve my health	64 (63)	65 (57)	60 (6)	59 (27)	66 (25)	62 (8)	60 (15)	62 (16)	67 (31)
To feel good	52 (51)	51 (45)	60 (6)	52 (24)	45 (17)	77 (10)	56 (14)	54 (14)	50 (23)
To relieve stress	50 (49)	51 (45)	40 (4)	52 (24)	50 (19)	46 (6)	64 (16)	42 (11)	48 (22)
To lose weight	47 (46)	47 (41)	50 (5)	46 (21)	45 (17)	62 (8)	40 (10)	62 (16)	44 (20)
To be part of a team	19 (19)	21 (18)	10 (1)	22 (10)	18 (7)	23 (3)	8 (2)	19 (5)	24 (11)
To compete	13 (13)	15 (13)	0 (0)	22 (10)	5 (2)	0 (0)	4 (1)	12 (3)	17 (8)
To be with friends	13 (13)	13 (11)	20 (2)	17 (8)	8 (3)	8 (1)	8 (2)	15 (4)	13 (6)
My MO referred me	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Note: P>0.05 Pearson chi-square test, difference between groups; MO, Medical Officer.

Table 4.4: Acceptance of intervention activities, n=128.

Intervention activities	Likely % (n)	Undecided % (n)	Unlikely % (n)
Selection of healthy refreshments in meeting rooms	96 (122)	3 (4)	2 (2)
Healthy meal choices available in the Galley/Wardroom	95 (121)	4 (5)	2 (2)
On ship taster sessions run by the ships PTI	89 (113)	6 (8)	6 (7)
On ship activity classes	88 (112)	8 (10)	5 (6)
Healthy snack options available in the NAAFI	86 (109)	7 (9)	8 (10)
Self check facilities	84 (107)	12 (15)	5 (6)
Health and fitness assessments and/or health screening	83 (106)	9 (12)	8 (10)
After work activity clubs	83 (105)	9 (11)	9 (12)
On site facilities (e.g. food preparation and storage areas)[1]	80 (127)	13 (16)	8 (10)
Healthy meals options available in the NAAFI	78 (99)	13 (16)	10 (13)
A lunchtime activity group	77 (98)	13 (16)	8 (10)
Weight management programme	74 (94)	13 (16)	14 (18)
Team or individuals activity challenges	72 (91)	17 (21)	12 (15)
Talks and presentations on physical activity by health professionals	69 (88)	12 (15)	20 (25)
Access to weekly physical activity messages via email and/or bulletin boards	66 (84)	16 (20)	19 (24)
Team or individual 'Eat well!' challenges	65 (82)	22 (28)	14 (18)
Recipes and tips for healthy eating[1]	64 (81)	17 (22)	19 (24)
Talks, presentations and workshops on healthy eating by health professionals, dietitians or nutritionists	60 (76)	24 (30)	17 (22)
Ships' company leagues, ladders and competitions	60 (76)	24 (31)	17 (21)
Access to weekly healthy eating messages via email and/or bulletin boards	51 (65)	24 (30)	26 (33)
Access to health promotion materials such as leaflets and posters promoting healthy eating	47 (60)	28 (35)	26 (33)
Participation in local or national healthy eating events	37 (47)	33 (42)	31 (39)
Cookery classes[2]	36 (46)	17 (22)	46 (58)

Note: [1] n=127; [2] n=126; PTI, Physical Training Instructor; NAAFI, Navy Army Air Force Institutes shop.

4.3.2 Qualitative data: focus groups and HWES

Four themes emerged from the focus group discussions and HWES in relation to intrapersonal, organisational, physical environment and policy factors. No themes emerged for interpersonal factors. Table 4.5 presents these themes and associated sub-themes.

Table 4.5: Focus group themes.

Major themes	Sub-themes
Intrapersonal factors	Determinants of health-related behaviours Personnel's behaviours and knowledge Feeding requirements
Organisational factors	Chefs Physical activity provision Health promotion activities Food procurement and storage Meal timings
Physical environment factors	Galley NAAFI shop Physical activity equipment
Policy factors	Food budget Personnel Functional Standards

Intrapersonal factors

Three sub-themes emerged in relation to intrapersonal factors: determinants of health-related behaviours (i.e. food choice, physical activity, takeaway usage and NAAFI shop usage); other personnel's behaviours and knowledge; and feeding requirements.

Determinants of health-related behaviours

The most commonly reported determinants of food choice were: food availability, that is what foods were available to personnel in the Galley (compartment of a ship where food is cooked, prepared and served) and sensory appeal (e.g., *"if it doesn't look very nice to eat people aren't going to have it and it will go to waste"*, SRs focus group). Some participants also commented that their lifestyle onboard ship and food placement were important factors effecting their food choice (e.g., *"working long days you get really hungry by the time of the evening meal so you don't really care what you're eating as long as it's filling you up and giving you energy to carry on"*, JRs focus group; *"you've got to pass the chips to get to the salad counter"*, SRs focus group).

The most commonly reported determinants of whether participants undertook physical activity were: organisational factors typically relating to how the ships programme negatively impacted on personnel's workloads and associated spare time whilst alongside (e.g., *"... our programme has driven people to other priorities"*, Officers focus group), with a number of participants considering that a deployment would enable them to engage in more physical activity (e.g., *"effectively your nine month deployment every two years is your time to get fit. And the rest of the time you fit it in when you can"*, SRs focus group); and, internal factors, specifically motivation (e.g., *"it's just getting into the mind set to just crack on and do it"*, SRs focus group), enjoyment, to get fit, boredom and fatigue. A few participants also reported that the physical environment (i.e. weather, equipment and space) was an important factor that negatively impacted on their ability to undertake physical activity (e.g., *"you can't really do much when we're at sea because there's not really the space to do it"*, JRs focus group).

Participants in the JRs and SRs focus groups discussed factors that influenced whether they got a takeaway or ate out whilst alongside. The main reasons were that they either did not want to eat the food onboard due to not liking what was on the menu or because they wanted some time off the ship (e.g., *"sometimes it's the case that you've been stuck onboard and you want to get away for a bit"*, SRs focus group). To improve mood was the most frequently cited reason for why the participants used the NAAFI shop (e.g., *"you've had a bad day and feel a bit miserable and go get a chocolate boost and it makes you feel better"*, Officers focus group).

Other personnel's behaviour and knowledge

All focus groups discussed the dietary behaviours of other personnel. The most commonly discussed topics were the high occurrence of takeaway usage by the ship's company (e.g., *"… if shore side actually sat and watched the amount of fast food that comes on the ships alongside on a weekly basis it's frightening…"*, JRs focus group) and that personnel like to complain about the feeding provision (e.g., *"people will moan no matter what you do"*, Officers focus group). A few participants made reference to other personnel's levels of nutrition knowledge, both positively (e.g., *"... it's probably people that are really into their fitness that really have a good understanding of the nutritional benefits of different foods…"*, Officers focus group), and negatively (e.g., *"some people just don't realise what effect the **** they put in their body will have on them in the long term"*, Officers focus group).

Feeding requirements

Participants in all focus groups discussed what foods they considered RN personnel need to eat to stay fit and healthy, this included talking about the importance of a balanced diet and the different nutrients and foods that personnel should eat. A few participants also highlighted the importance of portion sizes and energy demands, and considered that the feeding provision onboard ship was not conducive for staying fit and healthy.

Organisational factors

Five sub-themes emerged in relation to organisational factors: the chefs; physical activity provision; health promotion activities; food procurement and storage; and meal timings.

The chefs

The majority of the discussions about the chefs focused on the opinion that they need more time to prepare the food and that they do not have the nutritional knowledge or skills to provide healthy options (e.g., *"…I don't think our chefs would have the time or knowledge to do it"*, SRs focus group). A few participants shared the opinion that the chefs do a good job (e.g., *"I think the chefs try really hard and do a good job with a very small budget"*, Officers focus group); whereas, others thought that the chefs need to take more pride in their work.

The most commonly suggested intervention ideas related to the chefs from the focus groups and HWES were: for a nutritionist to provide the ship with a menu or recipe book; for the chefs to use healthier cooking methods; and for the chefs to be provided with nutrition education. A couple of participants also suggested that the ship should have more chefs. Participants in the focus groups discussed the potential impact of such interventions, however opinions were mixed. Some participants thought that the intervention would reduce the workload of the chefs, whereas others were concerned that it might increase their workload.

Physical activity provision

Most of the discussions about the physical activity provision onboard the ship focused on the topic of circuits, sport and the PTI. The participants highlighted that two levels of circuits were typically provided twice a day during a deployment. However, one participant commented that circuits had not been provided many times whilst the ship had been alongside in the UK. This view was supported by two other participants who believed that personnel played more sport when deployed, and the problem was when the ship was alongside when personnel have other priorities. A number of participants discussed that they thought that plenty of sport was available on the ship, making reference to ship, mess and departmental competitive teams. Discussions about the PTI focused on what physical activity sessions and support they delivered to the ship's company and the participants' opinions of them, all of which were positive.

The most commonly suggested physical activity intervention idea was for regular circuits to be provided for two different fitness levels (e.g., *"...I do feel that sometimes people are intimidated by attending that if they're not as fit as some people that go to circuits to have that opportunity to just you know at the lower end of the fitness spectrum"*, Officers focus group). A number of participants also suggested that there should be set times for personnel to attend compulsory physical training sessions delivered by the PTI, either as a department, or by themselves. Participants also discussed the idea of offering flight deck sports and suggested that the circuit times should be changed to during the working day where people should be released from work to attend them.

Health promotion activities

Health promotion activities that were predominantly discussed related to nutrition education, weight management support, nutrition labelling and more generic health promotion activities. Participants in all focus groups discussed the topic of nutrition education. The general consensus was that there is a need for nutrition education to be delivered onboard the ship (e.g., *"I think more education is required, I mean, I've never had any nutrition training, at all"*, UHC focus group). This view was supported by a discussion in the Officers focus group that was concerned about the validity of nutrition advice that is presented in the media. Of those participants who talked about the potential delivery method of the education the majority thought the best format would be a brief delivered to groups of between 20-30 personnel by the PTI, chefs or Medical Officer (MO). However, a number of participants were concerned about whether there would be time to fit the training in. The majority of participants who made comments about what the education should contain thought that it should focus on providing healthy eating advice, specifically how to make healthier choices whilst onboard. A couple of participants suggested that sports nutrition briefs would be popular with the ship's company.

Participants from the SRs and UHC focus groups talked positively about the weight management programme (WMP) that is delivered onboard ship during a deployment. However, a few participants had a negative opinion of the programme, specifically citing that if success is based on absolute weight loss, the people who weigh the most at the start will be more successful. Another participant was concerned whether the programme promotes sustainable weight loss. However, a number of participants commented that due to the time frame of the WMP (i.e. nine months), it is more like a lifestyle change rather than a crash diet. Furthermore, a large number of participants stated that they would like a WMP to be delivered during the deployment so that they could get weighed and measured regularly, where a few participants from the focus groups suggested that this could be an incentivised programme.

A large number of participants highlighted that they would like the energy content of dishes to be detailed on the menus (e.g., *"…it would be nice to just have an idea of how many calories are in that option, what if I take two scoops of potatoes how many would that add, so that if people want to control their calorie intake"*, Officers focus group). Where it was stated that this would enable them to make healthier choices.

In terms of methods to deliver health promotion onboard the ship, some participants reflected about the methods currently used to promote health. These included weekly and daily orders, in which activities that were scheduled throughout the week could be advertised. When discussing the health promotion activities they would like to be included in the intervention, ideas included: nutrition advice from a subject matter expert, ‘apps’ to track calories, pipes to advertise activities, leaflets and posters, workshops, a monthly health check and healthy eating advice on a team intranet site. However, some participants suggested that posters and use of an intranet site would be ineffective. A number of participants suggested that financial incentives could be used to encourage people to be more active by paying them based on how much exercise they did or based on their fitness test level.

Food procurement and storage

The majority of participants talked about recognising the difficulties that the chefs have in storing fresh fruit and vegetable provisions whilst deployed (e.g., *“we understand that fruit doesn’t keep…”*, JRs focus group; *“…the biggest issue we have is maintaining the fresh particularly when we are out…”*, SRs focus group). One of the chefs from the UHC focus group explained that fresh fruit and vegetables typically keep for up to two weeks on a deployment, after which tinned or frozen products are used. A number of participants also commented on the belief that the foods that the chefs can procure from the supplier limit how healthily they can eat onboard. The participants further went on to suggest that the supplier should offer healthier alternatives (i.e. reduced sugar, fat and salt).

Meal timings

Participants in the Officers and SRs focus groups discussed meal timings, with a number of participants stating that they do not like that there is a large gap between lunch and the evening meal, which could be up to eight hours. Participants suggested that the meal timings should be looked at as part of the intervention.

Physical environment factors

Three sub-themes emerged in relation to physical environment factors: the Galley, the NAAFI and the physical activity equipment.

The Galley

Participants from all four focus groups discussed what foods were typically provided in the Galley at breakfast, lunch and the evening meal, and their opinions about the provision. A large number of participants commented that they thought that the provision was unhealthy (e.g., *“it’s all fried it’s all deep fried stuff”*, JRs focus group; *“the food speaks for itself we just eat unhealthy food constantly”*, JRs focus group). However, a number of participants commented that they thought that healthy options were provided (e.g., *“so I* *think we do provide it it's just obviously down to the individual as to whether they take it"*, UHC focus group). The SRs focus group also had a discussion about the appearance of the food in the Galley suggesting that it was not very attractive and *"beige"*.

Participants from three of the focus groups talked about the continental breakfast intervention that had been trialled previously on the ship. The majority of comments were positive and supportive of the intervention (e.g., *"and the feedback, I enjoyed it and I heard a lot of the JRs were having that option rather than the cooked option"*, SRs focus group). However, some participants had negative views and thought that the provision was not healthy (e.g., *"…the alternative they came up with for sausage, bacon and eggs… were as I said cheese, ham, butter croissants, which wasn't healthy"*, SRs focus group).

In terms of intervention ideas, participants mainly discussed ideas to increase the availability and/or improve the quality of healthy options, restrict unhealthy options, and reduce the number of options. A few participants discussed their beliefs and opinions about the intervention ideas. Participants thought that although there might be some initial issues, personnel would accept change. Participants also discussed that making improvements to the food provision might result in less food waste and reduce costs.

Many participants discussed that they would like healthy options available in the Galley. More specifically, participants discussed what healthy options they would like available at breakfast (e.g., fruit yoghurts, Greek yoghurt, porridge, fruit, fruit juices and smoothies), lunch (e.g., more soup options, hot healthy options and a wide salad counter with mayonnaise served separately), dinner (e.g., more variety of main courses, starchy foods and vegetables; better quality protein; and, improved attractiveness of dishes), for dessert (e.g., "healthy desserts", fresh fruit and yoghurts), and at stand easy (i.e. healthy snacks). A number of participants also suggested a variety of fresh fruit be available daily in the Mess, and dressings and sauces be served on the side of dishes.

Participants from all focus groups and the HWES proposed ideas to restrict unhealthy options at the Galley. Ideas included: providing less fatty, fried foods (e.g., *"…take away the option of fatty foods. If it's there people will take it. I think it's human nature, it's the way that the country lives and people live"*, UHC focus group); reducing the amount of days desserts and cooked breakfasts are served; providing less dishes containing pastry; and, reducing the amount of starchy foods that are provided.

Following a discussion in the Officers focus group, where a couple of participants suggested personnel are given too much food, participants discussed providing fewer options at meals. Two responses in the HWES suggested that portion sizes be reduced. A number of participants also suggested that bottled water or filtered water dispensers be installed.

The NAAFI

The majority of participants talked about the types of products that were and were not available in the NAAFI shop (e.g., *"the NAAFI is just all nutty bars and stuff"*, JRs focus group; *"there's no fruit or anything"*, Officers focus group). A few participants also mentioned that the ship has vending machines, which allow personnel 24-hour access to snacks and beverages. A number of participants stated that they thought that the provision available in the shop was 'unhealthy' with not many 'healthy' foods being available. A few participants discussed the cost of the products, stating that it was expensive and that the shop is there to make money. However, one participant did not agree with this. A few participants suggested that the NAAFI is an alternative if you do not like the food in the Galley. However, some participants suggested that the provision available in the NAAFI was insufficient to provide an alternative to a meal, with a couple of participants suggesting that the food in the NAAFI should be viewed as a treat (e.g., *"the NAAFI should be somewhere you go if you want to buy a chocolate bar every now and again not something to eat because you don't like the main course"*, SRs focus group).

A number of participants discussed intervention ideas for the NAAFI shop including that they would like healthy options to be provided (e.g., dried fruit, fruit, yoghurts, cereal bars and sandwiches). Three participants suggested that the prices in the NAAFI should be reduced; two suggested that the NAAFI should be closed; and one suggested that the payment system needed addressing to remove the minimum spend of £10 on a card.

Physical activity equipment

Participants from all four focus groups discussed the physical activity equipment provision onboard the ship. This included several areas to do cardiovascular activities (exercise and spinning bikes, and rowing machines) and weights. Discussions about the provision were generally positive (e.g., *"yeah, it's pretty good in what equipment we've got on to say that it's a warship, it's a good gym"*, JRs focus group). However, one HWES respondent stated the gym onboard needs improving.

Intervention ideas focused around increasing the amount of gym equipment, improving the quality of gym equipment, and increasing the amount of space used for gym equipment onboard the ship.

Policy factors

Two sub-themes emerged in relation to policy factors: the food budget and the PFS.

Food budget

Participants in all focus groups held the opinion that the food budget was very small and believed that this negatively impacted on the quality and healthiness of the feeding provision (e.g., *"…the actual quality of the product, the raw materials that they are using* *are pretty low"*, UHC focus group). A number of participants also suggested that the food budget was insufficient to provide healthy options (e.g., *"...the budget doesn't stretch that far"*, SRs focus group). The consistent intervention idea across all focus groups was to increase the Daily Messing Rate (DMR).

Personnel Functional Standards
In terms of the PFS, which provide direction for personnel to complete a minimum of three hours of vigorous physical activity each week programmed as part of the working day[10], the view shared by the majority of the participants was this was not upheld. A couple of participants went on to share their opinion that Command were offering it but, due to their jobs (i.e. workload), personnel were not able to take it (e.g., *"yeah they offer it but how many people can actually take three hours a week during the working time and go and do phys. Not many people"*, SRs focus group). However, this view was not held by all, with two participants from the Officers focus group stating that they did meet the PFS and that there was Command support for physical activity on the ship.

The most commonly suggested intervention idea relating to the PFS was to make physical activity mandatory. A few participants also suggested that there needs to be tighter control of the Wednesday afternoon 'sports maker events', ensuring that personnel are actually playing sport during the allotted time rather than having an afternoon off.

4.4 Discussion

To inform the development of a healthy lifestyle intervention onboard a RN ship, the SEM of health behaviour[77] was used to identify a range of factors that influence the dietary, sedentary and physical activity behaviours of RN personnel. To the author's knowledge this is the first study that has examined the interaction of the key elements of the SEM of health behaviour within a military context. The results of this study offer quantitative and qualitative evidence of the interaction of intrapersonal factors, organisational factors, the physical environment and policy factors on the dietary, sedentary and physical activity behaviours of personnel. Although no specific themes emerged relating to the interpersonal level of the SEM of health behaviour, aspects relating to interpersonal factors emerged within the other levels of the model. The data reflect the unique environment in which RN personnel work and live.

4.4.1 Intrapersonal factors

Determinants of health-related behaviours, other personnel's behaviours and knowledge, and feeding requirements were the predominantly discussed intrapersonal factors relating to personnel's dietary, sedentary and physical activity behaviours. Similar to previous research undertaken with the US Army[149], food availability was the most commonly discussed determinant of food choice. This was in contrast to the findings in Chapter 3, where sensory appeal, health and price were the main determinants of food choice. These differences might be explained by the fact that only a small cohort from the study reported in Chapter 3 were based on a ship. As such, fewer participants in that study compared with the present study, were living and working in an environment where their food choices were being tightly constrained by food availability. The second most commonly reported determinant of food choice in this study was sensory appeal, which was similar to the findings in Chapter 3 and previous literature with civilian cohorts[157,160-162]. The most frequently cited barrier to eating more healthily in this study was the availability of “healthy foods” in the Galley and NAAFI. Combined, these findings suggest that an intervention to improve the dietary behaviours of personnel onboard a ship should focus on making healthy changes to food options, through increasing the availability of healthy foods and drinks, and improve the sensory appeal of foods. At a system level this could be achieved through: amending the MOD Catering and Dining policy[78] to ensure caterers are required to provide healthy menus, where in part this was achieved through the introduction of the AFFBS; reviewing and potentially amending the Defence food quality standards[218] to ensure the nutrient content of food products is healthy; working with the food supplier and NAAFI UK manager to identify opportunities to provide healthier products; and working with the Defence Maritime and Logistics School to ensure RN chefs are trained in preparing and delivering healthy menus.

Work demands and the lack of spare time and fatigue that personnel experience as a consequence, was the most common barrier to undertaking physical activity. This is consistent with previous research, reporting that long working hours and high work loads contributed to an inability of RN personnel to lead a healthy lifestyle[188]. Participants also cited the physical environment, in particular the weather, equipment and space available for exercising, as a barrier to undertaking physical activity. This was similar to previous work undertaken with RN personnel, where respondents stated that the gym facilities onboard ships were inadequate and needed improving[188]. These findings suggest that cultural change and shift in priorities needs to be demonstrated by all personnel, including senior management and the ship’s Command, to prioritise physical activity. Additionally, the exercise equipment and space for equipment onboard the ship needs to be improved.

In the present study the majority of participants reported extrinsic motivations for why they undertook physical activity indicating they were motivated to undertake physical activity to obtain rewards or outcomes that were separate from the behaviour itself. A number of participants from the focus groups also discussed that they undertook physical activity *“for enjoyment”*, meaning they were intrinsically motivated and undertook physical activity for the satisfaction that they gained from engaging in the activity itself. Previous research has shown that for long-term adherence to physical activity individuals must be intrinsically motivated[219]. This suggests that to bring about long-term improvements in personnel's physical activity behaviours the intervention to be delivered onboard the ship should aim to replace extrinsic motives with intrinsic motives.

Interventions to improve the health behaviours of individuals need to be tailored towards an individual's stage of change[220,221]. In the present study the majority of participants were either in the contemplation or preparation stage of change for improving the healthiness of their diet and increasing the amount of time that they participated in physical activity and over half of participants were actively trying to lose weight. These findings suggest that personnel are "ready to change". Additionally, 95% of HWES respondents stated that they were interested in becoming involved in the healthy lifestyle intervention, suggesting that any intervention should be fully supported by personnel.

It must be noted that although 56% of the sample were trying to lose weight only 24% were in the action and maintenance stage of change for improving their diet. This discrepancy might be explained by the findings of Garip[222], which suggested that RN personnel are more interested in managing their weight by engaging in exercise compared with making changes to dietary behaviours. However, it may also suggest that questions that measure RN personnel's stage of behaviour change may not provide reliable data.

4.4.2 Organisational factors

Participants discussed the impact that the chefs, food procurement and storage, health promotion activities, physical activity provision, and meal timings had on their dietary, sedentary and physical activity behaviours and their desire for improvements to be made to these factors. Although differences in opinions were evident when discussing whether the chefs did a good job, participants agreed that the chefs lacked the nutritional knowledge and/ or skills to provide healthy options. This point was also raised by Davison et al.[188], whereby personnel thought that chefs needed better nutrition education. It was also believed that for chefs to provide healthy options they needed to procure healthy food options from the supplier. The participants also disliked the large time gap between lunch and the evening meal. Thus, participants suggested that chefs should get appropriate nutrition education and a menu or recipe book produced by a nutritionist, the supplier should be required to offer healthy alternatives, and the meal timings should be reconsidered. Of note, the participants acknowledged that the intervention should be considerate of the number of chefs working on the ship, and the amount of time that the chefs have to prepare food to ensure that workloads are not increased.

In addition to providing nutrition education to the chefs, participants suggested nutrition education be delivered to the whole ship's company. Specifically, to deliver a brief that provides personnel with healthy eating advice and education on making healthier choices whilst onboard ship. Previous research undertaken with RN recruits during military training demonstrated that levels of nutrition knowledge were low[32]. Thus, reinforcing the need for effective nutrition education to be delivered to personnel. Respondents in the study by Davison et al.[188] also commented on the requirement for improved education and awareness of healthy food choices.

The participants seemed to be content with the provision of sport. However, there was disparity in comments regarding physical activity provision, particularly the provision of circuits, which appeared to be regularly provided during a deployment but less frequently whilst alongside. Discussions about the PTI and the support provided to the ship's company were positive. This was dissimilar to previous research[188], which might be explained due to Davison et al. including comments about numerous PTIs; whereas the present study only including discussions about one specific PTI. Regarding intervention options, participants suggested that circuits for different fitness levels and flight deck sports should be regularly provided during the deployment. There was also high participant acceptability for on-ship taster sessions run by the PTI. However, older participants stated that they would be less likely to engage in such activities, the reasons for which were not explored. This is concerning given the results in Chapter 3, which demonstrated that older personnel tended to be less active compared with younger personnel. Similar to previous research[188], the participants in the present study requested time be set in the working day/week for compulsory physical exercise, suggesting that they wanted support from the organisation to be more active.

Other health promotion activities that the participants said they would like to be delivered onboard the ship included weight management support and nutrition labelling. These interventions have been successful onboard US ships (WMP)[223] and at US Army bases (point-of-choice labelling)[126,128]. Additionally, participants proposed that they would like nutrition advice from a subject matter expert, "apps" to track energy intake, leaflets and posters, workshops, health checks and for healthy eating advice to be available on a team intranet site. Several participants also proposed the use of financial incentives to promote physical activity. However, this would be an extrinsic motivator and to bring about long-term improvements in personnel's physical activity behaviours extrinsic motives should be replaced with intrinsic motives[219].

In summary, the interventions that the participants suggested that relate to the organisation aim to enable personnel to make healthier dietary choices and to increase their physical activity levels and decrease their levels of sedentariness by increasing their capability and motivation, and through maximising opportunity[124].

4.4.3 Physical environment

In terms of feeding opportunities, whilst at sea personnel are provided with three main meals a day in the Galley. An extra meal (i.e. the midnight meal) is also provided for personnel working the night shift. In addition, personnel may purchase foods and beverages from the NAAFI shop when open and vending machines twenty-four hours a day. Whilst alongside, personnel can also eat away from the ship and can order takeaway food to be delivered to and consumed on the ship. Participants commented on the high occurrence of takeaway usage by the ship's company whilst alongside. This was attributed to personnel not wanting to eat the food onboard and instead wanting something different.

Similar to previous research[188], participants reported a range of views regarding the healthiness of the feeding provision in the Galley. Some participants commented that the provision was not healthy, and consequently was not conducive for staying fit and healthy, whereas others thought that healthy options were provided. Suggested interventions were to alter the properties and placement of objects or stimuli[87] by increasing the availability of healthy options, restricting the availability of unhealthy options, reducing the number of options overall, and improving the presentation and quality of healthy options. Participants believed that making improvements to the feeding provision would result in less food waste, which they believed would save the ship money. As reviewed in Chapter 2, interventions that have used similar methods to increase the availability of healthier food options in institutional settings have resulted in successful dietary outcomes[126-131,133-136]. With regards to other feeding opportunities participants considered that the food and beverage provision in the NAAFI was unhealthy, with few healthy foods being offered. As such, the participants suggested that the NAAFI should increase the availability of healthier foods. This has previously been proven to be a successful strategy in small food stores[224]. However, limiting the availability of unhealthy food should also be considered.

Although many comments about the physical activity equipment provision onboard the ship were positive, the participants suggested a number of ideas for improvements. These included: increasing the amount of gym equipment, improving the quality of gym equipment, and increasing the amount of space that is used for gym equipment onboard the ship. Similar to the study by Davison et al.[188], respondents also stated that improvements are needed in the gym facilities on ships to support personnel. However, the results from an evaluation of a multicomponent shipboard intervention that made improvements to fitness facilities showed improvements in physical fitness but no improvements in physical activity levels[130].

4.4.4 Policies

The food budget and the PFS were the predominantly discussed policy factors relating to personnel's dietary, sedentary and physical activity behaviours. Specifically, the food budget was perceived to be too small and thought to negatively impact on the quality and healthiness of the provision in the Galley. Furthermore, the majority of personnel stated that they did not achieve the PFS. Although the latter was not a failure of the policy *per se*, it highlights a failure of the organisation to enact the policy. This finding is supported by the data presented in Chapter 3, which suggested that compliance with the PFS could be improved, and the findings of Davison et al.[188] that reported personnel did not feel empowered to undertake exercise despite the provisions stated in the PFS.

The first policy related intervention idea suggested by personnel was to increase the DMR. Historically, healthier foods and beverages have been shown to be more expensive compared with unhealthier ones[225], resulting in healthier diets being less affordable[226]. Hypothetically, if the food budget onboard the ship was higher the healthiness of the feeding provision could be improved, which would enable personnel to make healthier dietary choices through maximising opportunity[124]. Moreover, when considering the findings of the studies included in the systematic review in Chapter 2, it could be assumed that improving the healthiness of the food on offer would improve the dietary behaviours of personnel.

The second policy related intervention idea was to make physical activity mandatory. Although this would eliminate choice, which is considered to be an intrusive intervention measure[62], it would maximise opportunity by giving personnel more time to undertake physical activity and making it more socially acceptable[124]. This intervention method would increase personnel's physical activity levels in the short-term. However, it might not lead to long-term behaviour change when personnel are drafted to another unit where the enactment of the PFS policy might be suboptimal.

Nearly a quarter of participants completing the HWES cited the "cost of healthy food" as a barrier to eating more healthily. As personnel onboard a ship do not physically pay for food at the Galley, it was assumed that this related to the cost of healthy foods in the NAAFI, which sets its own prices. Thus, suggesting that the NAAFI should incentivise healthy foods and beverages by making them more affordable. This intervention would facilitate personnel to make healthier dietary choices through maximising opportunity. Previous studies have shown that offering price reductions on healthier products in vending machines were associated with increased sales in a workplace setting[227]. Thus, suggesting that reducing the price of healthy foods and beverages in the NAAFI and vending machines might prove successful.

4.4.5 Study limitations

Several limitations must be acknowledged. Although efforts were taken to ensure that a purposive sample of participants from each mess and the UHC were included in the focus groups, the opinions and suggestions presented by this sample of participants cannot be viewed as being representative of the RN or of the whole ship. Furthermore, the focus groups contained between four and seven participants, which is lower than the five to eight recommended by Carlsen and Glenton[228]. The HWES provided supplementary evidence from a wider group of participants than those who participated in the focus groups. However, the HWES response rates were less than optimal being only 44% and 51% for HMS Dauntless and HMS Duncan, respectively. Furthermore, although the HWES were distributed to the whole ship's company onboard both ships; the representativeness of the study sample in terms of rank was dissimilar to the whole ship's company for both Officers and JRs. Moreover, the results might be biased whereby personnel who were interested in health might have been more likely to participate.

Another limitation was that participants in the focus groups knew each other, which might have led to participants being less candid in their comments. To minimise this and to enable deeper levels of discussion, and ultimately richer data, focus groups were convened according to participants' rank. As with all focus group data, the findings of the present study might be limited by the participants' tendency to provide socially desirable responses. To minimise this the facilitators of the focus groups were civilians and participants were informed that everything discussed in the focus group was confidential.

A further limitation of the study was in the analysis of the focus groups. Due to limited resource only the author undertook the transcribing and coding of the focus groups. Thus, the author's perspective may have influenced the coding manual and data analysis.

4.4.6 Conclusion

The findings from this study demonstrated the interaction of intrapersonal factors, organisational factors, policy factors and the physical environment on the dietary, sedentary and physical activity behaviours of RN personnel. The findings confirmed that a multi-level WSA should be taken to improve the health behaviours of personnel. This comprehensive approach would combine upstream, midstream and downstream strategies being cognisant that RN personnel do not live and work solely in the military environment. Thus, applying only upstream strategies, such as creating supportive environments through making changes to policies, may not be as successful at achieving behaviour change when individuals are exposed to the external community nutrition and physical activity environments.

To improve the dietary behaviours of personnel it was suggested that the intervention should: increase the DMR and the availability of healthy options in the Galley and the NAAFI; restrict the availability of unhealthy options in the Galley and the NAAFI; improve the presentation and quality of healthy options; ensure the supplier offers healthy alternatives; incentivise healthy foods in the NAAFI; reduce the number of options overall in the Galley; provide nutrition education and advice to the whole ship's company; provide nutrition education to the chefs, and a menu or recipe book; and, provide a WMP, health checks, nutrition labelling, and health promotion through utilising apps, leaflets, posters and workshops.

To reduce the sedentary behaviours and increase the physical activity behaviours of personnel it was suggested that the intervention should: create a culture change and shift in priorities to prioritise physical activity; make physical exercise mandatory; increase the amount and improve the quality of gym equipment; increase the amount of space that is used for gym equipment onboard the ship; provide regular circuits for different fitness levels, and flight deck sports; and, provide on ship taster sessions run by the PTI.

Overall, these interventions will enable personnel to make healthier dietary choices, increase their physical activity levels, and decrease their levels of sedentariness by increasing their capability and motivation, and through maximising opportunity. Further research is required to determine what specific multi-level multicomponent strategies can be applied on a RN ship and to clarify whether the opinions of the participants within the present study are consistent with reality. These will be explored in Chapter 5.

5 Evaluation of the nutrition and physical activity environment onboard Royal Navy vessels

5.1 Introduction

This Chapter presents a cross-sectional study to evaluate whether the physical environment onboard RN vessels supports healthier dietary and physical activity choices. The findings of the study were used to inform the development of the healthy lifestyle intervention outlined in Chapter 6.

As summarised in Chapter 1 obesity is a problem in the RN[30-37]. This was further confirmed by the findings presented in Chapter 3, which indicated that 29% of participants were classified as being at any risk of obesity related ill health. As previously discussed (see section 1.3) the health, economic and occupational implications of obesity to the RN are considerable, and is likely to result in reduced operational readiness and deployability. Due to a combined reduction and deficit in manning levels it is important that all RN personnel are both healthy and occupationally fit to deploy. Thus, it is imperative that action is taken to reduce the prevalence of obesity amongst personnel.

Although the determinants of obesity are extremely complex and multifaceted[54], dietary habits and physical inactivity have traditionally been identified as major risk factors[22,23]. Recognised dietary risk factors for obesity include: diets high in fat and low in fibre, diets high in energy dense foods, and the consumption of drinks that are high in sugar[146]. Previous research undertaken with RN personnel on operations at sea suggests that personnel's dietary behaviours may be predisposing them to obesity[18,19]. In these two studies the mean proportion of energy intake derived from total fat was higher and from carbohydrates was lower compared with the MDRVs[79]. Furthermore, participants had higher salt intakes and lower intakes of fruits and vegetables compared with the government healthy eating guidelines[18-20]. The research also demonstrated considerable variation in the self-reported frequency of structured physical training amongst personnel, with some individuals undertaking no sessions per week[18,19]. This lack of healthy physical activity behaviours was also evident in the study presented in Chapter 3, where 13% of study participants reported that they were either moderately inactive or inactive. Combined, these findings stress the need for interventions to improve the dietary and physical activity behaviours of RN personnel to both prevent and treat obesity.

To improve the health behaviours of personnel, it is fundamental to consider that individuals influence – and are influenced by – the physical, social, political, and economic environments in which they make health-related decisions[77,116,229,230]. This means that health promotion interventions need to create environments and policies that make healthy choices convenient, attractive and economical; produce strong social norms and social support for healthy choices; and both educate and motivate individuals to make these choices[84]. One method is to apply a WSA through cross-disciplinary and multi-agency activities that target the different levels of the social system[66,231].

The systematic review presented in Chapter 2 identified that there is no research to evaluate the effects of multi-level health promotion interventions that target dietary intake and/or physical activity behaviours in UK military establishments. Of the nine studies critiqued in the review, five included multi-level strategies and were delivered in military bases in the US, Finland, Denmark, Norway and Danish maritime setting[127,128,130,131,133-135]. The most commonly employed strategies included reducing barriers, increasing opportunities for and accessibility to healthy choices, restricting the availability of less healthy options and increasing cues to healthier behaviour. Only one study employed cross-disciplinary strategies by targeting both dietary and physical activity behaviours[130]. The systematic review concluded that the evidence base appeared to be in favour of implementing multi-level and multi-component interventions to improve the dietary behaviours of adults in institutions. However, due to the multi-level and multi-component nature of the intervention studies critiqued, the small number of studies included in the review, and the variable methodological quality of the studies and intervention reporting, it was difficult to determine which strategies and intervention activities were successful.

In developing any health promotion intervention the nutrition and physical activity environments need to be measured to determine the extent to which they support healthy choices. This will then inform the required improvements and the feasibility to make these improvements. To measure the effects of the nutrition environment on an individual's eating behaviour, Glanz et al.[232] proposed a conceptual model based on an ecological approach. The model identified four types of nutrition environments that combine to support healthy eating behaviours, namely: (i) community nutrition environment (i.e. type, location and accessibility of food outlets); (ii) organisational nutrition environment (e.g., home, school and work); (iii) consumer nutrition environment (e.g., availability of healthy options, price, promotions, placement and nutritional information); and (iv) information environment (i.e. media and advertising).

To the author's knowledge there is only one previous published study that has measured the healthiness of a military environment, where this study measured the consumer nutrition environment at and surrounding an Australian military base[233]. The study suggested there was scope for improvement in increasing the availability of healthy alternatives in the military dining facilities on the base and providing appropriate information to consumers so that they can both identify and make healthier choices. The applicability of these findings to a RN warship is limited due to the environment onboard a warship being distinctly different to that of a land base. Moreover, due to cultural differences in eating behaviours is likely to be even more dissimilar to the environment of an Australian land base.

5.1.1 Aim and objectives

To inform the development of the healthy lifestyle intervention this cross-sectional study aimed to evaluate whether the nutrition and physical activity environments onboard RN vessels support healthy dietary and physical activity choices.

The objectives of the study were to:

i. Analyse the vessel menus against nutrient and food-based guidelines;
ii. Assess the NAAFI shop and vending machine provision onboard the vessels against food-based guidelines;
iii. Audit the physical activity environment onboard the vessels; and
iv. Audit current health education and promotion activities delivered onboard the vessels.

5.2 Methods

5.2.1 Vessels

A convenience sample of seven ships and one submarine were selected to participate in the study, as directed by the Fleet Catering Warrant Officer (WO) (Table 5.1). The selection was intended to be representative of the different vessels in the RN Fleet at the time of the study.

5.2.2 Procedures

The author and another researcher undertook a one-day visit onboard each of the vessels between February 2014 and December 2014. The vessels were alongside during the visits. With the assistance of Catering Services, the PTI, the Medical Department, the NAAFI and the ship’s company onboard the vessels, an assessment tool – *Physical Activity and Nutrition Environment Assessment Tool* (PANEAT, Appendix 13) – was completed. The tool was developed specifically for the study and was based on the US military Nutrition Environment Assessment Tool (m-NEAT)[234]. The m-NEAT was deemed unsuitable to use to assess the environment of RN vessels as it was developed for US military bases, which include many commercial food outlets. Furthermore, it did not consider the physical activity environment or health education and promotion activities.

The PANEAT was used to assess accessibility to: i) healthy food options in the Galley, NAAFI and vending machines; ii) physical activity facilities; and, iii) healthy lifestyle education and promotion activities, onboard the vessels. Additionally, each vessel sent the author a sample of their menus between December 2013 and September 2015. Due to logistical difficulties, the study team were unable to visit HMS Ledbury and HMS Vigilant so a member of the crew onboard HMS Atherstone (in replacement of HMS Ledbury) and HMS Vigilant completed the proforma under the direction of the author.

Table 5.1: RN vessels participating in the study.

Vessel	Type of Vessel	Size of Vessels' Company	Length of Vessel (m)
HMS Bulwark	Landing Platform Dock Assault Ship	400-950	176
HMS Dauntless	Type 45 Destroyer	180-240	152
HMS Defender	Type 45 Destroyer	180-240	152
HMS Duncan	Type 45 Destroyer	180-240	152
HMS Illustrious	Invincible-class Light Aircraft Carrier	360-650	226
HMS Lancaster	Type 23 Frigate	80-190	133
HMS Ledbury/ Atherstone	Hunt-class Mine Countermeasures Vessel	23-42	60
HMS Vigilant	Vanguard Class Submarine	110-135	150

Note: HMS, Her Majesty's Ship.

5.2.3 Data analyses

The nutritional content of the menus over two weeks was calculated using a nutritional analysis package (Dietplan6, Forestfield Software Ltd, Horsham, UK). The assumptions made during the menu analyses are presented at Appendix 14. The results provided are for the average food portion sizes provided at the Galley[235], and do not consider foods chosen or wasted. Furthermore, the results do not include any snacks or self-supplemented provision consumed between meals.

The menus were analysed and compared with the MDRV[79]; the dietary guidelines for the UK population[236-238]; and, the AFFBS (Appendix 15)[78]. The NAAFI and vending machine provision were analysed and compared against the Government Buying Standards for Food and Catering Services (GBSF)[239] voluntary best practice criteria and the Food Standards Agency (FSA) food labelling guidelines[240]. The GBSF provision of foods and drinks are as follows: i) savoury snacks should only be available in packet sizes of 30 g or less; ii) confectionary and packet sweet snacks should be in the smallest standard single serve portion size available and not exceed 250 kcal; iii) sugar sweetened beverages should be available in no more than 330 ml containers; and iv) no more than 20% of beverages should be sugar sweetened[239]. Data are presented as means, counts and percentages with SD being reported in parentheses.

5.3 Results

5.3.1 Nutrition environment

Menu analysis: energy and nutrient

Details of the average daily nutrition content of the food provided onboard the vessels is presented at Table 5.2 (all meals) and Appendix 16 (breakfast, lunch and dinner). The mean daily energy provision was 3237 (357) kcal. The mean percentage of energy provided from protein, carbohydrate, total fat and saturated fat was 17%, 42%, 42%, and 15%, respectively. The mean daily provision of sugar, dietary fibre and salt was 94 (18) g, 37 (5) g and 15 (2) g, respectively. Although all of the vessels were compliant with the dietary guidelines for energy and dietary fibre, none were compliant with the dietary guidelines for the percentage of EI derived from protein, total fat, saturated fat or carbohydrates, or salt.

In terms of individual food items, at breakfast: grilled sausages, scrambled eggs, French toast, fried bread, croissants and black pudding had the highest total and saturated fat content; and, grilled sausages and black pudding had the highest salt content. At lunch and dinner: pies, pasties and main dishes made with processed meat products (e.g. toad in the hole) had the highest energy content; main dishes containing mince, processed meat products, fatty cuts of meat (e.g. lamb, braising steak and ribs), or cheese, and assorted salads with mayonnaise had the highest total and saturated fat content; desserts containing chocolate and crumbles had the highest sugar content; and, processed meat products, pies and pasties had the highest salt content.

Menu analysis: food group

Compliance of the vessel menus with the 15 AFFBS that could be assessed against ranged between 20% and 40% for each vessel (Table 5.3). None of the vessels were compliant with seven of the 15 standards, and all vessels were compliant with two standards. Compliancy with the other six standards ranged between 13% and 88% of vessels (Table 5.3).

Appendix 17 details the feeding provision onboard the vessels for all meals per food group. The main findings from the food group analysis were:

Fruit and vegetables

a. Fruit and vegetables combined were provided, on average, 6.2 portions per day.
b. There was generally good variation in the vegetable provision at dinner.
c. Baked beans and processed peas were the most frequently served vegetables at lunch, where spaghetti in tomato sauce was also served as a vegetable option onboard some vessels.

d. On average, 29% of the vegetable options were cooked in oil or fat, or served in a cheese or cream sauce.

Potatoes, bread, rice, pasta and other starchy carbohydrates

a. Between zero and five different types of starchy foods were provided each day at each of the main meals, totalling an average of three options per day.
b. Potato options made up, on average, 69% of the starchy food choices.
c. No wholegrain or higher-fibre starchy foods were provided.
d. Starchy foods cooked in fat or oil were served, on average, 18% of the time at breakfast, 61% of the time at lunch and 59% of the time at dinner. The highest provision of starchy food options cooked in fat or oil at lunch and dinner was 86 and 88%, respectively.
e. On average, 19% of the daily breakfast cereal provision was high in total sugar (i.e. more than 22.5 g per 100 g). On average, 51% of the daily breakfast cereal provision was high in fibre (i.e. more than 6 g per 100 g).

Beans, pulses, fish, eggs, meat and other proteins

a. Three protein items were available at breakfast, and one to five protein option choices were available at lunch and dinner.
b. Fish (white and sea food) was provided, on average, 3.6 portions per week.
c. Oily fish was provided, on average, 0.2 portions per week.
d. Processed meat products were provided, on average, 3.4 portions per day, with two portions being provided at breakfast every day (i.e. sausages and bacon). Processed meat product options made up, on average, 41% and 13% of the protein options at lunch and dinner, respectively. The highest provision of processed meat products at lunch and dinner was 69 and 25%, respectively.
e. Red meat options made up 22% and 49% of the protein options at lunch and dinner, respectively. Poultry options made up 22% and 24% of the protein options at lunch and dinner, respectively.
f. A vegetarian main course was offered, on average, 6.6 times per week. This main course option contained cheese or vegetables, and no other source of protein on average 54% of the time.

Dairy and alternatives

a. Milk and/or dairy foods were provided, on average, 2.2 portions per day.

Food and drinks high in fat and/or sugar

a. A main course option, which was deep-fried or served in a cheese or creamy sauce, was provided, on average, 13% of the time.
b. A main course option containing pastry was provided, on average, 9% of the time.

c. A main course option, which was battered or bread-crumbed, was provided, on average, 10% of the time.
d. On average, 33% of the desserts provided were fruit-based desserts.

Soup

a. Soup was provided, on average, 67% of the time. No soup option was available onboard HMS Ledbury or HMS Vigilant. The type(s) of bread roll (i.e. white, brown or wholemeal) accompanying the soups were not specified.

Light lunch option

a. A light lunch option (i.e. baguette, salad or jacket potato) was provided in addition to other main protein options on average 63% of the time. No light lunch option was available onboard HMS Ledbury or HMS Vigilant.

Mess environment

In accordance with the MOD catering and dining policy[78], personnel onboard each vessel were provided with three meals each day in the Mess (i.e. breakfast, lunch and dinner). Whilst at sea, between 45 min and one hour were allocated for each mealtime, where breakfast started at *circa* 0700, lunch at *circa* 1200 and the evening meal at *circa* 1900. The actual timings varied depending on the vessel. Breakfasts started later on Sundays. Personnel also had access to hot and cold drink making facilities in their Mess deck that were used during ‘stand easy’ (morning break).

A “healthy” meal choice was available onboard the majority of vessels. However, this was typically from the salad or jacket potato bar. The healthy meal choice was highlighted on the menus, but not at the servery, on half of the vessels (HMS Atherstone, HMS Dauntless, HMS Defender and HMS Lancaster). Healthy main meal, starchy food and vegetable choices were not placed at the front/start of the servery to promote selection onboard any of the vessels.

In accordance with the AFFBS[78] salt was only provided at a central service point (i.e. not on the tables) in the SR and JR Mess onboard HMS Dauntless and HMS Duncan. Salt was provided on the tables in the Wardroom (Officers Mess) onboard these two vessels. Salt was provided on the tables in the Wardroom and SR Mess onboard HMS Bulwark, but not in the JR Mess. Salt was provided on the tables for all Messes onboard HMS Atherstone, HMS Defender, HMS Illustrious, HMS Lancaster and HMS Vigilant.

A wide variety of alcoholic and non-alcoholic beverages were available in the Wardroom and SR Mess onboard all ships, including: beer, lager, cider, alcopops, wine, spirits, sugar-sweetened soft drinks (e.g., cola) and sugar-free soft drinks (e.g., diet cola). JR were required to sign for alcohol and had a two-can limit (i.e. no more than two cans of beer, or equivalent, per day). No alcohol was available onboard HMS Vigilant. Bar snacks (e.g., nuts, crisps and chocolate bars) were also available in the Wardroom and SR Mess onboard all ships.

NAAFI provision

A NAAFI shop was available onboard all the vessels except HMS Atherstone and HMS Vigilant. The NAAFI was typically open for two to four hours per day during a deployment, and up to two hours per day whilst alongside. The provision was typically confectionary and sweet snack items (e.g., flapjacks, cereal bars and biscuits), savoury snacks items (e.g., crisps, nuts, Peperami and beef jerky), meal replacements (e.g., Cup-a-soup, Pot noodles, noodles, tuna light lunch and porridge pots), sugar-sweetened and sugar-free soft drinks, energy drinks and frozen confectionary.

The detailed provision of the NAAFI shops onboard the vessels is presented at Table 5.4. When analysed according to the GBSF and FSA guidelines:

a. Between 61% and 81% of confectionary and packet sweet snack items on the vessels were available in the smallest standard single serve portion size available. None of the vessels complied with this GBSF.
b. Between 33% and 72% of confectionary and packet sweet snack items on the vessels exceeded 250 kcal per item. None of the vessels complied with this GBSF.
c. Between 12% and 38% of savoury snacks were available only in packet sizes of 30 g or less. None of the vessels complied with this GBSF.
d. Between 78% and 100% of beverage options on the vessels were sugar sweetened.
e. Between 14% and 89% of the sugar containing drink options on the vessels were available in no more than a 330 ml portion size. None of the vessels complied with this GBSF.
f. Between 8% and 28% of total food products were deemed to be ‘healthy’ snacks/meal alternatives (i.e. a sugar, total fat and saturated fat content that is low or medium according to the FSA food labelling guidelines)[240].

Vending machine provision

A vending machine was available near the NAAFI shop onboard all vessels except HMS Atherstone and HMS Vigilant. The provision typically consisted of confectionary and sweet snack items, savoury snack items, sugar-sweetened and sugar-free soft drinks and energy drinks. The detailed provision of the vending machine content onboard the vessels is presented at Table 5.5. In terms of complying with the five GBSF, none of the vessels’ vending machines complied with the GBSF for providing: no more than 20% of beverages that are sugar sweetened; confectionary and packet sweet snack items being available in the smallest standard single serve portion size available; and no confectionary and packet sweet snack items exceeding 250 kcal per item. One of the vessel's vending machines complied with the GBSF for savoury snacks only being available in packet sizes of 30 g or less, and two of the vessel's vending machines complied with the GBSF for sugar containing drink options being available in no more than a 330 ml portion size.

5.3.2 Physical activity environment

All seven ships had at least one dedicated space for exercise equipment (i.e. gym) onboard. The majority of the ships also used additional compartments, the flight deck (or equivalent outdoor space) and the hangar (where applicable). However, this depended on the ship's state of readiness and flying duties. All ships had a wide range of cardiovascular and strength/weight training equipment available, but there were differences in the amount and type of equipment on the different ships (Table 5.6). The provision of exercise equipment onboard the submarine HMS Vigilant was limited due to there being no dedicated space; equipment had been fitted onboard where space allowed.

All the vessels, except HMS Atherstone and HMS Vigilant, had a PTI onboard. HMS Atherstone and HMS Vigilant also did not have an Endurance Training Leader (ETL). ETLs are personnel who have undertaken a 2-day training qualification to enable them to deliver physical training sessions, basic circuit training and stretching activities when a PTI is not available. The PTIs onboard the vessels delivered a variety of circuits, which were provided between two and four times a day; flight deck sports; competitions; Fleet physical activity challenges; and adventurous training whilst the vessels were deployed.

5.3.3 Health education and promotion activities

Health education posters were placed outside the sickbay onboard all ships. This was typically National Health Service materials and based on National health awareness days. No health education materials (e.g., leaflets or posters) were displayed in the Wardroom, SR Mess or JR Mess onboard any of the vessels. Posters were presented in the gym onboard HMS Defender and HMS Lancaster. However, these focused on muscle anatomy, stretching and weight training rather than health and fitness *per se*. No health education materials were available onboard HMS Vigilant. In general, health education materials were not specific to military personnel or of a consistent format.

The provision of health promotion activities onboard the vessels was dependent upon the PTI and the MO. Nutrition support and one-to-one physical training advice was delivered by the PTI onboard all the vessels that had one, when requested. Support included coaching personnel how to lift weights correctly and delivering walk to run programmes. Onboard HMS Illustrious, the PTI and MO delivered a healthy lifestyle and physical training brief to the ship's company. No support or advice was delivered onboard HMS Atherstone or HMS Vigilant. The general training that RN MOs, PTIs and chefs have received, and specifically in the area of health and wellbeing is summarised at Appendix 18.

Table 5.2: Nutritional analysis of menus – average daily provision all meals.

Ship	Energy	Protein		Carbohydrate		Sugar	Fat		Saturated Fat		Dietary Fibre	Salt
	(kcal) Mean (SD)	(g) Mean (SD)	(%) Mean (SD)	(g) Mean (SD)	(%) Mean (SD)	(g) Mean (SD)	(g) Mean (SD)	(%) Mean (SD)	(g) Mean (SD)	(%) Mean (SD)	(g) Mean (SD)	(g) Mean (SD)
HMS Bulwark	3268 (371)	136 (16)	17 (2)	348 (46)	43 (3)	94 (18)	148 (21)	41 (3)	52 (7)	14 (1)	40 (4)	15 (2)
HMS Dauntless	3229 (268)	131 (16)	16 (1)	334 (32)	41 (2)	96 (14)	152 (15)	42 (2)	52 (6)	14 (2)	36 (4)	16 (2)
HMS Defender	3153 (382)	128 (16)	16 (2)	324 (56)	41 (3)	89 (25)	149 (19)	43 (3)	54 (6)	16 (2)	35 (9)	15 (3)
HMS Duncan	3495 (321)	139 (18)	16 (1)	349 (39)	40 (2)	101 (11)	171 (18)	44 (2)	61 (8)	16 (2)	39 (4)	16 (2)
HMS Illustrious	3331 (334)	136 (14)	16 (2)	351 (39)	42 (2)	106 (19)	153 (22)	41 (3)	53 (7)	14 (1)	39 (4)	15 (2)
HMS Lancaster	3148 (301)	135 (18)	17 (1)	326 (35)	41 (2)	88 (16)	145 (16)	41 (2)	51 (7)	15 (1)	37 (4)	15 (2)
HMS Ledbury	2924 (338)	124 (24)	17 (2)	308 (34)	42 (3)	84 (12)	133 (20)	41 (4)	47 (8)	14 (2)	32 (4)	13 (3)
HMS Vigilant	3348 (310)	141 (18)	17 (2)	353 (43)	42 (3)	97 (18)	153 (13)	41 (2)	50 (5)	14 (2)	41 (5)	14 (2)
Average	3237 (357)	134 (18)	17 (2)	337 (43)	42 (3)	94 (18)	150 (20)	42 (3)	52 (8)	15 (2)	37 (5)	15 (2)
Dietary reference values	3600/ 2800[1]*	-	13.5-15*	-	50-55*	-	-	31.5-35*	-	<11†	30†	<6†

Note: [1] Male/Female; * MDRV Active Service [79]; † dietary guidelines for the UK population [236-238]; Compliancy with DRVs: green, compliant; red, non-compliant.

Table 5.3: Compliancy of menus with AFFBS.

AFFBS	HMS Bulwark	HMS Dauntless	HMS Defender	HMS Duncan	HMS Illustrious	HMS Lancaster	HMS Ledbury	HMS Vigilant
At least 5 portions of fruit and vegetables are provided every day	green	green	green	green	green	green	red	green
Vegetables cooked in fat/oil or served in a cream/cheese sauce are not provided more than once per meal	red	red	red	red	red	red	red	red
At least one-third of starchy food options are non-potato	red	green	red	red	green	red	green	green
At least 25% of non-potato starchy options are wholegrain or high-fibre versions	red	red	red	red	red	red	red	red
At least 50% of breakfast cereal options are high-fibre	green	green	red	green	green	red	green	green
Starchy food cooked/prepared with fat/oil is not provided more than once per day across lunch/dinner	red	red	red	red	red	red	red	red
No more than 50% of breakfast cereal options are high in total sugar	green	green	green	green	green	green	green	green
Main course options made with pastry are not provided more than once per day	red	red	red	red	red	red	red	green
At least two portions of fish are provided per week	green	green	green	green	green	red	green	green
At least one portion of oily fish is provided per week	red	red	red	red	red	red	red	red
At least one vegetarian main course option per day contains either: eggs, beans, peas, lentils or vegetable-based sources of protein	red	red	red	red	red	red	green	red
Processed meat products are not provided more than once per day across lunch/dinner	red	red	red	red	red	red	red	red
A portion of milk/ dairy foods are provided at every meal	red	red	red	red	red	red	red	red
At least 50% of the dessert options available are based on fruit	red	red	red	red	red	red	red	red
Tap water is visible and freely available	green	green	green	green	green	green	green	green
Compliancy per vessel (%)	**33**	**40**	**27**	**33**	**40**	**20**	**23**	**38**

Note: Compliancy with AFFBS: green, compliant; red, non-compliant.

Table 5.4: NAAFI provision.

Vessel	Edible products (n)	Confectionary[1] and packet sweet snacks[2]			Savoury snacks[3]		Soft drinks[4]			Meal replacements[5] (n)	Healthy snacks[6] (n [% of total provision])
		n	Available in smallest standard single serve portion size (n [%])	Exceeding 250 kcal per item (n [%])	n	Available in packet sizes of 30 g or less (n [%])	n	Sugar containing soft drinks (n [%])	Sugar containing drinks available in no more than a 330 ml portion size (n [%])		
HMS Bulwark	75	27	19 (70)	9 (33)	15	5 (33)	9	7 (78)	3 (43)	19	16 (26)
HMS Dauntless	74	25	16 (64)	18 (72)	16	6 (38)	13	12 (92)	8 (67)	12	9 (17)
HMS Defender	80	28	18 (64)	11 (39)	17	2 (12)	11	9 (82)	4 (44)	20	18 (28)
HMS Duncan	97	47	38 (81)	19 (40)	20	5 (25)	16	16 (100)	2 (14)	11	6 (8)
HMS Illustrious	170	92	70 (76)	37 (40)	29	4 (14)	12	10 (83)	4 (40)	28	22 (15)
HMS Lancaster	80	38	23 (61)	16 (42)	10	2 (20)	10	9 (90)	8 (89)	16	14 (22)

Note: [1] sweets, chocolate bars; [2] flapjacks, muffins, cakes, biscuits, doughnuts, chocolate/yoghurt coated dried fruit/nuts/seeds; [3] crackers, crisps, snack a jacks, savoury nuts, beef jerky, peperami; [4] fruit juice, water, fizzy drinks, milkshakes, flavoured water; [5] noodles, tuna light lunch, pasta, cup-a-soup, porridge pots, rice; [6] snack a jacks, soreen loaf, dried fruit (no coating), nuts/seeds (no salt/coating), beef jerky, original porridge pot, cup-a-soup, koka noodles.

Table 5.5: Vending machine provision.

Vessel	Product slots (n)	Slot content (n [%])	Sugar containing drinks available in no more than a 330 ml portion size (n [%])	Confectionary and packet sweet snack items in the smallest standard single serve portion size available (n [%])	Confectionary and packet sweet snack items available exceeding 250 kcal per item (n [%])	Savoury snacks/ crisps available in packet sizes of 30 g or less (n [%])
HMS Bulwark	26 food	1 savoury snack (4) 3 crisps (12) 1 sweet snack (4) 6 sweets (23) 12 chocolate bars (46) 2 hot beverages (8) 1 meal replacement (4)		17 (89)	2 (11)	0 (0)
	12 drink	2 fruit juice (17) 2 sugar-free soft drinks (17) 8 sugar sweetened soft drinks (67)	5 (63)			
HMS Dauntless	16 food	1 savoury snack (6) 5 crisps (31) 1 snack bar (6) 2 sweets (13) 7 chocolate bars (44)		7 (70)	4 (40)	2 (33)
	6 drink	1 sugar-free soft drink (17) 3 sugar sweetened soft drinks (50) 2 energy drinks (33)	3 (60)			
HMS Defender	16 food	2 savoury snacks (13) 2 crisps (13) 1 sweet snack (6) 2 snack bars (13) 3 sweets (19) 6 chocolate bars (38)		8 (67)	5 (42)	0 (0)
	6 drink	1 sugar-free soft drink (17) 5 sugar sweetened soft drinks (83)	5 (100)			

Table 5.5: Vending machine provision continued.

Vessel	Product slots (n)	Slot content (n [%])	Sugar containing drinks available in no more than a 330 ml portion size (n [%])	Confectionary and packet sweet snack items in the smallest standard single serve portion size available (n [%])	Confectionary and packet sweet snack items available exceeding 250 kcal per item (n [%])	Savoury snacks/ crisps available in packet sizes of 30 g or less (n [%])
HMS Duncan	16 food	4 crisps (25) 1 snack bar (6) 5 sweets (31) 6 chocolate bars (38)		7 (58)	5 (42)	0 (0)
	8 drink	3 sugar-free soft drinks (38) 5 sugar sweetened soft drinks (63)	5 (100)			
HMS Illustrious	27 food	1 sweet snack (4) 6 snack bars (22) 9 sweets (33) 10 chocolate bars (37) 1 meal replacement (4)		23 (88)	6 (23)	0 (100)
	16 drink	3 sugar-free soft drinks (19) 13 sugar sweetened soft drinks (81)	12 (75)			
HMS Lancaster	14 food	1 savoury snack (7) 1 crisps (7) 4 sweets (29) 8 chocolate bars (57)		7 (50)	5 (36)	0 (0)
	8 drink	1 sugar-free soft drink (13) 7 sugar sweetened soft drinks (87)	6 (86)			

Table 5.6: Provision of exercise equipment.

Equipment		HMS Atherstone (n)*	HMS Bulwark (n)	HMS Dauntless (n)	HMS Defender (n)	HMS Duncan (n)	HMS Illustrious (n)	HMS Lancaster (n)	HMS Vigilant (n)
Cardiovascular	Treadmill	0	6	1	3	1	4	0	No
	Rowing machine	1	8	3	2	4	8	1	Yes
	Stepper	0	2	0	0	0	0	1	No
	Cross trainer	1	5	2	1	1	5	1	No
	Exercise bike	1	4	2	0	3	7	1	Yes
	Spinning bike	0	12	10	6	5	13	3	No
	Mountain bikes	0	0	0	9	6	0	0	No
Weights and Strength training	Free weights	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Olympic bar	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	Weights bench	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	Heaves/ dipping bar	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	Punch bag	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	Power bag	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	Exercise mats	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Kettle bells	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	Medicine balls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	Skipping ropes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	Tactical gym box	No	Yes	Yes	No	Yes	Yes	No	No

Note: * number of pieces of each type of equipment on each vessel.

5.4 Discussion

To inform the development of the healthy lifestyle intervention the present study evaluated whether the nutrition and physical activity environments onboard RN vessels support healthy dietary and physical activity choices. To the author's knowledge this is the first study that has measured the healthiness of the physical environment onboard military vessels.

5.4.1 Nutrition environment

In summary, the findings from the present study support the results presented in Chapter 4 which indicated that the most frequently cited barrier to eating more healthily onboard RN vessels was related to the availability of healthy foods in the Galley and NAAFI shop. The findings from both studies suggest that there is a need to improve both the nutritional content and healthiness of vessel menus. In the present study although all the vessels were compliant with the dietary guidelines for energy and dietary fibre, none were compliant with the dietary guidelines for percentage of EI derived from protein, total fat, saturated fat or carbohydrates, or salt. Hence, it is likely that the menus would result in personnel consuming diets too high in total fat, saturated fat, total sugars and salt, and too low in carbohydrates. This assumption is supported by previous research investigating the dietary intakes of personnel onboard two deployed warships, which reported that the proportion of energy derived from carbohydrates was lower, and the proportion of energy derived from total fat and protein, and salt intake was higher compared with the recommendations[18,19]. Furthermore, when looking at the healthiness of the vessel menus in terms of food-based standards, compliancy with the AFFBS ranged between 20% and 40% for each vessel, and 13% and 100% for each standard. Overall, these findings suggest that the vessel menus did not support healthy choices.

Although the impact of seasonality was not investigated, the UHC focus group discussion (see subsection 4.3.2) noted that fresh fruit and vegetables typically keep for up to two weeks on a deployment, after which tinned or frozen products are used. Thus, it could be assumed that a vessel's geographical location would have a greater impact on the menus than seasonality. However, the level of information in the menus provided did not allow this analysis to be undertaken.

Due to the limitations of the nutritional analysis software package, the menus could not be analysed for the provision of free sugars. Free sugars are sugars that are added to foods and drinks by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups and fruit juice[241]. When the menus were analysed for the provision of total sugars, the mean provision was higher than the maximum amount of sugars that an adult should consume daily to maintain a healthy diet[241]. This is concerning, first because of the link between sugar consumption and the risk of dental caries[237], and second due to dental problems being reported in the top five of ‘disease non-battle injuries’ causing Service personnel to present for treatment[242]. This may have a negative impact on operational capability due to personnel having to leave their primary role to receive dental care[242] and will incur significant financial cost due to personnel having to be returned to the UK.

In the present study the provision of foods and drinks in the NAAFI shop and vending machines onboard the ships was typically unhealthy with none of the vessels being fully compliant with the GBSF. These findings support the results presented in Chapter 4 that indicated that there is a need to improve the healthiness of the NAAFI and vending machine provision onboard vessels by expanding the availability of healthy options and restricting the availability of unhealthy options. As the NAAFI is a not-for-profit organisation it would be concerned about the impact of changing the provision on customer satisfaction levels rather than profits *per se*. However, previous studies have demonstrated that providing healthier vending machine products (i.e. products with a lower energy, total fat, saturated fat and sugar content) in the workplace does not negatively affect customer satisfaction levels or profits[227,243]. Thus, supporting the recommendation to improve the healthiness of the NAAFI and vending machine provision onboard the vessels.

Overall, the findings of the present study and the study reported in Chapter 4 concur with the conclusions of the study which measured the healthiness of the nutrition environment of an Australian military base[233]. This study suggested there was scope for increasing the availability of healthy alternatives in military dining facilities and providing appropriate information to consumers so that they can identify and make healthier choices. The latter recommendation is also of relevance to the RN, as the present study reported a lack of standardisation in the labelling of healthy meal choices onboard the vessels. As discussed in Chapter 2, previous interventions that have altered the military or maritime nutrition environment by increasing the availability of healthy food options,[126-131,133-136] or which promote the supply of healthy foods through introducing health promotion information or applying labelling to foods at the point-of-choice[126,128,134,135], have shown positive effects on energy and nutrient intake, food intake and/or the food selection quality of personnel. Thus, it is suggested that the provision of healthy foods is increased and that food items are labelled as part of the healthy lifestyle intervention. According to the results presented in Chapter 4 personnel would support this intervention activity.

Consideration also needs to be taken into the adequacy of the nutrition education that is provided to both the chefs who write the menus and the Logistics Officers (LO) who sign off the menus. This was a concern raised by participants of the focus groups reported in Chapter 4. In two of the interventions included in the systematic review undertaken in

Chapter 2 cooking courses for chefs in the military and maritime environments were successfully implemented[130,131,133]. Thus, to improve the healthiness of RN vessel menus it is also necessary to consider intervention activities that aim to increase the nutrition education levels of those who write and sign off the menus.

At the time of the study the monetary allowance for military personnel per day for catering purposes, known as the DMR, ranged between £2.58 (December 2013) and £2.78 (September 2015)[244]. To improve the healthiness of the feeding provision onboard the vessels so they are compliant with the AFFBS, members of Catering Services onboard the vessels said that the DMR would need to be increased. This viewpoint was shared by the participants of the focus groups in the study reported in Chapter 4. However, some methods to improve the healthiness of the menus also offer opportunities to save money (e.g., using smaller amounts of a strong tasting cheese in sauces compared with larger amounts of mild tasting cheese)[245].

It is recognised that providing a healthy menu can be extremely challenging onboard a RN ship or submarine, particularly during an overseas deployment. In addition to the DMR chefs encounter the following challenges: limited food storage capacity, in particular refrigeration space; limited shelf life of fresh produce (specifically fruit, vegetables and milk); equipment failure; the resupply chain; and the food preferences of personnel onboard. Chefs are also limited by the foods they can source whilst in the UK and overseas from the *Core Provisions List* (CPL) and the *Multinational Logistics Services* (MLS) provisions baskets, respectively. Thus, to improve the healthiness of the menus it is necessary to consider logistical factors and ensure that healthy food options are available for chefs to source from the CPL and MLS provisions baskets.

5.4.2 Physical activity environment

In summary, the findings from the present study indicated that the physical activity environments onboard the ships supported healthy choices. Where although there were differences in the amount and type of fitness equipment available, all the ships had at least one dedicated space for exercise equipment onboard and provided a wide range of equipment. Furthermore, all the ships, except HMS Atherstone, had a PTI onboard who delivered a range of activities for the ships' company. Due to limitations in the amount of space available for the provision of fitness equipment and the lack of a PTI onboard the submarine HMS Vigilant, the environment onboard the submarine was deemed to be not as supportive of healthy physical activity choices as the ships.

Previous research in the maritime environment reported that improving the availability and quality of fitness facilities was associated with improved physical fitness of the ship's company[127]. Making such improvements resonates with the findings of the study undertaken in Chapter 4, in which participants suggested improvements to the provision of physical activity equipment onboard including an increase in the amount of gym equipment, improvement in the quality of equipment and increase in the amount of space for equipment. Furthermore, previous research has shown that interventions that are effective in increasing physical activity levels provide individuals with professional guidance about starting an exercise programme followed by on-going support[97,246]. It is therefore necessary that in addition to making improvements to the provision of fitness equipment onboard the vessels, each vessel should have a suitably trained PTI or ETL to provide guidance and support, and to deliver activities.

5.4.3 Health education and promotion activities

There were also differences in the availability of health education resources onboard the vessels, where this was dependent upon the motivation and creativity of the PTI, Medical Department and Catering Services to create resources, as no central resources were available. The resources used were not specific to military personnel or of a consistent format. Strategies that have proved successful at delivering healthy lifestyle education and promotion to employees in the workplace setting include: the use of health education materials (e.g., brochures and posters)[102]; group and/or individual counselling[88]; shopping tours[88]; individual diet plans[88]; weekly health promotion email messages[88]; and worker participation in programme planning[88]. As such, it is recommended that bespoke health education and promotion resources are developed for the RN by subject matter experts and that these are used in the sickbay, Mess and physical activity environments onboard the vessels, and on any relevant noticeboards. According to the results of the study undertaken in Chapter 4, this intervention would be supported by personnel, as participants in the study wanted nutrition education and health promotion activities to be provided to the whole ship’s company through utilising apps, leaflets, posters and workshops. Furthermore, the participants requested that they would like the continued delivery of the existing WMP with the MO offering additional health checks.

Consistent with a WSA, health promotion activities both onboard RN vessels and in RN establishments should be coordinated by the UHC and involve the PTI, Medical Department, Catering Services and representatives from the different mess decks. PTIs and MOs should work in collaboration to deliver group and individual counselling and educational briefs targeting key health behaviours (i.e. increasing physical activity levels, decreasing sedentary behaviours, improving dietary quality, smoking cessation and reducing hazardous drinking behaviours), where any advice that is delivered to personnel should be evidence-based. Additionally, the UHC should review the Galley and NAAFI feeding provision periodically throughout a deployment to ensure that healthy options are available and that the menus comply with the AFFBS and GBSF[78]. Health education and promotion activities in all units should be guided centrally by the NHWB.

Consideration needs to be given as to what approach should be taken to improve the nutrition and physical activity environments onboard RN vessels. Due to the hierarchical nature of the RN as an organisation, and the fact that personnel are used to following orders, potentially a hard paternalism approach could be taken. Hard paternalism refers to measures that force or coerce individuals to act in a particular way to promote their well-being, regardless of their own will, values, beliefs or preferences[247]. Hypothetically such an approach could be easily achieved onboard a ship, as personnel are a captive audience whose food and physical activity choices are constrained by the environment. For example, by enforcing standards to restrict access to unhealthy foods and drinks, personnel could be forced to eat healthily. According to the findings presented in Chapter 2, of the seven interventions included in the systematic review that made healthy changes to the food content and options and measured food intake and/or food selection quality, all seven reported significant positive effects. These findings suggest that such an approach may work in the military. However, it is important to consider that RN personnel do not exclusively live in a military environment. As such, health behaviours may regress when personnel are exposed to the wider environment. Furthermore, the impact that food has on morale in the military should not be underestimated[248], such that Command may be unwilling to act due to not wanting to cause any discontent among personnel during a deployment. As such, an approach that combines hard paternalism and libertarian paternalism measures may offer a better solution by creating physical and social environments that empower individuals to adopt or maintain healthy behaviours.

5.4.4 Study limitations

Limitations of the present study are, first, the included vessels were a convenience sample of ships and submarines. However, this selection was intended to be representative of the different vessels in the RN Fleet at the time of the study as guided by the Fleet Catering WO. Second, the tool (PANEAT) used to assess the nutrition and physical activity environments onboard the vessels was not validated. However, as discussed in subsection 5.2.2 there were no other assessment tools deemed applicable. Last, as previously highlighted, the menu analysis only took account of the average amounts of food provided at the Galley and did not consider foods chosen, wasted, or other foods and drinks consumed between meals. Thus, although the analysis reflected the provision it is unlikely to be representative of an individual’s actual dietary intake.

5.4.5 Conclusion

The findings from this study indicated that the nutrition environments onboard RN vessels did not support healthy dietary choices. To reduce obesity risk the availability of healthy options should be increased and the availability of unhealthy options should be limited. Additionally, vessel menus need to be amended to reduce the total fat, saturated fat, free sugars and salt content; and to be fully compliant with the AFFBS. Healthy options should be labelled and personnel should be educated with regards to the components and the importance of consuming a healthy balanced diet. The NAAFI and vending machine provision onboard RN vessels should be improved to increase compliancy with the GBSF. Additionally, UHCs should review the feeding provision periodically to ensure it complies with the AFFBS and GBSF.

When considering the unique logistical constraints that affect the healthiness of vessel menus, consideration needs to be given at a policy level to determine whether the current DMR is sufficient to provide healthy menus. Healthy foods should be made available on the provision lists, and RN chefs should take the lead in modifying menus due to their knowledge of the many logistical factors that affect menu design, which may differ between vessels. Finally, chefs and LO should undertake nutrition education training (i.e. capacity building) to inform the design and subsequent review of vessel menus.

Although there were differences in the amount and type of fitness equipment available onboard the vessels, the physical activity environments supported healthy choices. However, it is important that all vessels, where space allows, be fully equipped with working fitness training equipment. Additionally, it should be ensured that each vessel has at least one PTI or ETL to provide guidance, support and to deliver a range of exercise classes.

There were differences in the health education and promotion activities delivered onboard the vessels, where resources used were not adapted to the military environment. As such, it is recommended that health promotion materials are adapted for the RN and that these are used in the sickbay, Mess and physical activity environments onboard the vessels, and on any relevant noticeboards. It is also recommended that PTIs and MOs work in collaboration to deliver group and individual counselling and educational briefs targeting health behaviours and weight management.

The amendments that have been proposed, which aim to facilitate RN personnel to adopt or maintain prudent health behaviours, are multi-level multi-component activities. Thus further supporting the application of the SEM. Consistent with a WSA it is recommended that the proposed activities be steered by the UHC onboard the vessels to ensure that any action taken is joined-up and coordinated between the different departments. The specific activities that will be delivered as part of the healthy lifestyle intervention will be discussed in the following Chapter.

Section 2: Intervention

6 Healthy lifestyle intervention

6.1 Introduction

This Chapter begins by providing a synopsis of Chapters 1 to 5, which demonstrated the need for a healthy lifestyle intervention in the RN and the approach to take. A conceptual model illustrating the theoretical basis for the healthy lifestyle intervention that was delivered onboard the intervention ship is then presented. To inform the development of the intervention a strengths, weaknesses, opportunities and threats (SWOT) analysis was undertaken and an outcomes hierarchy diagram developed; these are presented. Finally, a logframe and evaluation framework for the intervention are presented.

As discussed in Chapter 1, the UK Armed Forces are not immune to the obesity epidemic. This poses considerable health, economic and occupational risks, and in due course will impact on operational readiness and deployability. To counteract this the goal of the healthy lifestyle intervention, described in this chapter, was to increase the proportion of RN personnel who are fit to deploy. To inform the development of the intervention the research reported in Chapters 1 to 5 was carried out, namely to assess the need for an intervention, by determining the health status and lifestyle behaviours of RN personnel, and to identify the integral components and theoretical approach of the intervention. Due to the multifaceted aetiology of obesity and the complex relationships that exist between individuals, groups, and their environments, obesity must be tackled using a multifaceted approach that addresses the whole system. Thus, the SEM of health behaviour[77] was proposed as the conceptual basis for the intervention. The proposed model hypothesised that factors at the intrapersonal, interpersonal, organisational, physical environment and policy levels influence RN personnel's dietary and physical activity behaviours, which influence their energy balance, classification of obesity and readiness to deploy (i.e. deployability).

A systematic review was conducted to look at the effectiveness of environmental-based interventions, aimed at improving the dietary and physical activity behaviours, and body composition indices of adults in institutions (Chapter 2). The review concluded that the evidence appears to favour implementing environmental interventions in institutions to improve the dietary behaviours of adults. However, due to the multi-level and multi-component nature of the intervention studies it was difficult to determine which strategies were successful. Environmental strategies that were typically employed focused on reducing barriers, increasing opportunities for and accessibility to healthy choices, restricting the availability of less healthy options, and increasing cues to healthy behaviours. It was not possible to draw conclusions about the effectiveness of environmental interventions to improve physical activity behaviours or body composition indices, or to make recommendations about the content or delivery of interventions; this was due to the small number of studies and the variable methodological quality of the studies and intervention reporting. Nevertheless, the findings suggested that the healthy lifestyle intervention should combine multi-level and multi-component strategies through taking a socio-ecological approach.

A cross-sectional study to assess the prevalence of overweight and obesity and the health behaviours of RN personnel to identify the need for a healthy lifestyle intervention was then conducted (Chapter 3). The findings indicated that 29% of participants were classified as being at risk of obesity related ill health, with risk being higher amongst Ratings and older participants. Sensory appeal, health and price were reported as the strongest determinants of food choice. Food choice motives and dietary behaviours differed by gender, age group, rank and risk of obesity related ill health. Although most participants reported being physically active (70%), 13% reported they were either inactive or moderately inactive. Overall, the findings confirmed a need for a healthy lifestyle intervention.

A mixed methods study was then undertaken onboard two RN ships to inform the development of the healthy lifestyle intervention (Chapter 4). The study explored the feasibility and acceptance of a proposed intervention with the intervention ship's company and intervention deliverers. The findings demonstrated the interaction between intrapersonal factors, organisational factors, the physical environment and policy factors on the health behaviours of personnel. Thus, confirming that the intervention should take a multi-component multi-level WSA. The interventions suggested were to enable personnel to make healthier dietary choices, increase their physical activity levels and decrease their levels of sedentariness by increasing their capability and motivation, and through maximising opportunity.

Following this a cross-sectional study was undertaken onboard a representative sample of RN vessels to inform the development of the healthy lifestyle intervention (Chapter 5). The study evaluated whether the nutrition and physical activity environments onboard the vessels supported healthy dietary and physical activity choices, and thus identify what changes were needed to improve the healthiness of the environment. The findings indicated the physical environment onboard RN vessels did not support healthy dietary choices but did support healthy physical activity choices. Intervention activities that took a multi-component multi-level WSA were proposed.

In summary, the findings in Chapters 1 to 5 confirmed the need for a healthy lifestyle intervention to reduce the prevalence of obesity, improve RN personnel's behaviours and to create healthier physical and social environments on a RN ship. They also suggested that the intervention should take a multi-component, multi-level, WSA.

6.2 Conceptual model

> *"A conceptual model provides a framework for the organisation of the knowledge of a discipline, determining the focus of the discipline and serving as a guide for observation and interpretation."*[249]

Social ecological models have been successfully used as a framework for interventions to improve a range of health behaviours, including motor vehicle safety[229], tobacco control[229,250] and injury prevention[251]. Social ecological models acknowledge that dynamic relationships exist between individuals, groups, and their environments. They focus on the belief that individuals influence, and are influenced by, the physical, social, political, and economic environments in which they make health-related decisions[77,116,229,230]. The models recognise that individually based risk factors must be contextualised[202] and that interventions targeting individual behaviour change are only achievable and sustainable if the physical and social environments in which they are embedded are supportive[77,101,115-117].

Interventions that make structural changes to the environment, so that healthier options become the default choice, have a greater potential impact compared with interventions that focus on individual level strategies as they reach more people and require less individual effort[81]. As such, they are assumed to be more effective, efficient and equitable compared with other health promotion strategies to effect behaviour change[81]. Interventions should aim to create policies and environments that make healthy choices convenient; are attractive and economical; produce strong social norms and social support for healthy choices; and, both motivate and educate individuals to make these choices[84,115].

The environment onboard a warship provides an ideal and unique opportunity to improve the dietary and physical activity behaviours of personnel through a WSA. This is particularly the case during a deployment, where the ship's company are a captive audience, and individual food and physical activity choices are constrained by the ship's environment. Ensuring the healthiness of a ship's environment is a strategy to reach the whole ship's company, and thus have greater impact compared with individual level behaviour change strategies alone[81].

According to the SEM[77] an individual's health behaviours affect and are affected by multiple levels of influence, namely: intrapersonal factors (biological, psychological); interpersonal processes and primary groups (social, cultural); organisational/ institutional factors; community factors; the physical environment; and, public policy factors. The model places individuals at the centre and assumes that making changes to the environment will result in individual behaviour change. In 2015 Golden et al.[230] proposed an updated SEM of health behaviour, known as the inside out model. This model places social policies and environments at the centre; conceptualising the ways in which individuals, their social networks and organised groups create a community setting that promotes healthier policies and environments. Applying Golden et al.'s framework to the RN implies the ideal scenario is one where structural, social and political changes are made to empower a ship's company to modify their environment and their health behaviours (i.e. a capacity building approach). This way the whole ship fosters healthier policy and environmental development, which facilitates healthy choices. However, the inside out model assumes there is a fair and equitable distribution of resources and power across individuals that, due to the hierarchical nature of the RN, is not the case. Consequently, this model is not appropriate for the RN. As such, the constructs of the original SEM[77] were used to develop a conceptual model to show the factors that influence the dietary intake, physical activity levels and sedentary behaviours of RN personnel onboard a ship (Figure 6.1). The model was based on Chapters 1 to 5 and hypothesises that factors at the intrapersonal, interpersonal, institutional and community, physical environment and public policy level influence an individual's dietary, physical activity and sedentary behaviours that, in turn, influence their energy balance and ultimately their classification of obesity and whether they are deployable. These factors, in particular the environmental factors, were targeted in the development and implementation of the healthy lifestyle intervention that was delivered onboard the intervention ship. The model was also used to develop the evaluation strategy for the intervention.

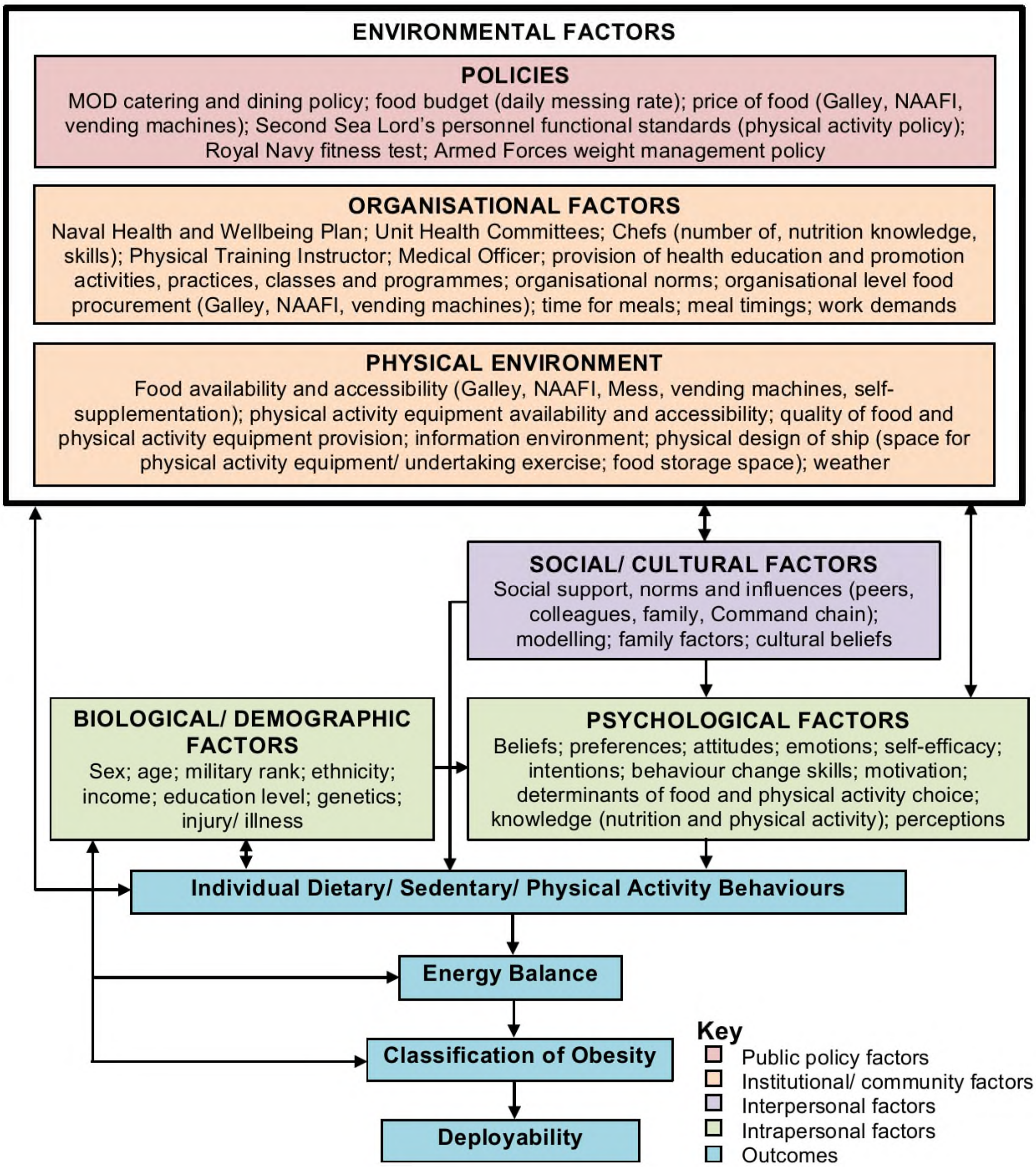

Figure 6.1: Socio-ecological determinants of diet, physical activity and sedentary behaviours and the ensuing risk of obesity in the RN.

6.3 SWOT analysis

To inform the development of the healthy lifestyle intervention a SWOT analysis was undertaken using the results from Chapters 3, 4 and 5. Its purpose was to identify the positive and negative internal attributes of the intervention ship, and the external factors that could improve and undermine the prospects of the intervention[252,253].

In doing the SWOT analysis, first, the quantitative and qualitative findings in Chapters 3, 4 and 5 were categorised as strengths, weaknesses, opportunities and threats (Table 6.1). These were then integrated as strengths-opportunities (S-O), weaknesses-opportunities (W-O), strengths-threats (S-T), weaknesses-threats (W-T), from which 14 strategies were identified to improve the healthiness of the environment onboard the intervention ship (Table 6.2). These strategies focused around organisational, physical environment and policy factors through increasing the availability of healthy foods and physical activities; restricting the availability of less healthy foods; improving existing and introducing new health promotion services and activities; and empowering the UHC to lead the healthy lifestyle intervention.

Table 6.1: SWOT analysis to inform the implementation of a healthy lifestyle intervention onboard a RN ship.

Strengths (S)	Weaknesses (W)
1. Personnel's readiness to change: losing body weight, increasing physical activity levels and eating more healthily (C4)	1. High prevalence of personnel classified at risk of obesity related ill health (C3)
2. Interest of personnel of strategies to improve the healthiness of the nutrition and physical activity environment (C4)	2. Sub-optimal dietary intakes and physical activity levels (C3)
3. Interest of personnel in becoming involved in the healthy lifestyle intervention (C4)	3. High consumption of takeaways alongside (C4)
4. Physical fitness equipment provision (C4/C5)	4. Frequent use of NAAFI shop (C4)
5. Provision of physical activity classes and sport (C4/C5)	5. Personnel's lack of nutritional knowledge (C4)
6. PTI is good at their job (C4)	6. Personnel's lack of time/ motivation/ interest in undertaking physical activity or eating more healthily (C4)
7. Weight management programme (C4/C5)	7. Chef's lack of nutritional knowledge and motivation (C4)
8. Provision of health promotion materials (C5)	8. Lack of healthy eating options in Galley/ unhealthy menus (C4/C5)
9. UHC which coordinates health promotion activities (C5)	9. Lack of attractiveness and poor placement of healthy options in Galley (C4/C5)
	10. Lack of nutrition labelling in Galley (C4/C5)
	11. Lack of healthy eating options in NAAFI shop/ vending machines (C4/C5)
	12. Lack of healthy foods available from supplier (C4)
	13. Chefs lack time to prepare food (C4)
	14. Provision of physical activity classes (C4)
	15. Physical fitness equipment provision (C4)
	16. Poor compliance with Personnel Functional Standards (C4)
Opportunities (O)	**Threats (T)**
1. Demand for healthy food (C4)	1. Personal determinants of food choice (C3)
2. Improve healthiness and attractiveness of existing feeding provision in Galley (C4/C5)	2. Injury rates (C4)
3. Improve healthiness of foods procured from supplier (C4)	3. Ship's programme (C4)
4. Improve healthiness of existing feeding provision in NAAFI shop/ vending machines (C4/C5)	4. Space for physical fitness equipment provision (C4)
5. Improve use of nutrition labelling (C4/C5)	5. Weather (C4)
6. Increase provision of physical activity classes/ sport delivered by PTI (C4)	6. Lack of food storage/ preparation areas on board (C4)
7. Improve compliance with PFS (C4)	7. Shortage of chefs (C4)
8. Improve existing provision of physical fitness equipment (C4)	8. Food resupply chain (C4/C5)
9. Increase use of physical activity competitions (C4)	9. Cost of healthy foods in NAAFI shop (C4)
10. Deliver nutrition and physical activity education training to personnel (C4)	10. Food budget (C4/C5)
11. Deliver nutrition education training/ provide nutrition resources to chefs (C4)	
12. Improve existing weight management programme (C4)	
13. Introduce health checks (C4)	
14. Improve access to health promotion materials (C4)	
15. Increase food budget (C4/C5)	

Note: C3, Chapter 3; C4, Chapter 4; C5, Chapter 5; NAAFI, Navy Army Air Force Institutes shop; PFS, Personnel Functional Standards; PTI, Physical Training Instructor.

Table 6.2: SWOT analysis strategies.

S-O Strategies	W-O Strategies
1. In conjunction with W-O3 increase the provision of PTI delivered classes and sport, and improve the physical fitness equipment provision (S2, S4, S5, S6, O6, O8) 2. In conjunction with W-O4 improve the existing weight management programme (S7, O12) 3. Work with UHC to prioritise activities which aim to create a healthy nutrition and physical activity environment on the ship (S9, O2, O3, O4, O5, O6, O7, O8, O9, O10, O11) 4. Improve the accessibility of health promotion materials (S8, O14)	1. Develop education resources targeted at the chefs and the ships company to facilitate and motivate individuals to adopt or maintain prudent dietary and physical activity behaviours (W2, W3, W4, W5, W6, W7, W10, O5, O10, O11, O14) 2. Improve the healthiness and attractiveness of the feeding provision on board the ship through improving the supply of healthy foods, increasing the food budget and educating chefs (W7, W8, W9, W11, W12, O2, O3, O4, O11, O15) 3. Improve the physical activity environment by increasing the provision of PTI delivered classes and sport, improving the existing provision of equipment and mandating PFS (W2, W14, W16, O6, O7, O8, O9) 4. Improve the weight management programme (W1, O12, O13)
S-T Strategies	**W-T Strategies**
1. In conjunction with S-O3 work with UHC to prioritise and co-ordinate activities which fit in with the ship's programme (S9, T3, T5) 2. Work with the UHC to ensure that healthy foods can be resupplied whilst deployed (S9, T8) 3. In conjunction with W-O3 and W-O4 improve the physical activity environment and weight management programme to reduce injury rates (S4, S5, S7, T2)	1. In conjunction with W-O1 develop education resources to facilitate and motivate individuals to adopt or maintain prudent dietary and physical activity behaviours (W2, W3, W4, W5, W6, W10, T1, T2) 2. Provide healthy menu plans for the chefs to implement whilst deployed; thus, reducing the burden on the chefs of writing menus (W8, T7) 3. In conjunction with W-O2 improve the healthiness of the feeding provision through increasing the food budget (W8, T10)

Note: S-O, strengths-opportunities; W-O, weaknesses-opportunities; S-T, strengths-threats; W-T, weaknesses-threats; PFS, Personnel Functional Standards; PTI, Physical Training Instructor; UHC, Unit Health Committee.

6.4 Outcomes Hierarchy

An outcomes hierarchy provides a two-dimensional representation of all the outcomes required to bring about the overall aim of an intervention[254]. It also demonstrates the links between different outcomes and can be used to assist with intervention planning, communicating the intervention's approach to stakeholders, developing indicators, designing evaluation questions, and identifying evaluation priorities[254]. Given the benefits of this approach, an outcomes hierarchy diagram was developed for the intervention to be delivered (Figure 6.2). The primary outcome was to increase the proportion of RN personnel who are fit to deploy. The secondary and tertiary outcomes are the things that need to be changed to help deliver the primary outcome. Specifically, these were to increase the proportion of personnel who adopt or maintain prudent dietary and physical activity behaviours, to increase the proportion of personnel classified at no risk of obesity related ill health and to create a healthier environment onboard the intervention ship. Below this the outcome indicators that are the short-term, quantifiable changes that lead to the intervention's tertiary, secondary and primary outcomes are shown.

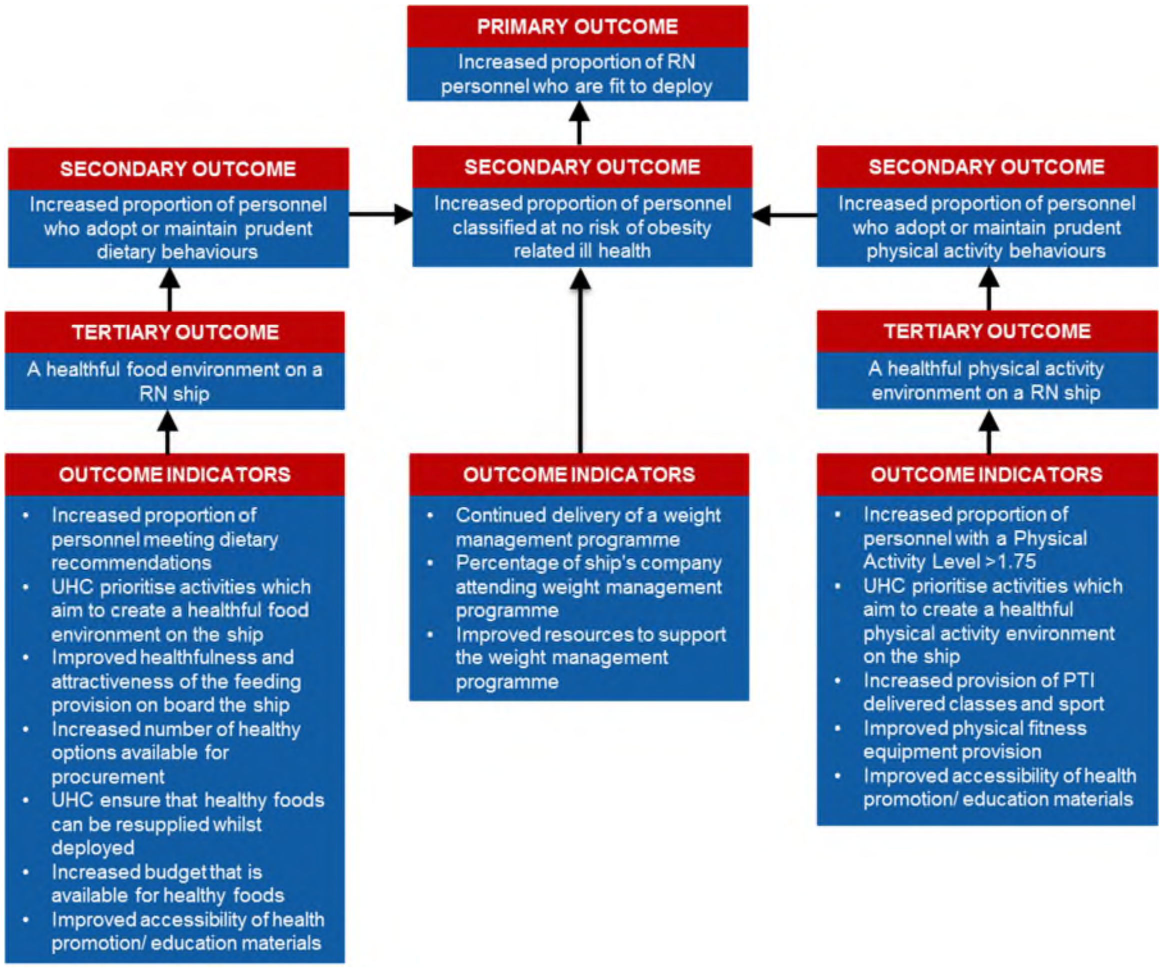

Figure 6.2: Intervention outcomes hierarchy.
Note: PTI, Physical Training Instructor; RN, Royal Navy; UHC, Unit Health Committee.

6.5 Intervention logframe

> *"A logic model is a graphic display or map of the relationship between a program's resources, activities, and intended results, which also identifies the program's underlying theory and assumptions."*[255]

Logic models are tools used in programme planning, implementation and evaluation. They present the intervention logic of a project with a series of if-then statements[252,256]:

- if the inputs are available, then the activities can be done;
- if activities are undertaken, then outputs will be achieved;
- if outputs are achieved, then outcomes will be met; and
- if outcomes are met, then the objectives will be achieved and this will contribute to achieving the impact of the project in the long term.

Logic models include the important assumptions and risks that underlie the intervention logic, and outline how the intervention will be monitored and evaluated[252,256]. The benefits of using a logic model include: that they can be used to achieve stakeholder consensus; organise thinking; relate activities to expected results; set performance indicators; and allocate responsibilities[257]. Conversely, their limitations include that: logic models represent intention, not reality; unintended outcomes may be overlooked; they focus on positive change, where change might not always be positive; they simplify the complex nature of causal attribution where many factors influence process and outcomes; and they may stifle creativity and spontaneity[258].

After considering the benefits and limitations of using a logic model to inform the planning, implementation and evaluation of the intervention onboard the intervention ship, it was decided that the benefits outweighed the limitations. Thus, a logframe matrix based on the Logical Framework Approach[256,259] was developed. To inform the development of the logframe matrix, the outcomes hierarchy and recommended intervention strategies derived from the SWOT analysis were discussed with the UHC onboard the intervention ship. The purpose was to determine which strategies were feasible to implement based on the human, financial and material resources available. Following the discussion, a logframe matrix was developed (Appendix 19).

In the logframe the project description, performance indicators, means of evaluation, and risks and assumptions are detailed in the four columns. The first row of the logframe presents the aim of the intervention (i.e. to increase the proportion of RN personnel who are fit to deploy). The second row states the objective (i.e. to reduce the prevalence of obesity onboard a RN ship over a 9-month deployment). The third row presents the three outcomes (i.e. to increase the proportion of personnel who adopt or maintain prudent dietary and physical activity behaviours and to increase the proportion of personnel classified at no risk of obesity related ill health). The fourth row presents the outputs to achieve each outcome. These outputs correspond to the strategies generated from the SWOT analysis and thus target organisational, physical environment and policy factors. The final row presents the activities needed to accomplish the intervention outputs, and hence, strategies from the SWOT analysis. These activities aim to: increase availability and accessibility to healthy foods and physical activities; restrict availability and accessibility to less healthy foods; improve existing and introduce new health promotion services and health promotion and education activities; empower the UHC to lead the healthy lifestyle intervention; and, build capacity through training the chefs. Thus, taking a cross-disciplinary, multi-agency, multi-level approach, which reflects the strategies typically employed in the interventions reviewed in Chapter 2, and is cognisant with a WSA[66].

Following the discussion on the logframe with the UHC, it was agreed the author would facilitate the healthy lifestyle intervention and the UHC would take charge of implementation over the duration of the deployment. This was to ensure that any action taken would be joined up and coordinated between the different departments. Additionally, it was agreed that the principal members of the intervention delivery team would include the MO, Medical Assistants, PTI and Catering Services, which included the chefs and Logistic Officer. Thus, the intervention would be delivered by a multi-disciplinary team.

6.6 Evaluation framework

The framework for evaluating the healthy lifestyle intervention is presented at Figure 6.3. It is based on the Centers for Disease Control and Prevention's (CDC) Center of Excellence for Training and Research Translation (Center TRT) evaluation framework[260]. The Center TRT's framework provides an overview of the entire programme process and is built on CDC's six essential steps to evaluation guidance that is continuously engaging stakeholders and intended users, describing the programme, focusing the evaluation design, gathering credible evidence, justifying conclusions, and disseminating and using findings[261]. The framework is structured according to sections of a logic model and draws on the findings presented in Chapters 1 to 6 of the thesis.

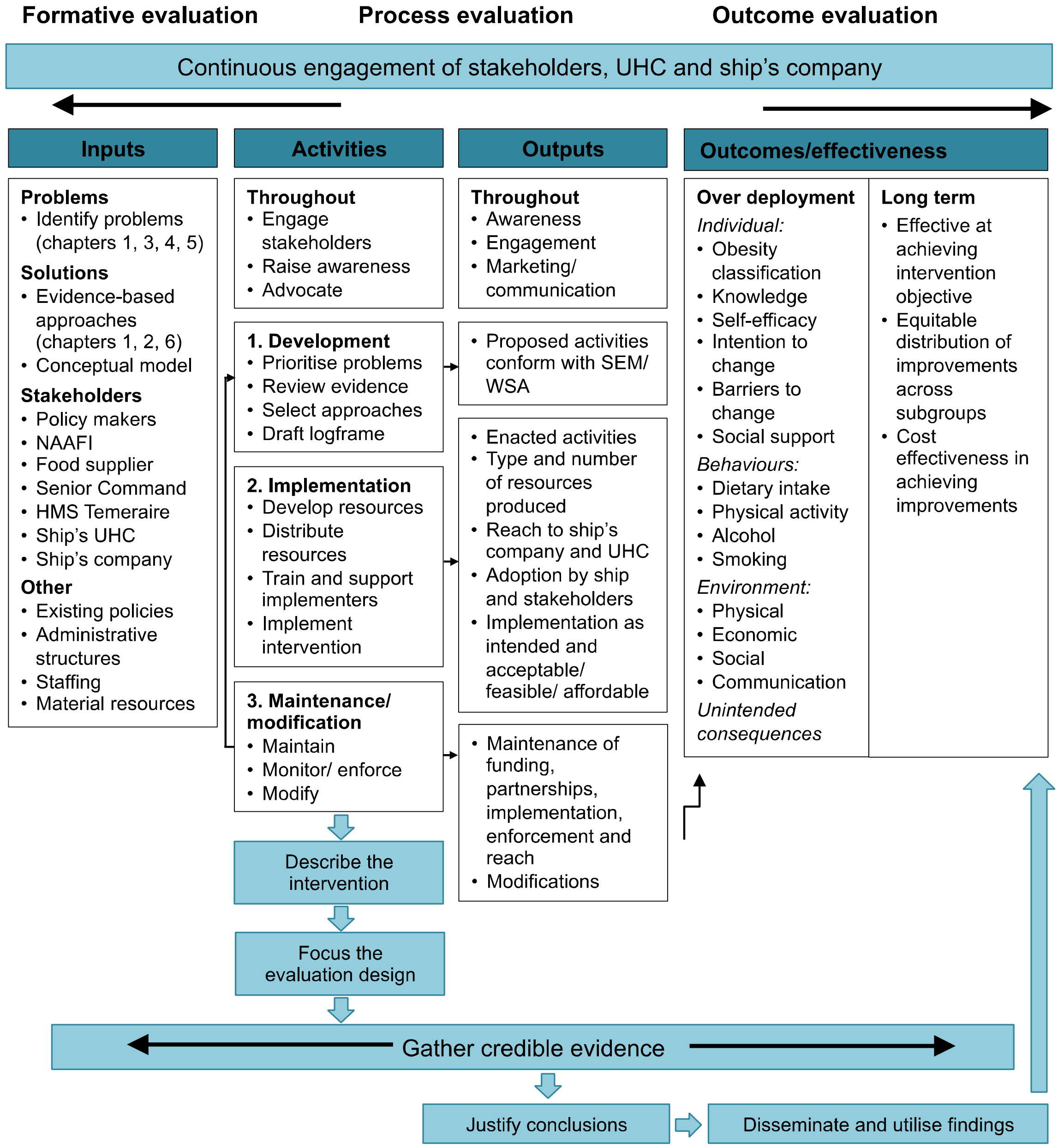

Figure 6.3: Healthy lifestyle intervention evaluation framework.
Note: NAAFI, Navy Army Air Force Institutes; HMS, Her Majesty's Service; UHC, Unit Health Committee; SEM, Socio-Ecological Model; WSA, Whole Systems Approach.

Section 3: Intervention evaluation

7 Changes in health status, health behaviours and psychosocial variables over a typical deployment

7.1 Introduction

To evaluate the success of the healthy lifestyle intervention the results need to be compared with what would have happened if the intervention had not taken place. Because it was not possible to randomly allocate individuals to receive the intervention onboard an intervention ship, a “control ship” that would not receive the intervention, would be used as the comparator.

7.1.1 Aims

Thus, this study aimed to first determine changes over a deployment in the physical measurements, health-related behaviours and psychosocial variables of RN personnel onboard a control ship over a typical deployment; and second, to further consolidate the results from Chapter 3 that indicated the need for a healthy lifestyle intervention onboard a RN ship.

7.2 Methods

7.2.1 Study design and ship

This repeated measures study was approved by MODREC (527/MODREC/14) and complied with the Declaration of Helsinki[151]. Navy Command Logistics and Infrastructure selected HMS Defender to be the control ship. The ship was chosen due to being the same class of ship as the intervention ship – a Type 45 destroyer – with a similar size ship’s company (the complement), and she was scheduled to undertake a deployment over the summer months in the Middle East and Gulf, which the intervention ship was also scheduled to undertake. Although the findings from the study undertaken in Chapter 5 identified some differences in both the nutrition and physical activity environments between the two ships, neither ship was systematically better or worse than the other. The main differences between the ships was the length of deployment where the control and intervention ships were scheduled to be deployed for 7-months and 9-months, respectively; and the timing of the deployment where the control and intervention ships were scheduled to be deployed between May and December 2014 and March and December 2015, respectively. Due to the real-life setting of this research this could not be altered.

7.2.2 Recruitment

Recruitment was undertaken according to the methods described in subsection 4.2.2.

7.2.3 Participants

A convenience sample of 91 RN personnel volunteered to participate in the study, representing 46% of the ship's company (see Appendix 20 for an outline of the sample size for the ship, study and variables). The sample was deemed to represent the demographics of the whole ship's company (see Table 7.3).

7.2.4 Procedures

Participants' height, body weight and waist circumference were measured by the author pre-deployment (May 2014) and end-deployment (December 2014) according to the methods described in subsection 3.2.4. BMI was calculated and risk of obesity related ill health, based on BMI and waist circumference measurements, according to the NICE classifications (see Table 3.1).

Participants completed a questionnaire (Appendix 21) at both time points, which was a shortened version of the 'Well@Work' baseline employee questionnaire[262]. The questionnaire included questions on health behaviours (i.e. physical activity; smoking; alcohol; and, eating behaviours), psychosocial variables (i.e. self-efficacy, knowledge, intention to change, barriers to change and social support), and a set of demographic parameters. The nutrition knowledge of participants was assessed using the 'General Nutrition Knowledge Questionnaire' (GNKQ, Appendix 22)[263]. The GNKQ was developed for use in UK adult populations, with acceptable and above internal consistency (Cronbach's alpha=0.70-0.97)[263], and has previously been administered in a Naval population[32,33].

The dietary intake of participants was measured over four days at pre- and end-deployment through completion of a food diary, which was developed for use in a military environment (Appendix 23)[264]. The pre- and end-deployment diaries were completed during the first and last week of deployment, respectively. Dietary intake data were analysed by a Registered Dietitian for total EI and nutrient intake using a nutritional analysis package (DietPlan6, Forestfield Software Ltd, Horsham, UK). The adequacy of dietary intake was assessed in relation to the MDRV for energy[79], the Scientific Advisory Committee on Nutrition (SACN) dietary guidelines for the UK population[236,237,265] and the government's guidelines for healthy eating[80]. A prudent diet score, between zero and twelve, was given based on individual compliance with twelve dietary recommendations at each time point (see Table 7.8). Participants were grouped into quartiles based on the number of twelve dietary recommendations they achieved.

The prevalence of under reporting EI was determined by calculating the ratio of EI to basal metabolic rate (BMR), where EI was determined from the food diaries and BMR using standard equations based on weight, age and gender[266]. The EI:BMR ratio for each individual was compared with the cut-off value of 1.35, which Goldberg suggested is the lowest value that could, within defined bounds of statistical probability, reflect actual EI over a given measurement period[267]. At pre- and end-deployment 51% and 58% of participants, respectively, had an EI:BMR below the cut-off (see Figure 7.1 for the EI:BMR distribution at pre-deployment). Of those below the cut-off at pre-deployment 31% lost over 3% of their initial weight, 7% gained over 3% of their initial weight and 62% did not change weight over the deployment. Although this suggests that around a third of the sample were under reporting dietary intake at pre-deployment, this could not be confirmed as weight was not measured over the four-day measurement period. Thus, the assumption that body weight was stable, which is assumed in the Goldberg cut-off method[268], could not be ascertained. So as to not introduce unknown bias into the analyses under reporters were retained in the data set.

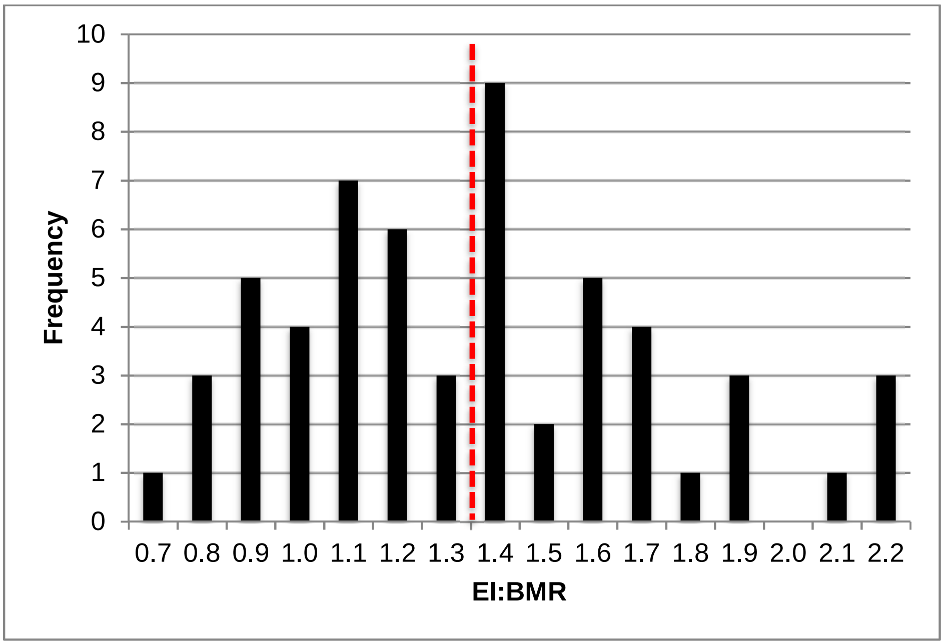

Figure 7.1: Histogram of pre-deployment EI:BMR distribution, n=57.

Information describing the physical activity behaviours of participants was collected over four days, at pre- and end-deployment, using a physical activity diary that has been validated in a military cohort[269] and previously used in a maritime environment[18,19] (Appendix 24). Participants detailed their physical activities for each 15 min over a 24-h based on a pre-defined list[270,271] (Table 7.1). The data were then coded, whereby each physical activity was assigned a physical activity ratio (PAR) value. The PAR reflects the energy cost of the activity expressed as a multiple of BMR and takes into account differences in gender, body size and composition. Values range between 1.0 for sleep and 5.8 for intense activity. Participants' overall physical activity levels (PAL) were then calculated by summing the various activities during the day, multiplied by the time spent in each activity as a proportion of the day. Participants' PAL were compared with the Food and Agriculture Organization (FAO) classifications of lifestyles (Table 7.2)[271] and against the recommendation of a desirable PAL value of 1.75 or more[271]. The average energy requirement (total energy expenditure, TEE) of participants' was calculated by multiplying the PAL by the BMR. As with the food diary, the pre- and end-deployment physical activity diaries were completed during the first and last week of deployment, respectively.

Table 7.1: PAR values for physical activities taken from FAO[271] and Vaz et al.[270].

Activity	PAR
Sleeping	1.0
Sitting (eating at table, reading, desk duties, computer based work)	1.4
Relaxing (watching TV, watching a film or playing on computer)	1.6
Standing (personal admin, watch duty)	1.6
Light activity (general ship duties, unloaded transit around ship, ladder climbing)	3.6
Moderate activity (manual handling tasks, loaded transit around ship)	4.5
Intense activity (fire fighting, shoring, emergency drills, physical training)	5.8

Table 7.2: FAO classification of lifestyles in relation to PAL[271].

Category	PAL value
Sedentary or light activity lifestyle	1.40-1.69
Active or moderately active lifestyle	1.70-1.99
Vigorous or vigorously active lifestyle	2.00-2.40

7.2.5 Data analyses

Data analyses were conducted using IBM SPSS Statistics Version 25. Pre- and end-deployment data are presented as means plus SD or medians plus IQR. Descriptive statistics were determined for all variables and normality checks performed. Where data were not normally distributed the equivalent non-parametric statistical analyses were applied, details are included in the text as appropriate. Paired samples t-tests were conducted to determine differences between pre- and end-deployment for continuous data, and McNemar tests and Pearson Chi-square tests for differences in categorical data. An alpha value of 0.05 was deemed to be statistically significant.

7.3 Results

7.3.1 Participant demographics

The median age of participants was 28 (24-35) years. Eighty-eight percent were male; 19% were Officers, 19% were SRs and 63% were JRs. These proportions were similar to those of the whole ship's company (Table 7.3). There was limited ethic diversity, with 9% of participants describing themselves as 'other' than 'White British'. Education levels varied, with 31% of participants receiving education up to GCSE level only.

Table 7.3: Demographics of study sample and whole ship.

Variable (units)	Statistic	Study sample (n=91)	Whole ship (n=196)
Age (years)	Median (IQR)	28 (24-35)	28 (24-35)
Gender: Males Females	%	88 12	91 9
Rank: Officers SR JR	%	19 19 63	13 22 65

Note: P>0.05 Pearson's Chi-square Test and Mann-Whitney U Test, difference between study sample and whole ship.

7.3.2 Weight, waist circumference, BMI and NICE risk classification

Mean weight, waist circumference and BMI did not differ between pre- and end-deployment (Table 7.4). Based on pre-deployment NICE risk classification, participants classified at 'any risk' had a lower mean weight, waist circumference and BMI at end-deployment compared with pre-deployment ($P<0.05$; Table 7.5). There were no differences for those classified at 'no risk'.

Table 7.4: Weight, waist circumference and BMI over the deployment.

Variable (units)	Statistic	Pre-deployment (n=68)	End-deployment (n=68)
Weight (kg)	Mean (SD) Range 95% CI	84.7 (13.2) 58.8-114.6 3.1	84.2 (12.5) 57.7-114.3 3.0
Waist circumference (cm)	Mean (SD) Range 95% CI	89.2 (11.7) 71.0-120.8 2.8	88.1 (10.0) 69.8-117.4 2.4
BMI ($kg.m^{-2}$)	Mean (SD) Range 95% CI	27.2 (3.6) 19.6-37.8 0.9	27.0 (3.3) 18.9-27.0 0.8

Note: P>0.05 Paired samples t-test, difference to pre-deployment for weight, waist circumference and BMI.

Table 7.5: Weight, waist circumference and BMI over the deployment based on pre-deployment NICE risk classification.

Variable (units)	Statistic	NICE risk: 'any risk' (n=23)		NICE risk: 'no risk' (n=45)	
		Pre-deployment	End-deployment	Pre-deployment	End-deployment
Weight (kg)	Mean (SD)	96.5 (10.9)	94.2 (11.2) *	78.7 (9.8)	79.0 (9.8)
Waist circumference (cm)	Mean (SD)	101.5 (9.2)	96.8 (10.1) ***	82.9 (6.7)	83.7 (6.4)
BMI ($kg.m^{-2}$)	Mean (SD)	30.8 (2.8)	30.0 (2.9) *	25.3 (2.4)	25.4 (2.3)

Note: * P<0.05, ***P<0.001 Paired samples t-test, difference to pre-deployment for 'any risk'; P>0.05 Paired samples t-test, difference to pre-deployment for 'no risk'.

Changes in weight between pre- and end-deployment ranged from a loss of 10.1 kg to a gain of 9.6 kg. Changes in waist circumference ranged between a decrease of 14.5 cm and an increase of 15.9 cm. Twelve percent of participants (n=8) lost over 5% of their initial body weight, of which seven were classified as being at 'any risk' of obesity related ill health at pre-deployment; 3% (n=2) gained over 5% of their body weight, of which one was classified at 'any risk' at pre-deployment; and, 85% (n=58) had no change in their body weight over the deployment, of which fifteen were classified at 'any risk' at pre-deployment.

At pre-deployment 34% of participants (n=23) were classified at 'any risk' of obesity related ill health. Although this reduced to 28% (n=19) at end-deployment, the reduction was not statistically significant. When changes in NICE risk classification were compared over the deployment, 16% of participants (n=11) improved, 4% (n=3) deteriorated, and 79% (n=54) did not change (Table 7.6).

Table 7.6: Change in NICE risk classification over the deployment, n=68.

		End-deployment (n)			
		No risk	Increased risk	High risk	Very high risk
Pre-deployment (n)	No risk	43	2	0	0
	Increased risk	4	3	0	0
	High risk	0	3	3	1
	Very high risk	2	0	2	5

Note: green, improvement; blue, no change; red, deterioration.

7.3.3 Self-reported general health

At pre-deployment 59% of participants (n=36) rated their general health as 'good or very good'. Although this increased to 74% (n=45) at end-deployment, this was not statistically significant. Similarly, there were no differences for participants classified at 'any risk' and 'no risk' of obesity related ill health pre- and end-deployment. When comparing changes in self-reported general health over the deployment, 25% of participants (n=15) improved, 7% (n=4) deteriorated, and 69% (n=42) did not change (Table 7.7).

Table 7.7: Change in self-reported health over the deployment, n=61.

		End-deployment (n)		
		Good & very good	Fair	Poor & very poor
Pre-deployment (n)	Good & very good	32	3	1
	Fair	13	9	0
	Poor & very poor	0	2	1

Note: green, improvement; blue, no change; red, deterioration.

7.3.4 Dietary intake

Sixty-three participants (69%) completed food diaries at both pre- and end-deployment. Mean daily EI was higher (~7%) pre-deployment compared with end-deployment (P<0.05; Table 7.8). The proportion of total EI derived from carbohydrates and saturated fat was higher pre-deployment compared with end-deployment (P<0.05 and P<0.001; Table 7.8). Total sugar intake was higher and salt intake was lower at pre-deployment compared with end-deployment (P<0.01; Table 7.8). There were no differences in the proportion of total EI derived from protein or total fat, dietary fibre intake or the proportion of participants who consumed a dietary protein supplement over the deployment (Table 7.8).

There were no statistically significant differences in the proportion of participants meeting dietary recommendations over the deployment (Table 7.9), even when participants were grouped by prudent diet score. When comparing changes in prudent diet score over the deployment, 23% of participants (n=12) improved, 23% (n=12) deteriorated, and 55% (n=29) did not change (Table 7.10).

Table 7.8: Dietary intake over the deployment, n=63.

Variable (units)	Statistic	Pre-deployment	End-deployment
Energy (kcal)	Mean (SD)	2436 (660)	2263 (486)*
Percentage of EI: Protein (%) Carbohydrate (%) Total fat (%) Saturated fat (%)	Mean (SD)	 20 (3) 37 (7) 42 (5) 15 (3)	 20 (4) 36 (5) * 41 (5) 13 (3) ***
Sugar (g)	Median (IQR)	65.3 (48.7-104.6)	58.0 (38.8-83.1) ##
Dietary fibre (g)	Mean (SD)	21.0 (8.1)	20.7 (7.0)
Salt (g)	Median (IQR)	6.8 (5.1-8.6)	9.4 (6.9-11.7) ###
Protein supplement used	% (n)	18 (11)	22 (14)

Note: * P<0.05, *** P<0.001 Paired samples T-test, difference to pre-deployment; ## P<0.01, ### P<0.001 Wilcoxon Signed Rank Test, difference to pre-deployment.

Table 7.9: Proportion of participants meeting dietary recommendations over the deployment.

	Variable	n	Pre-deployment % (n)	End-deployment % (n)
 1 2 3	Percentage of EI: Carbohydrate >50% Total fat <35% Saturated fat <11%	63	 0 (0) 10 (6) 6 (4)	 5 (3) 10 (6) 24 (15)
4	Sugar <90 g		68 (43)	78 (49)
5	Dietary fibre >23 g		35 (22)	32 (20)
6	Salt <6 g		38 (24)	14 (9)
7	Fruit and vegetables: ≥5 portions a day	61	49 (30)	49 (30)
8	Starchy foods: consumed at every meal		59 (36)	56 (34)
9	Fish: 2 portions a week		28 (17)	25 (15)
10	Red and processed meat: <90 g per day		2 (1)	3 (2)
11	Dairy: 2-3 portions a day		6 (4)	5 (3)
12	Fluid: 8 glasses a day		21 (13)	33 (20)

Note: P>0.05 Pearson chi-square test, difference to pre-deployment.

Table 7.10: Change in prudent diet score over the deployment, n=53.

		End-deployment (n)			
		1-3	4-6	7-9	10-12
Pre-deployment (n)	1-3	22	12	0	0
	4-6	12	6	0	0
	7-9	0	0	1	0
	10-12	0	0	0	0

Note: green, improvement; blue, no change; red, deterioration.

Participants identified pre-deployment as being at ‘any risk’ of obesity related ill health had lower total EI from protein and total sugar intake but higher salt intake at end-deployment ($P<0.05$; Table 7.11). For those classified at ‘no risk’ mean daily EI and the proportion of total EI derived from saturated fat was lower and salt intake higher at end-deployment compared with pre-deployment ($P<0.05$; Table 7.11). The proportions of participants meeting individual dietary recommendations at pre- and end-deployment did not differ according to NICE risk classification (Table 7.12). Likewise, there were no differences in prudent diet score based on NICE risk classification at pre- and end-deployment (data not shown).

Table 7.11: NICE risk classification and dietary intake over the deployment.

Variable (units)	Statistic	NICE risk: 'any risk' (n=18)		NICE risk: 'no risk' (n=39)	
		Pre-deployment	End-deployment	Pre-deployment	End-deployment
Energy (kcal)	Mean (SD)	2091 (583)	2076 (384)	2581 (634)	2364 (455) *
Percentage of EI: Protein (%) Carbohydrate (%) Total fat (%) Saturated fat (%)	Mean (SD)	 20 (3) 37 (8) 42 (6) 16 (4)	 18 (2) * 36 (4) 42 (4) 14 (3)	 21 (4) 37 (7) 41 (4) 15 (3)	 21 (5) 36 (5) 40 (5) 12 (3) ***
Sugar (g)	Median (IQR)	63.9 (52.7-81.8)	57.2 (46.4-83.7) ##	64.5 (48.7-110.5)	64.2 (36.1-85.8)
Dietary fibre (g)	Mean (SD)	19.2 (10.6)	18.0 (4.2)	21.6 (6.6)	22.3 (7.3)
Salt (g)	Median (IQR)	6.3 (5.1-7.3)	8.1 (6.4-10.8) #	7.0 (5.0-8.6)	9.9 (7.8-12.0) ###
Protein supplement used	% (n)	6 (1)	0 (0)	23 (9)	33 (13)

Note: * P<0.05, ***P<0.001 Paired samples t-test, difference to pre-deployment; # P<0.05, ## P<0.01, ### P<0.001 Wilcoxon Signed Rank Test, difference to pre-deployment.

Table 7.12: Proportion of participants meeting dietary recommendations over the deployment based on pre-deployment NICE risk classification.

Variable	NICE risk: 'any risk' (n=18)		NICE risk: 'no risk' (n=39)	
	Pre-deployment % (n)	**End-deployment % (n)**	**Pre-deployment % (n)**	**End-deployment % (n)**
Percentage of EI:				
Carbohydrate >50%	0 (0)	6 (1)	5 (2)	0 (0)
Total fat <35%	17 (3)	6 (1)	8 (3)	13 (5)
Saturated fat <11%	11 (2)	11 (2)	5 (2)	33 (13)
Sugar <90 g	83 (15)	78 (14)	62 (24)	77 (30)
Dietary fibre >23 g	17 (3)	6 (1)	44 (17)	44 (17)
Salt <6 g	50 (9)	22 (4)	36 (14)	8 (3)
Fruit and vegetables: ≥5 portions a day	50 (9)	61 (11)	51 (20)	46 (18)
Starchy foods: consumed at every meal	56 (10)	61 (11)	59 (23)	51 (20)
Fish: 2 portions a week	11 (2)	28 (5)	39 (15)	26 (10)
Red and processed meat: <90 g per day	0 (0)	0 (0)	3 (1)	5 (2)
Dairy: 2-3 portions a day	17 (3)	0 (0)	3 (1)	8 (3)
Fluid: 8 glasses a day	17 (3)	22 (4)	23 (9)	36 (14)

Note: P>0.05 Pearson chi-square test, difference to pre-deployment.

7.3.5 Physical activity levels

Sixty-four participants (70%) completed physical activity diaries both pre- and end-deployment. The mean time taken for the seven activities (sleeping, sitting, relaxing, standing, light activity, moderate activity and intensity) are presented in Figure 7.2. Participants' spent less time doing light activity and more time relaxing at end-deployment compared with pre-deployment (P<0.01; Figure 7.2). Otherwise there were no differences in the mean time participants undertook the different activities over the deployment.

Time spent in doing activities did not differ pre- and end-deployment based on being at 'any risk' of obesity related ill health. However, participants classified at 'no risk' pre-deployment spent less time doing light activity and more time relaxing at end-deployment compared with at pre-deployment (P<0.05; Figure 7.2).

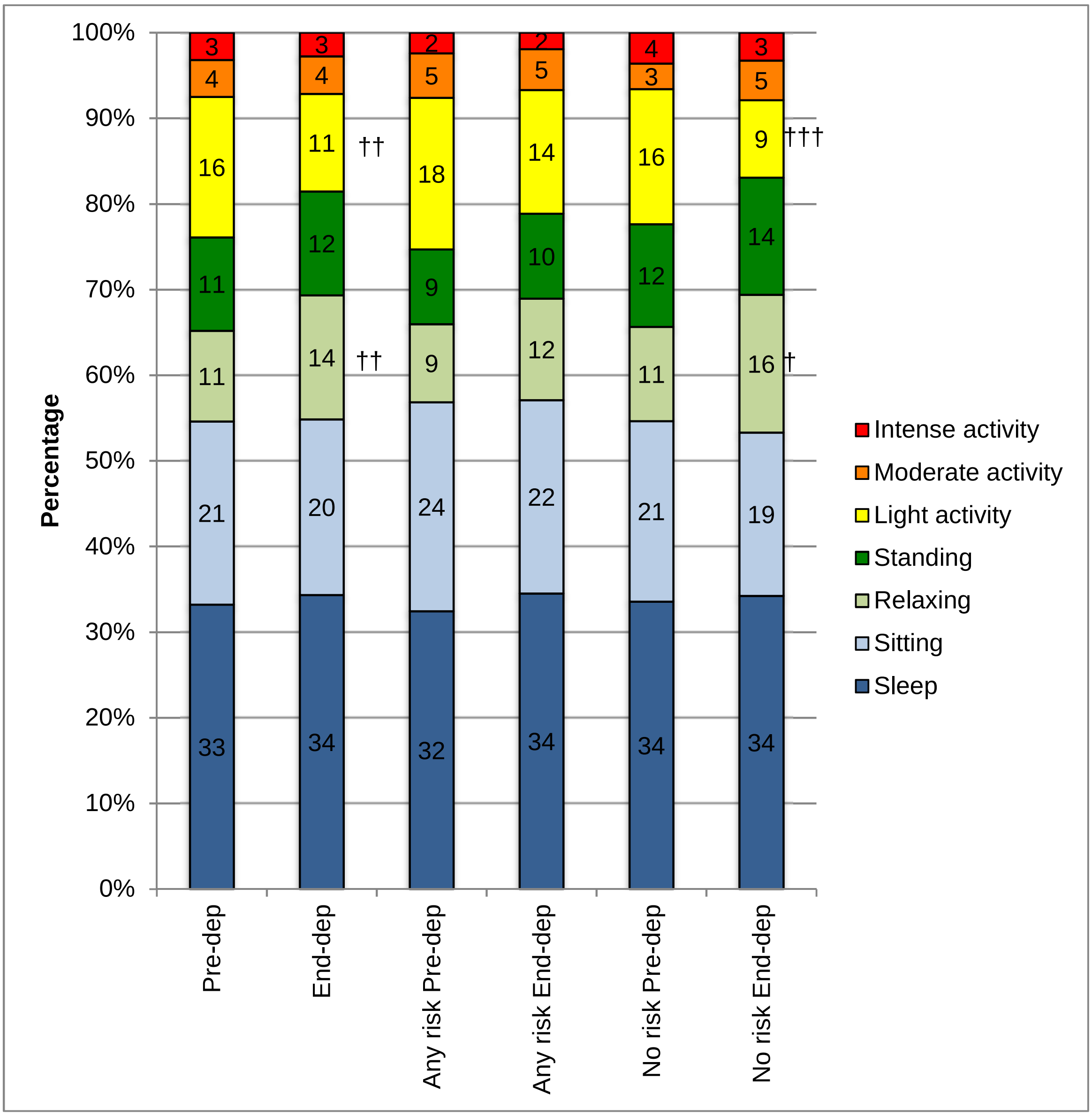

Figure 7.2: Physical activity levels over the deployment (n=64; any risk n=19, no risk n=39).

Note: † P<0.05, †† P<0.01, ††† P<0.001 Paired samples t test, difference to pre-deployment; P>0.05 Paired samples t test, difference to pre-deployment for 'any risk'.

PAL and EE were lower at end-deployment compared with pre-deployment (P<0.01; Table 7.13). This was also the case for participants classified at 'no risk' of obesity related ill health pre-deployment (P<0.01; Table 7.14). Although there was an increase in the proportion of participants with a PAL below 1.70 between pre- and end-deployment (28% vs. 47%) this finding was not statistically significant. Furthermore, although there were no statistically significant differences in PAL or EE over the deployment for participants classified at 'any risk' pre-deployment, both values were lower at end-deployment compared with pre-deployment. The proportion of participants who had a PAL below the recommended FAO cut off of 1.75 was higher at end-deployment than pre-deployment (n=64, 53% vs. 33%, $X^2(1)=61.5$, P<0.001).

Table 7.13: PAL and EE over the deployment.

Variable	Statistic	n	Pre-deployment	End-deployment
PAL	Median IQR 95% CI range	64	1.9 1.6-2.2 1.76-2.06	1.8 ** 1.5-2.0 1.65-1.89
EE	Mean (SD) Range 95% CI	58	3433 (696) 2286-5249 188	3265 (765) †† 2001-5066 187

Note: ** P<0.01 Wilcoxon Signed Rank test, difference to pre-deployment; †† P<0.01 Paired samples t test, difference to pre-deployment.

Table 7.14: PAL and EE over the deployment based on pre-deployment NICE risk classification.

Variable	Statistic	NICE risk: 'any risk' (*n* 19)		NICE risk: 'no risk' (*n* 39)	
		Pre-deployment	End-deployment	Pre-deployment	End-deployment
PAL	Median (IQR)	1.9 (1.7-2.3)	1.8 (1.5-2.1)	1.9 (1.6-2.2)	1.7 (1.6-2.0) **
EE	Mean (SD)	3807 (694)	3495 (803)	3402 (718)	3138 (664) ††

Note: ** P<0.01 Wilcoxon Signed Rank test, difference to pre-deployment; †† P<0.01 Paired samples t test, difference to pre-deployment.

7.3.6 Membership of sport and exercise groups/clubs

The proportion of participants measured at pre- and end-deployment who reported being a member of a sport or exercise group or club onboard the ship did not differ (n=61, 20% vs. 31%). Likewise for participants classified at 'any risk' (n=18, 17% vs. 33%) or 'no risk' (n=39, 23% vs. 28%) of obesity related ill health at pre-deployment.

7.3.7 Smoking behaviours

Thirty-four percent (n=29) of participants were current smokers at pre-deployment. Of the n=18 current smokers pre-deployment who were measured at end-deployment, 28% (n=5) had stopped smoking. Three participants, one of whom did not have a smoking history, became smokers by end-deployment. The proportion of smokers measured at pre- and end-deployment did not differ over the deployment (n=59, 31% vs. 27%).

7.3.8 Alcohol behaviours

The proportion of participants who consumed alcohol '2+ times a week' fell over the deployment (P<0.05; Figure 7.3). This was also the case for participants classified at 'no risk' of obesity related ill health at pre-deployment (n=38, 45% vs. 21%, X^2 (1)=4.8, P<0.05). Frequency of alcohol consumption was not associated with being at 'any risk' at pre-deployment. However, there was a trend for the proportion of participants classified at 'any risk' at pre-deployment who consumed alcohol '2+ times a week' was lower at end-deployment (22% vs. 33%), but this difference was not statistically significant.

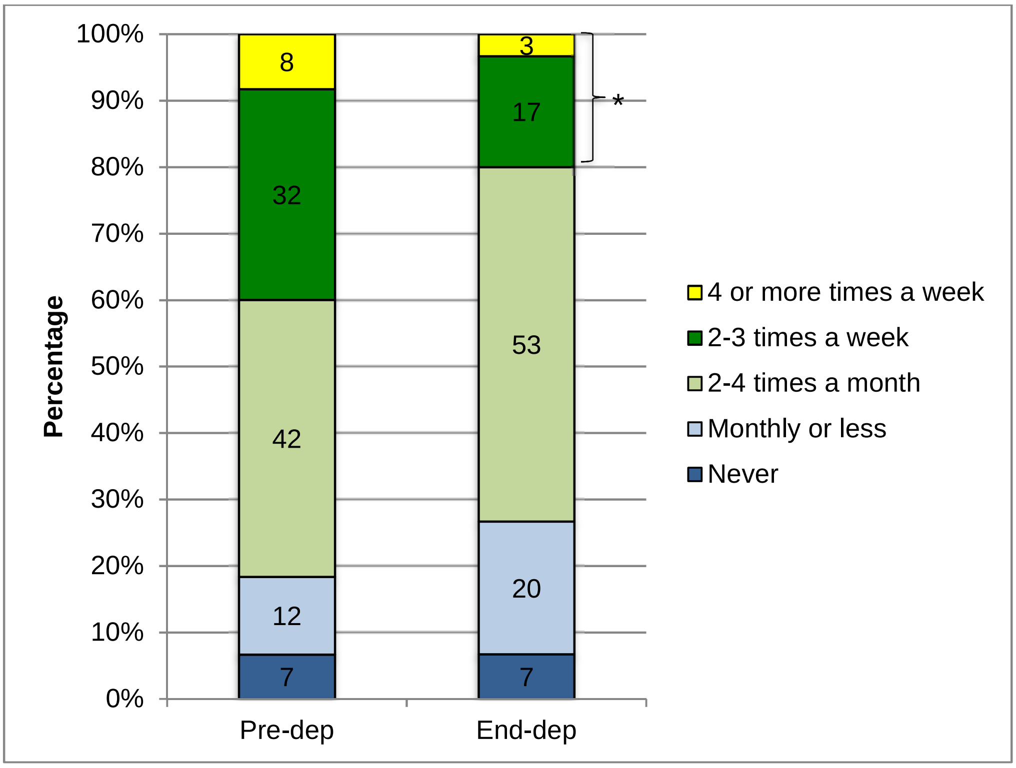

Figure 7.3: Alcohol consumption frequency over the deployment, n=60.
Note: * P<0.05 Pearson chi-square test, difference to pre-deployment.

The number of units that participants consumed on a typical day when they were drinking did not differ over the deployment (Figure 7.4). Furthermore, there were no changes in the proportion reporting binge drinking. Likewise there were no differences in the number of units consumed or binge drinking behaviours over the deployment based on pre-deployment NICE risk classification. In terms of binge drinking behaviours over the deployment, 3% (n=2) improved, 10% (n=6) deteriorated, and 86% (n=51) did not change (Table 7.15).

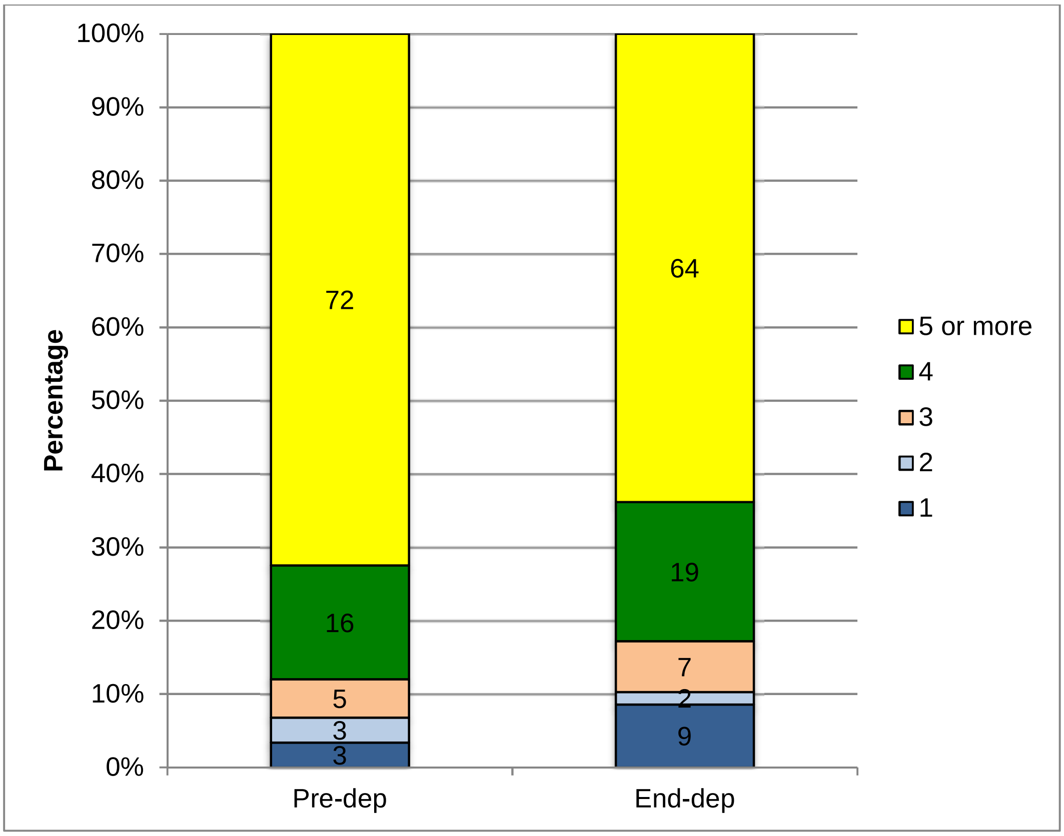

Figure 7.4: Alcohol consumption units over the deployment, n=58.
Note: P>0.05 Pearson chi-square test, difference to pre-deployment.

Table 7.15: Change in binge drinking behaviour over the deployment, n=59.

		End-deployment (n)	
		Yes	**No**
Pre-deployment (n)	**Yes**	40	2
	No	6	11

Note: green, improvement; blue, no change; red, deterioration.

7.3.9 Stage of change: diet, physical activity and smoking

A higher proportion of participants were in the combined action and maintenance stages of dietary change at end-deployment compared with pre-deployment (P<0.05; Figure 7.5), which was also the case for participants classified at 'no risk' of obesity related ill health at pre-deployment (n=37, 62% vs. 38%, X^2 (1)=4.4, P<0.05). Although there were no statistically significant differences in the proportion of participants classified at 'any risk' at pre-deployment, the proportion in the action or maintenance stage of dietary change was higher end-deployment compared with pre-deployment (50% vs. 28%).

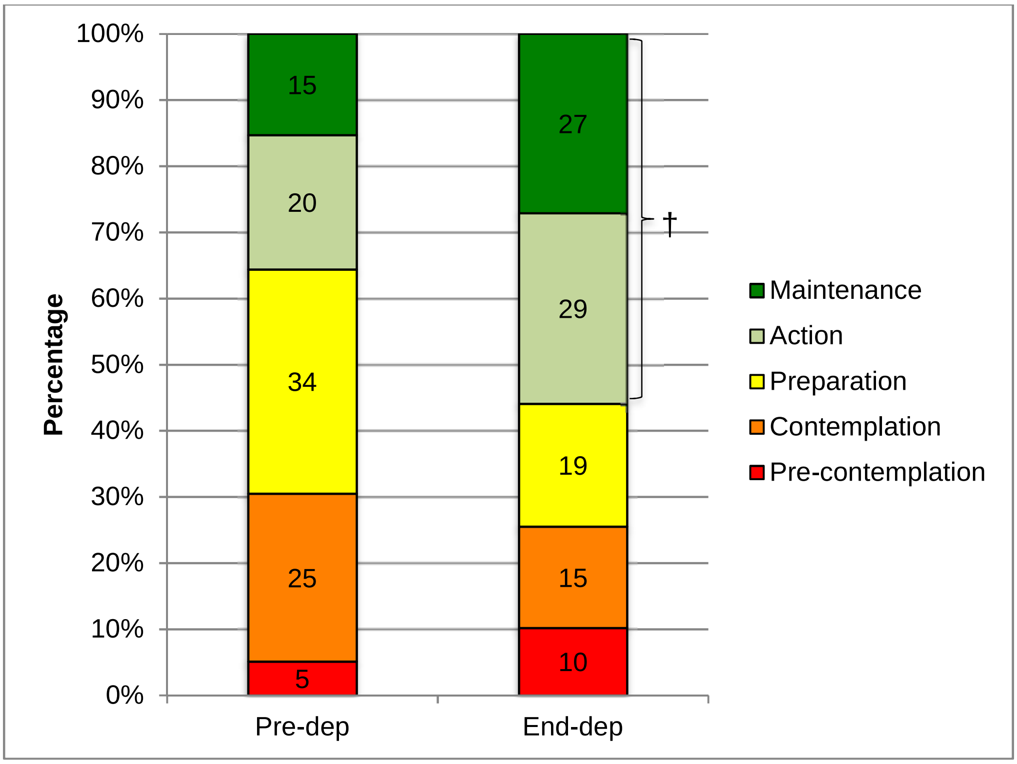

Figure 7.5: Dietary stage of change over the deployment, n=59.
Note: † P<0.05 Pearson chi-square test, difference to pre-deployment.

The proportion of participants in the different stages of physical activity change did not differ over the deployment (Figure 7.6). The same was true irrespective of pre-deployment NICE risk classification.

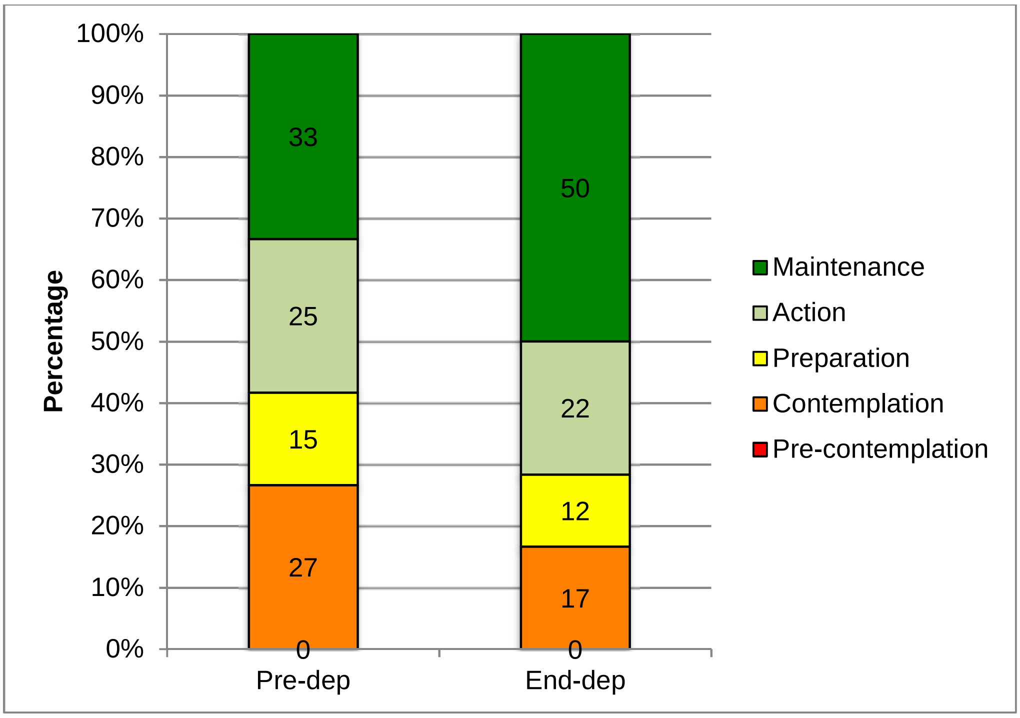

Figure 7.6: Physical activity stage of change over the deployment, n=60.
Note: P>0.05 Pearson chi-square test, difference to pre-deployment.

Of the three participants who indicated they were going to give up smoking within the next month at pre-deployment one had stopped smoking at end-deployment. The seven who said they were going to give up smoking over the deployment and the two who said they may give up smoking within the next year, remained smokers at end-deployment.

7.3.10 Self-efficacy: diet and physical activity

There were no changes in the mean score for how confident participants were that they could eat a healthy balanced meal or that they could take part in exercise or physical activity in the proposed difficult situations over the deployment (Table 7.16). Likewise, there were no differences in self-efficacy over the deployment based on pre-deployment NICE risk classification.

Table 7.16: Diet and physical activity self-efficacy over the deployment.

Variable	Statistic	n	Pre-deployment	End-deployment
Self-efficacy: diet	Mean (SD)	61	1.9 (0.5)	1.9 (0.5)
Self-efficacy: physical activity	Mean (SD)	60	2.0 (0.5)	2.0 (0.6)

Note: P>0.05 Paired samples t-test, difference to pre-deployment for diet and physical activity; 1, not at all confident; 2, moderately confident; 3, very confident.

7.3.11 Social support: diet, physical activity and alcohol

Overall, the mean score for the number of times participants received encouragement to make healthy food choices and be physically active during the past month did not differ between pre- and end-deployment. Participants received more encouragement to make healthy drinking (alcohol) choices pre-deployment compared with end-deployment (P<0.017; Table 7.17). Similarly, there were no differences in social support over the deployment for participants based on pre-deployment NICE risk classification.

Table 7.17: Diet, physical activity and alcohol social support over the deployment.

Variable	Statistic	n	Pre-deployment	End-deployment
Social support: diet	Mean (SD)	61	2.4 (1.1)	2.1 (1.1)
Social support: physical activity	Mean (SD)	58	2.6 (1.2)	2.5 (1.3)
Social support: alcohol	Median (IQR)	59	1.7 (1.0-2.3)	1.0 (1.0-2.0) *

Note: *P<0.05 Wilcoxon Signed Rank test, difference to pre-deployment for alcohol; P>0.05 Paired samples t-test, difference to pre-deployment for diet and physical activity; 1, never; 2, rarely; 3, sometimes; 4, often; 5, very often.

7.3.12 Knowledge: nutrition, physical activity, smoking and alcohol

Overall, the nutrition knowledge of participants increased over the deployment (P<0.05; Table 7.18). Changes in nutrition knowledge ranged from a decrease of 12% to an increase of 17%. There was no change in the physical activity knowledge of participants, or the percentage of participants who correctly reported the alcohol guidelines or the hazards of smoking over the deployment (Table 7.18). Furthermore, there were no differences in nutrition or physical activity knowledge or the percentage of participants who correctly reported the alcohol guidelines or the hazards of smoking over the deployment based on pre-deployment NICE risk classification.

Table 7.18: Nutrition, physical activity, smoking and alcohol knowledge over the deployment.

Variable	Statistic	n	Pre-deployment	End-deployment
Nutrition knowledge (%)	Mean (SD)	66	55 (10)	57 (10) *
Physical activity knowledge (%)	Median (IQR)	58	72 (64-80)	76 (72-84)
Smoking knowledge	% (n)	56	98 (55)	96 (54)
Alcohol knowledge	% (n)	59	44 (26)	42 (25)

Note: * P<0.05 Paired samples t test, difference to pre-deployment.

7.3.13 Barriers to physical activity

The most frequently cited barriers for participants being more physically active did not differ pre- and end-deployment. Indeed similar to the pre-deployment results, at the end-deployment time point *"I don't have time"* (58%), *"no motivation"* (32%) and *"can't be bothered"* (25%) were the most frequently cited barriers to participants being more physically active (Table 7.19). Pre-deployment NICE risk classification was not associated with any of the barriers.

Table 7.19: Barriers to physical activity over the deployment, n=60.

Barrier	Pre-deployment % (n)	End-deployment % (n)
I don't have time	55 (33)	58 (35)
No motivation	30 (18)	32 (19)
Can't be bothered	30 (18)	25 (15)
I need to rest and relax in my spare time	18 (11)	10 (6)
There are no suitable facilities	18 (11)	8 (5)
I don't put priority on physical activity	17 (10)	8 (5)
There is no-one to do it with	13 (8)	13 (8)
I've got young children to look after	12 (7)	Not applicable
I'm active enough	8 (5)	12 (7)
I'm not the sporty type	7 (4)	8 (5)
I don't enjoy physical activity	5 (3)	8 (5)
Traffic is too heavy	5 (3)	Not applicable
My health is not good enough	2 (1)	8 (5)
I might get injured or damage my health	2 (1)	3 (2)
I can't afford it	2 (1)	0 (0)
I'm too old	0 (0)	3 (2)
Too fat/ overweight	0 (0)	0 (0)

Note: P>0.05 Pearson chi-square test, difference to pre-deployment.

7.4 Discussion

The aims of this study were first to determine changes over a deployment in the physical measurements, health-related behaviours and psychosocial variables of RN personnel onboard the control ship, HMS Defender, over a typical deployment; and second, to further consolidate the results from Chapter 3 that indicated the need for a healthy lifestyle intervention onboard a RN ship. The second aim will be discussed first, followed by the first aim.

7.4.1 Further evidencing the need for a healthy lifestyle intervention

The findings from this study indicated that at pre-deployment 34% of participants were classified as being at ‘any risk’ of obesity related ill health. This was 5% higher than the results presented in Chapter 3, which is concerning as the participants in this study formed nearly half of the complement of an operationally deploying ship.

At pre-deployment the participants derived a higher proportion of their total EI from total fat, saturated fat and protein, and a lower proportion from carbohydrates, compared with the MDRVs[79]. Furthermore, participants consumed less dietary fibre and more salt compared with the recommendations for the UK population[236,237]. These findings were consistent with data reported previously onboard RN ships[18,19]. Additionally less than half of the participants consumed at least five portions of fruit and vegetables a day, less than a third consumed two portions of fish a week and less than one in 10 met the dietary recommendations for red and processed meat or consumed 2-3 portions of dairy products per day. Overall these findings indicate that participants’ diets were not compliant with the government’s healthy eating guidelines[80].

Although the median PAL for the participants at pre-deployment exceeded the FAO recommendation for a desirable PAL value of 1.75 or more to reduce the risk of becoming overweight[271], 33% of participants had a PAL below this value. In other words, one-third of participants were not being sufficiently active to stay healthy.

With regards to smoking, at pre-deployment 34% of participants were self-reported smokers. This is concerning as it is higher than data reported previously onboard RN ships (19-26%)[18,19] and the prevalence reported in Chapter 3. In terms of alcohol behaviours, 71% of the participants reported they had participated in binge drinking over the past month. Although this cannot be directly compared with previously reported data on alcohol behaviours in the RN, due to the use of different measurement tools, heavy drinking has been identified as a concern in the Naval Service[272].

In summary, the results from the present study confirm the findings of Chapter 3 that indicate steps need to be taken both to reduce the prevalence of overweight and obesity, and to improve the health behaviours of RN personnel. Thus, further evidencing the need for a healthy lifestyle intervention.

7.4.2 Changes in physical measurements over the deployment

In agreement with previous findings participants' weight, waist circumference or BMI did not change over the deployment[18,19]. Twelve percent of participants achieved a clinically meaningful weight loss of 5-10% of initial weight[273]. However, for participants classified at 'any risk' of obesity related ill health at pre-deployment, mean weight, waist circumference and BMI were lower at the end-deployment time point. Although not of statistical significance it is notable that there was a 6% reduction in the proportion of participants classified as being at 'any risk' over the deployment, with 16% of participants improving their risk classification. However, despite these improvements, 28% of participants remained 'at risk' at end-deployment. Thus, indicating that action is required to reduce obesity among personnel over a deployment.

7.4.3 Changes in health behaviours over the deployment

The participants consumed less energy and derived a lower proportion of their total EI from carbohydrates and saturated fat at the end of the deployment compared with pre-deployment. As the proportion of total EI derived from protein and total fat remained unchanged over the deployment this change in energy intake at end-deployment may be due to an increase in energy intake from alcohol. These findings were similar to previous studies onboard RN ships which also reported that participants consumed less energy overall, but derived a higher proportion of total EI from protein at end-deployment compared with pre-deployment[18,19]. Although the study onboard HMS Daring reported that the proportion of total EI derived from carbohydrates was lower at end-deployment; it also reported that energy from total fat was higher at end-deployment[19]. Whereas, the study onboard HMS Dauntless reported that energy from carbohydrates and total fat remained the same over the deployment[18]. Although the difference in energy intake between pre- and end-deployment in the present study was statistically significant, the mean change was only a reduction of 173 kcal and the SD for the two time points were large. Thus, it needs to be considered whether the difference in energy intake is meaningful. However, despite this what is clear from the findings of this and the two previous studies is that the proportion of energy derived from carbohydrates is lower, and the proportion of energy derived from total fat, saturated fat and protein is higher across the deployment compared with the MDRVs for active duty[79].

Although there was a reduction in sugar intake over the deployment there was an increase in salt and no change in dietary fibre intake. The median salt intake and mean dietary fibre intake were higher and lower, respectively, at both times compared with the recommendations for the UK population[236,237]. In terms of compliance with the government's healthy eating guidelines, there were no changes in the proportion of participants who were compliant over the deployment. This indicates that, overall, participants' were not achieving a healthy balanced diet across the deployment.

Similar to an earlier study, approximately one-fifth of participants consumed dietary protein supplements over the deployment[19]. The reasons for this were not explored in the present study; however, previous research undertaken with British Army personnel reported that the most frequent reasons soldiers gave were to recover from training or physical activity, to improve physical performance, to prepare for a period of training or physical activity and to supplement the diet[274]. Although the MOD acknowledges that some supplements in certain circumstances can have positive effects, supplement misuse can have detrimental effects on health and can lead to a positive compulsory drug test outcome[275], which would result in personnel being discharged from the Services. For this reason supplement usage onboard RN ships warrants further exploration.

Participants spent a similar amount of time undertaking moderate and intense physical activity and less time undertaking light physical activity at the end of the deployment compared with pre-deployment. This resulted in participants having a lower PAL and EE at end-deployment. At pre- and end-deployment 33% and 53% of participants, respectively, had a PAL below the desirable value of 1.75 or more to reduce the risk of becoming overweight[271]. Moreover, 47% of participants had a PAL that would be classified as having a 'sedentary or light activity lifestyle' at the end-deployment time point. This finding suggests that there was a reduction in compliance with physical activity over the deployment. There were no changes in the proportion of participants who reported being a member of a sport or exercise group or club onboard the ship over the deployment. These findings suggest that to reduce the risk of developing co-morbidities associated with obesity participants need to be more active.

Similar to previous data the proportion of participants who were smokers did not change over the deployment[18,19]. Where although five out of 18 current smokers at pre-deployment had stopped smoking by the end-deployment time point, three participants had commenced smoking over the deployment. The reasons for this were not explored. These findings suggest that participants need to be provided with more smoking cessation support throughout a deployment. Another approach that the RN could take to tackle smoking would be to enforce a smoking ban across its surface Fleet, as it has with its Submarine Service. Although this would be a hard paternalist approach by banning a legal commodity it would be in line with the Secretary of State for Defence's direction for Defence to go smoke-free by the end of 2022. Furthermore, in support of such an approach, research has demonstrated that smoking has implications for military readiness, because personnel who smoke have lower fitness levels and a greater risk for physical injury[276-278].

Although the frequency that participants consumed alcohol '2+ times a week' reduced from 40% to 20% over the deployment there were no differences in the number of units consumed when they did drink alcohol. Although not statistically significant the proportion of participants who reported binge drinking over the deployment increased by 7%, with 78% of participants reporting binge drinking at end-deployment. Previous research in the UK Armed Forces also reported that the prevalence of heavy drinking is higher during overseas deployments[272,279]. Together these findings suggest that there is a culture of drinking in the RN that needs to be addressed. Furthermore, this finding together with the physical activity and smoking data suggest that there was a reduction in compliance with individuals assimilating healthy behaviours over the deployment. This could have been explored further through capturing data more frequently across the 7-month deployment.

After grouping participants according to their pre-deployment NICE risk classification, those classified at 'any risk' showed a reduction in total sugar intake but an increase in salt intake over the deployment. Those at 'any risk' did not show any other improvements in health behaviours over the deployment. In contrast, participants classified at 'no risk' showed the following improvements in health behaviours over the deployment: a reduction in EI, a reduction in the proportion of total EI derived from saturated fat, and a reduction in frequency of alcohol consumption. However, participants at 'no risk' also showed deteriorations in measurements, namely an increase in salt intake and a reduction in PAL and EE. In summary, there were no systematic improvements or deteriorations of health behaviours for participants based on pre-deployment NICE risk classification.

7.4.4 Changes in psychosocial factors over the deployment

Although not of statistical significance it is notable that 25% of participants experienced an improvement in self-reported general health over the deployment. Where at end-deployment 74% of participants reported their health was either 'good' or 'very good'. This was similar to that for adults in the HSE[280].

Changes in the proportions of participants who were in the different stages of change for dietary, physical activity and smoking behaviours were observed over the duration of the deployment. At end-deployment a higher proportion of participants were in the action and maintenance stages of dietary change compared with pre-deployment, with 41% of participants progressing through the cycle of change. At end-deployment, a higher proportion of participants were in the action and maintenance stages of physical activity change compared with at pre-deployment, although this was not statistically significant, with 37% of participants progressing through the cycle of change. This finding is contradictory to the physical activity diary data, which indicated that participants were less active at end-deployment. It is possible that this disparity may be due to the diary only capturing self-reported activity levels over a short duration (4-days) at discrete time points over the deployment. Of the ten participants who indicated that they were going to give up smoking over the deployment only one had stopped smoking at end-deployment. Again this finding suggests that more smoking cessation support should be provided throughout a deployment to those who are both preparing and attempting to give up smoking.

There were no changes in self-efficacy or social support related to dietary and physical activity behaviours over the deployment. However, participants received more encouragement to make healthy drinking (alcohol) choices at pre-deployment compared with end-deployment, which might explain the increase in binge drinking behaviours reported at end-deployment. There were also no differences in the reporting of barriers to being more physically active. Where at end-deployment over half of the participants reported that *"I don't have time"* was a barrier to being more physically active. This finding combined with the fact that participants were less active at the end-deployment time point suggests that Command need to support personnel to make time for physical activity during a deployment.

Although the increase in the nutrition knowledge of the participants over the duration of the deployment was of statistical significance the mean change was only 2.1 (6.9)%. This equates to participants answering between one and two extra questions correctly. Thus, the improvement shown might be due to measurement error or just due to chance rather than an improvement in knowledge *per se*. Additionally, there were no improvements in participants' knowledge of physical activity guidelines, alcohol guidelines or the hazards of smoking over the deployment. Although for the latter, over 96% of participants correctly reported the hazards of smoking. Overall, the findings suggest that personnel onboard RN ships would benefit from being offered structured health education sessions.

When participants were grouped according to their pre-deployment NICE risk classification, no changes were found in psychosocial factors over the deployment for participants classified at 'any risk'. The only change that participants classified at 'no risk' experienced over the deployment was that a higher proportion were in the action and maintenance stages of dietary change at the end of the deployment compared with pre-deployment. In summary, no systematic improvements or deteriorations were found for the participants in psychosocial factors based on pre-deployment NICE risk classification.

7.4.5 Study limitations

The study has a number of limitations that should be taken into account when interpreting the findings. First, due to the nature of the setting in which this research was undertaken, only 75% of the sample were available to be measured at the end of the deployment, that is equivalent to 35% of the whole ship's company. Furthermore, whilst the study sample was representative of the demographics of the whole ship's company it was not possible to determine whether the sample was representative in terms of their NICE risk classification, health behaviours or psychosocial factors. These factors might therefore limit the reliability of the results of this study.

Second, the survey instruments used to collect data on participant's health behaviours and psychosocial factors all used self-report methods, which may involve recall or reporting bias. However, as discussed in subsection 7.2.4 both the food and physical activity diaries have been previously validated in military cohorts and the other questionnaire has been used extensively in the Well@Work project and comprised previously validated parameters. Although the questions that measured alcohol consumption were able to measure changes over time, due to the specific questions used, the data could not be compared with other military or civilian population data. The data describing the sports, recreational and other physical activities that participants completed over the deployment could not be used due to poor data quality. The methods used to assign physical activities a PAR value might have led to both under- and over-estimations of participants PAL and EE due to the wide range of activities being assigned to each group.

Grouping participants according to pre-deployment NICE risk classification resulted in small sample sizes that may have increased the likelihood of a Type II error (i.e. a false-negative) and reduced the power of the study (i.e. the probability of observing an effect in the sample).

7.4.6 Conclusion

When examining the pre-deployment data presented in this chapter the findings confirm those in Chapter 3, which indicate that steps need to be taken to both reduce the prevalence of obesity and improve the health behaviours of RN personnel. Thus, further evidencing the need for a healthy lifestyle intervention onboard a RN ship.

Overall, in terms of changes in the physical measurements, health-related behaviours and psychosocial variables of RN personnel onboard the "control ship" over a typical deployment, there were improvements in five variables; deteriorations in six; and no significant changes in 32 (see Appendix 25). As the control ship did not receive an intervention it was not expected that there would be any changes over the deployment.

In summary, the findings indicated no changes in participants' weight, waist circumference or BMI over the deployment, with 28% of participants remaining 'at risk' of obesity related ill health at end-deployment. In terms of health-related behaviours, there were improvements in some dietary variables, and no changes or deteriorations in others. Nevertheless, the findings highlighted that over the deployment participant's diets were not compliant with dietary guidelines. Furthermore, the study demonstrated that at pre- and end-deployment 33% and 53% of participants, respectively, were not being active enough to reduce the risk of developing co-morbidities associated with obesity. The study also found no change in the proportion of participants who were smokers and little change in alcohol behaviours over the deployment. Overall, the findings consolidated the need for a healthy lifestyle intervention to improve the health behaviours of personnel during a deployment and to ultimately reduce the prevalence of obesity. Furthermore, the findings from the stage of change data highlighted that a deployment is a good time to implement a healthy lifestyle intervention as personnel say they are ready to change.

In terms of psychosocial factors, the study findings indicated that there was a small increase in nutrition knowledge but that participants received less encouragement to make healthy drinking (alcohol) choices at the end of the deployment. There were no changes in: self-efficacy or social support related to diet and physical activity behaviours; the reporting of barriers to being more physically active; or, knowledge of physical activity guidelines, alcohol guidelines or the hazards of smoking over the deployment. The latter findings suggest that personnel onboard RN ships would benefit from being offered structured health education sessions over a deployment. Notably, the most frequently reported barrier to being more physically active at both time points was *"I don't have time"*. This finding infers that Command need to support personnel to enable them to make time for physical activity during a deployment.

Although participants classified at 'any risk' of obesity related ill health at pre-deployment had a lower mean weight, waist circumference and BMI at the end-deployment time point, no clear systematic improvements or deteriorations in health behaviours or psychosocial factors for participants based on NICE risk classification were evident. This is likely due to the small sample size. Thus, it is difficult to make clear recommendations based on NICE risk classification.

Overall, the findings from the present study further consolidate the need for a healthy lifestyle intervention to be delivered onboard a RN ship over a deployment. The findings from this chapter will now be compared with those from the intervention ship. These findings are presented in Chapter 8.

8 Evaluation of the healthy lifestyle intervention

8.1 Introduction

This Chapter presents the evaluation of the ‘healthy lifestyle intervention’, which was delivered onboard HMS Duncan between March 2015 and December 2015, based on the evaluation framework presented at Figure 6.3. The framework was built on the CDC’s Center TrT’s framework, which comprises six essential steps of evaluation practice[261]. These steps are described below.

8.2 Step one: engaging stakeholders

Stakeholders are people or organisations that have an investment in what will be learned from the evaluation and what will be done with the knowledge learned. Three principal groups of stakeholders were identified as relevant in the evaluation process: (i) those involved in intervention operations, (ii) those served or affected by the intervention, and (iii) primary users of the evaluation. These were:

- The ship’s UHC;
- The NAAFI shop and food supplier who supported and assisted in the delivery of the intervention and were primary users of the evaluation;
- Defence and Navy Command Logistics and Infrastructure and HMS Temeraire who make decisions on funding for food and exercise equipment, respectively, and were involved in intervention operations and affected by evaluation findings;
- The ship’s company who the intervention served and were affected by the findings;
- UHCs and Service personnel onboard other vessels and establishments; and
- Senior Command who endorsed the intervention and were primary users of the evaluation findings due to being in a position to create change.

Although all stakeholders were involved in the planning, development and implementation of the intervention, not all were involved in the planning or delivery of the evaluation because additional resource was not available to support the evaluation. Thus key stakeholders involved in the evaluation were prioritised based on their roles. These were the Fleet Catering WO, who represented Navy Command Logistics and Infrastructure, and the UHC that included the intervention deliverers: PTI, MO, LO, head chef and NAAFI manager. Stakeholders were invited to engage in the evaluation process from planning and delivery to taking action based on the findings.

Stakeholders discussed and agreed the evaluation methods and tools needed to assess the effectiveness of the intervention. Emphasis was on the need for the tools to be as simple as possible and easy and fast to complete; thus reducing participant burden. The approved tools are outlined under means of evaluation in the intervention logframe presented at Appendix 19.

8.3 Step two: describing the intervention

In Chapter 6, the need and rationale for the intervention (section 6.1), what it aimed to accomplish (section 6.4), the activities involved (section 6.5), the resources and personnel required to carry out the intervention (section 6.5), and the context in which the intervention would operate (section 6.2) were explained. The intended intervention activities are described below at Table 8.1. Further detail is presented at Appendix 19.

Table 8.1: Healthy lifestyle intervention intended activities.

Socio-ecological level	**Intended activities**
Policy	• RNutr works with food budget holder to increase budget available for healthy foods throughout the deployment
Organisational	• RNutr and UHC undertake needs assessment to identify opportunities to enable personnel to adopt or maintain prudent health behaviours • RD/RNutr develop and deliver a nutrition education brief, develop health menu plans and provide a guidance document for the ship's chefs pre-deployment • RNutr works with food supplier to increase the number of healthy food options available on the provision list pre-deployment • RD/RNutr develop health promotion, health education, sport and exercise nutrition and behaviour change resources pre-deployment • MO and PTI deliver health education and sport/exercise nutrition briefs, and behaviour change workshops throughout the deployment • MO and PTI deliver a WMP throughout the deployment • MO offers monthly health-checks throughout the deployment • UHC identify whether PFS can be mandated during the deployment • PTI delivers: monthly physical activity challenges, Fleet challenges and inter-departmental games; weekly flight deck sports and departmental circuits; and, daily circuits throughout the deployment • PTI delivers fitness class taster sessions throughout the deployment • PTI installs an onboard progression board pre-deployment
Physical environment	• UHC identify activities to create a healthier environment on the ship • RNutr works with Logistics Officer to identify what healthy snacks can be provided in the Wardroom pre-deployment • Comment cards are provided for the ship's company to provide feedback on menu changes throughout the deployment • RNutr works with the ship's NAAFI Manager to increase the provision of healthy options, restrict the provision of unhealthy options and improve the product placement of healthy options in the shop throughout the deployment • RNutr works with UHC to ensure on-going healthy foods resupply • Point-of-choice and menu nutrition labelling for healthy options are provided and implemented in the Galley throughout the deployment • Pedometers are provided to ship during the deployment • Range/number of gym equipment is increased pre-deployment

Note: MO, Medical Officer; NAAFI, Navy Army Air Force Institutes shop; PFS, Personnel Functional Standards; PTI, Physical Training Instructor; RD, Registered Dietitian; RNutr, Registered Nutritionist; UHC, Unit Health Committee; WMP, Weight Management Programme.

8.4 Step three: focusing the evaluation design

Six elements were considered to ensure the evaluation design met the needs of stakeholders:

(i) the purpose of the evaluation;
(ii) the intended users, particularly the ship's UHC, Navy Logistics and Infrastructure and Senior Command;
(iii) the potential uses of the evaluation findings;
(iv) the evaluation questions to measure effectiveness;
(v) the data collection methods; and
(vi) how the evaluation plan will be implemented.

To determine the effectiveness of the intervention a list of evaluation questions were developed by the author, the UHC and Fleet Catering WO. Questions were developed to measure both the intervention's process and outcome. The intervention logframe (Appendix 19) was used to identify indicators, sources of data, and information about the data collection methods to answer the evaluation questions. Roles and responsibilities for gathering and analysing the data were clarified and a timeline was developed for collecting the data. Finally, methods for ensuring data quality were considered. The agreed evaluation plan is presented at Table 8.2.

Table 8.2: Healthy lifestyle intervention evaluation plan.

Evaluation questions	Question indicators	Data sources/ methods	Person responsible	Timing	Quality assurance
1. To what extent has the intervention been implemented as intended? (process)	Activities enacted and resources produced as intended according to logframe: 1.2.1a, 1.2.1b, 1.2.2, 1.2.3a, 1.2.3b, 1.2.5a, 1.2.5b, 1.4.1, 1.5.1, 1.6.1, 1.6.2, 1.6.3a, 1.6.3b, 2.1.2, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, 2.2.7, 2.2.8, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4a, 2.4.4b, 3.1.1, 3.1.2, 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6, 3.2.7, modifications	End-deployment structured interviews with intervention deliverers, intervention resource list, end-deployment questionnaire, UHC monthly reports	AS, MO, Fleet Catering WO	Dec 2015	Structured interviews: interviewer and observer will compare notes
2. Did the intervention reach those classified at risk of obesity related ill health? (process)	% of study participants attending different activities based on obesity classification	End-deployment questionnaire	AS, MO	Dec 2015	-
3. How satisfied were the ship's company with the intervention? (process)	Satisfaction with intervention activities	End-deployment questionnaire	AS, MO	Dec 2015	-
4. Did the implemented intervention conform to the key components of a WSA? (process)	WSA key components (Table 1.2)	Chapter 6, end-deployment structured interviews with intervention deliverers, intervention resource list, UHC monthly reports	AS, MO	Dec 2015	Structured interviews: interviewer and observer will compare notes
5. Was the intervention feasible and sustainable? (process)	Agreeableness of intervention deliverers of feasibility and sustainability of intervention	End-deployment structured interviews with intervention deliverers	AS	Dec 2015	Structured interviews: interviewer and observer will compare notes
6. Was the intervention affordable? (process)	Catering balance	Catering balance	AS, head chef	Dec 2015	-

Note: AS, author; DMR, Daily Messing Rate; MO, Medical Officer; NAAFI, Navy Army Air Force Institutes; UHC, Unit Health Committee; WO, Warrant Officer; WSA, Whole Systems Approach.

Table 8.2: Healthy lifestyle intervention evaluation plan continued.

Evaluation questions	Question indicators	Data sources/ methods	Person responsible	Timing	Quality assurance
7. To what extent has the intervention achieved its objective? (outcome)	% change in proportion of ship's company who are classified at risk of obesity related ill health	Pre- and end-deployment height, weight and waist circumference measurements	AS	Feb and Dec 2015	Same measurer who has demonstrated good intra-rater test-retest reliability of measuring height and waist circumference (see subsection 3.2.4)
8. To what extent has the intervention achieved its outcomes? (outcome)	8a. % change in proportion of ship's company who adopt or maintain prudent dietary behaviour (1) 8b. % change in proportion of ship's company with a PAL >1.75 8c. % change in proportion of ship's company classified at no risk of obesity related ill health	8a. Pre- and end-deployment questionnaire and food diaries 8b. Pre- and end-deployment physical activity diaries 8c. Pre- and end-deployment height, weight and waist circumference measurements	8a. AS and MO 8b. AS and MO 8c. AS	8a/b. Mar and Dec 2015 8c. Feb and Dec 2015	8a. See subsection 7.2.4 8b. See subsection 7.2.4 8c. Same measurer who has demonstrated good intra-rater test-retest reliability of measuring height and waist circumference (see subsection 3.2.4)
9. To what extent has the intervention created a healthier nutrition environment? (outcome)	9a. Activities enacted as intended according to logframe: 1.2.4a, 1.2.4b, 1.2.4c, 1.3.1 9b. Outputs created as intended according to logframe: 1.1, 1.2, 1.3, 1.4, 1.6	NAAFI stock list, UHC monthly reports, end-deployment structured interviews with intervention deliverers, monthly menus, food procurement list, intervention resource list	AS, NAAFI manager, MO, head chef, food supplier	Data from Chapter 5 and Dec 2015	Structured interviews: interviewer and observer will compare notes
10. To what extent has the intervention created a healthier physical activity environment? (outcome)	10a. Activities enacted as intended according to logframe: 2.3.1 10b. Outputs created as intended according to logframe: 2.1, 2.2, 2.3, 2.4	End-deployment structured interviews with PTI, intervention resource list, end-deployment questionnaire	AS, MO	Data from Chapter 5 and Dec 2015	Structured interviews: interviewer and observer will compare notes

Note: (1) according to prudent diet score (see subsection 7.2.4); AS, author; MO, Medical Officer; NAAFI, Navy Army Air Force Institutes shop; PAL, Physical Activity Level; PTI, Physical Training Instructor; UHC, Unit Health Committee.

Table 8.2: Healthy lifestyle intervention evaluation plan continued.

Evaluation questions	Question indicators	Data sources/ methods	Person responsible	Timing	Quality assurance
11. How successful was the WMP? (process)	Outputs created as intended according to logframe: 3.1a, 3.1b, 3.2	UHC monthly reports, end-deployment structured interviews with MO and PTI, intervention resource list	AS, MO	Dec 2015	Structured interviews: interviewer and observer will compare notes
12. Has there been equitable distribution of improvements in intervention outcomes based on gender and rank? (outcome)	Differences in question indicators 8a-8c based on gender and rank	Data sources 8a-8c	AS and MO	See timing 8a-8c	See quality assurance 8a-8c
13. Were there any differences in outcome measures between the "intervention" and "control" ship? (outcome)	9a. % change in proportion of intervention ship's company who adopt or maintain prudent dietary behaviours vs. control ship (1) 9b. % change in proportion of intervention ship's company with a Physical Activity Level (PAL) >1.75 vs. control ship 9c. % change in proportion of intervention ship's company classified at no risk of obesity related ill health vs. control ship	Data sources 8a-8c and Chapter 7	AS and MO	See timing 8a-8c and Chapter 7	See quality assurance 8a-8c
14. Did the intervention lead to changes in knowledge, self-efficacy, intention to change, barriers to change and perceptions of social support? (outcome)	Change in knowledge, self-efficacy, intention to change, barriers to change and perceptions of social support	Pre- and end-deployment questionnaire	AS and MO	Feb and Dec 2015	-
15. Did the intervention lead to changes in other health behaviours? (outcome)	Change in smoking and alcohol behaviours	Pre- and end-deployment questionnaire	AS and MO	Feb and Dec 2015	-

Note: (1) according to prudent diet score (see subsection 7.2.4); AS, author; MO, Medical Officer; PAL, Physical Activity Level; PTI, Physical Training Instructor; UHC, Unit Health Committee.

8.5 Step four: gathering credible evidence

8.5.1 Methods

Intervention ship

Navy Command Logistics and Infrastructure selected HMS Duncan to be the intervention ship. She was deployed to the Middle East and Gulf between March (pre-deployment) and December 2015 (end-deployment).

Recruitment

Recruitment was undertaken according to the methods described in subsection 4.2.2.

Participants

A convenience sample of 115 RN personnel volunteered to participate in the study, representing 48% of the ship's company (see Appendix 26 for an outline of the sample size for the ship, study and variables). The sample was deemed to represent the demographics of the whole ship's company (see Table 8.3).

Table 8.3: Demographics of study sample and whole ship.

Variable (units)	Statistic	Study sample (n=115)	Whole ship (n=241)
Age (years)	Median (IQR)	28 (24-33)	28 (24-33)
Gender: Males Females	%	87 13	89 11
Rank: Officers SR JR	%	21 23 57	13 23 65

Note: P>0.05 Pearson's Chi-square Test and Mann-Whitney U Test, difference between study sample and whole ship.

Procedures

Participants were measured at pre- and end-deployment. Measurements of height, weight, waist circumference, physical activity behaviours, smoking behaviours, alcohol behaviours, dietary intake and psychosocial variables were undertaken according to the methods detailed in subsection 7.2.4. In addition, participants answered questions to identify their awareness and opinions about the intervention at end-deployment (see Appendix 27)[262].

The prevalence of under reporting EI was determined according to the methods described in subsection 7.2.4. At pre- and end-deployment 65% and 80% of participants, respectively, had an EI:BMR ratio below the cut-off. Of those below the cut-off at pre-deployment 43% lost over 3% of their initial weight, 11% gained over 3% of their initial weight and 46% did not change weight over the deployment. Although this suggests that over a third of participants were under reporting EI at pre-deployment, this could not be confirmed as weight was not measured over the four-day measurement period. Thus, the assumption that body weight was stable could not be ascertained. Furthermore, based on the results presented in Chapter 7 it would be anticipated that some individuals would be trying to lose weight during the deployment, meaning that some of these under reporters may actually be correct measurements. So as to not introduce unknown bias into the analyses under reporters for EI were retained in the data set.

Five semi-structured interviews were undertaken with intervention deliverers at the end of the deployment. This included two group interviews, one with the chefs (*n* 8) and one with the MO and PTI, and three one-to-one interviews with the LO, NAAFI manager and Fleet Catering WO. The author and a member of the project team, both of whom took notes, conducted the interviews. Participation in the interviews was voluntary, and informed consent was obtained prior to the interviews commencing. The interviews explored the extent to which the intervention was delivered as planned, if it conformed to the key components of a WSA, if it was feasible and sustainable, and to what extent it created a healthier nutrition and physical activity environment onboard the ship. Following a short brief on the nature of the interview, participants were asked to comment on what specific intervention activities they were involved in delivering, their opinions on the effectiveness of the intervention activities, to comment on future changes they considered should be made and anything else that they deemed relevant.

A sample of menus from across the deployment were collected from the head chef. The nutrition content of the feeding provision was calculated according to the methods detailed in subsection 5.2.2. Additional sources of data included: the catering balance from the head chef, the food procurement list, the NAAFI stock list, the intervention resource list and UHC monthly reports.

Data analyses

Data analyses were conducted using IBM SPSS Statistics Version 25. Pre- and end-deployment data are presented as means plus SD or medians plus IQR. Descriptive statistics were determined for all variables and normality checks performed. Where data were not normally distributed the equivalent non-parametric statistical analyses were applied, details are included in the text as appropriate. Paired samples t-tests were conducted to determine differences between pre- and end-deployment for continuous data, and Pearson Chi-square tests for differences in categorical data. An alpha value of 0.05 was deemed to be statistically significant.

The field notes from the semi-structured interviews and qualitative data from the end-deployment questionnaires were transcribed into a Word document. Any identifiable information was removed. The transcripts were imported into the qualitative data analysis software NVivo Version 12 (QSR International) and read through until saturation was reached, after which thematic analysis was conducted according to the methods of Braun and Clarke[217] (see subsection 4.2.4). All text in the transcripts was coded deductively. Semantic themes were identified, where themes were then considered in relation to the evaluation questions presented at Table 8.2.

The menus were analysed and compared with the MDRVs[79] and AFFBS (Appendix 15). Menus were compared with the baseline menus for HMS Duncan presented in Chapter 5.

8.5.2 Process evaluation

Q1: To what extent has the intervention been implemented as intended?

Of the 13 activities to increase the proportion of personnel on the intervention ship who adopted or maintained prudent dietary behaviours over the deployment, 10 (77%) were implemented as intended. The six that required development or involved discussions pre-deployment were delivered as intended (see Appendix 28). Data from the end-deployment semi-structured interviews with the intervention deliverers highlighted that the following were implemented as intended: a nutrition brief was delivered to chefs pre-deployment; nutrition labelling was provided on the menus and at the servery; port stop briefs were delivered by the MO at each port stop; and joining routine/pre-deployment briefs were delivered by the MO. An additional two activities were implemented during the deployment, but their frequency could not be determined from the data. These were food comment cards being reviewed by the chefs that were subsequently used to amend menus. It was not clear whether healthy snacks were provided in the Wardroom (Officers' mess) over the deployment.

Of the 16 activities to increase the proportion of personnel on the intervention ship who adopted or maintained prudent physical activity behaviours over the deployment, 11 were implemented as intended. The four that required development or involved discussions pre-deployment were delivered as intended (Appendix 28). Data from the end-deployment semi-structured interviews and questionnaires highlighted that the following were implemented as intended over the deployment: daily circuits for different fitness levels; provision of pedometers to the ship; installation of departmental scoreboards; taster sessions for different fitness classes; sport and exercise nutrition briefs delivered by the PTI; port stop briefs delivered by the MO at each port stop; and joining routine/pre-deployment briefs delivered by the MO. Four activities were delivered during the deployment, but not with the frequency intended, namely: Fleet and whole ship physical activity challenges that were undertaken twice over the deployment rather than monthly; and inter-departmental games and flight deck sports, for which frequency could not be determined. There was no evidence to suggest that departmental circuits were delivered weekly during Defence Watches.

Data from the end-deployment semi-structured interviews and questionnaires highlighted that all nine activities to increase the proportion of personnel classified at no risk of obesity related ill health over the deployment were implemented as intended. The MO and PTI commented on the negative effects of port stops and mid-deployment leave on the health behaviours of those attending the WMP.

Data from the end-deployment semi-structured interviews and questionnaires, and the UHC reports indicated that modifications were made to the healthy lifestyle intervention. These were driven by the UHC and included: the provision of additional activities including port stop walks; the introduction of a competitive element to the WMP, both individual and group; healthy 4 pm snacks being provided in lieu of an evening dessert several times a week; additional healthy red meat recipes being requested by the chefs and subsequently provided by the INM; the inclusion of healthy lifestyle representatives from each mess on the UHC; to provide an opportunity for feedback on intervention activities and ideas for future activities; and the addition of nutrition and healthy lifestyle facts on weekly orders.

Q2: Did the intervention reach those classified at risk of obesity related ill health?

Of the 27 participants who were classified as being at 'any risk' of obesity related ill health at pre-deployment, 25 completed an end-deployment questionnaire, of which 24 (96%) reported that they participated in at least one intervention activity over the deployment. The most popular activities were Fleet challenges, which are individual/team based sporting challenges followed by engaging in the WMP; exercise classes; and healthy lifestyle intervention activities, including nutrition initiatives; nutrition briefs; and port stop walks (see Table 8.4).

Table 8.4: Participation in intervention activities based on NICE risk classification.

Intervention activity	**NICE risk classification**	
	At any risk % (n)	**No risk % (n)**
Fleet and other activity challenges	72 (18)	57 (40)
Weight management programme	60 (15)	26 (18) *
Exercise classes (including circuits)	36 (9)	44 (31)
Healthy lifestyle intervention (including nutrition initiatives, nutrition briefs, port stop walks)	32 (8)	33 (23)
Sport events, sports teams, flight deck sports	20 (5)	21 (15)
Health measurements	16 (4)	11 (8)
Adventurous training	8 (2)	9 (6)
Smoking cessation clinic	4 (1)	10 (7)

Note: * P<0.01 Pearson Chi-square test, difference to participants classified at any risk.

Q3: How satisfied were the ship's company with the intervention?

Of the 103 participants measured at end-deployment, 95 (92%) completed the 'what did you think' question in the end-deployment questionnaire (Table 8.5). Over three-quarters of participants strongly agreed or agreed that the intervention helped them to improve their health and be more physically active. Nearly two-thirds strongly agreed or agreed that the intervention helped them to lose weight, whilst over half strongly agreed or agreed that the intervention helped them to quit smoking and eat more healthily. Over three-quarters and over half of participants strongly agreed or agreed that the intervention gave them more opportunity to be physically active and to eat more healthily, respectively. Nearly three-quarters and over half of participants strongly agreed or agreed that the intervention made them more motivated to be more physically active and to eat more healthily, respectively. Over half of participants strongly agreed or agreed that the intervention made it more affordable to be physically active. Nearly two-thirds of participants strongly agreed or agreed that the intervention changed the way they felt about being physically active; and over half of participants strongly or agreed that the intervention changed the way that they felt about their health and eating more healthily. There was no clear consensus for the responses to the other questions.

In addition to the data presented at Table 8.5, 43 free text comments were provided in the end-deployment questionnaire. These comments could be grouped as: positive opinions of intervention activities, negative opinions of intervention activities and recommendations for future changes onboard RN ships. Table 8.6 presents these themes and associated sub-themes derived from participants' comments. Although 15 comments related to positive opinions about the changes that were made to the feeding provision over the deployment, 11 negative comments were also made. Eight additional negative comments were about the skills, knowledge and attitudes of the chefs. Eighteen comments were recommendations for future changes onboard RN ships, including how to increase the healthiness of the feeding provision and to improve the attitudes and knowledge of the chefs.

Table 8.5: Satisfaction with the intervention activities, n=95.

The intervention activities…		Strongly agree/ Agree % (n)	Neither agree or disagree % (n)	Disagree/ Strongly disagree % (n)	N/A % (n)
Helped you to:	Improve your health	76 (72)	18 (19)	3 (3)	2 (2)
	Be more physically active	76 (72)	17 (16)	4 (4)	3 (3)
	Lose weight	64 (62)	20 (19)	12 (11)	4 (4)
	Quit smoking*	54 (7)	15 (2)	31 (4)	0 (0)
	Eat more healthily	52 (49)	26 (25)	17 (16)	5 (5)
	Reduce stress	37 (35)	35 (33)	25 (24)	3 (3)
	Improve your performance at work	27 (26)	51 (48)	19 (18)	3 (3)
	Drink less alcohol	27 (26)	30 (28)	33 (31)	11 (10)
Gave you more opportunity to:	Be physically active	76 (72)	15 (14)	7 (7)	2 (2)
	Eat more healthily	52 (49)	21 (20)	25 (24)	2 (2)
Make you more motivated to:	Be more physically active	74 (70)	19 (18)	5 (5)	2 (2)
	Eat more healthily	54 (51)	25 (24)	18 (17)	3 (3)
	Quit smoking*	39 (5)	46 (6)	15 (2)	0 (0)
	Drink less alcohol	34 (32)	27 (26)	27 (26)	12 (11)
Make it more affordable to:	Be physically active	54 (51)	26 (25)	9 (8)	12 (11)
	Eat more healthily	42 (40)	26 (25)	22 (21)	10 (9)
Change the way you feel about:	Being physically active	65 (62)	24 (23)	9 (8)	2 (2)
	Eating more healthily	55 (52)	25 (24)	17 (16)	3 (3)
	Your health	52 (49)	33 (31)	14 (13)	2 (2)
	Quitting smoking*	39 (5)	54 (7)	8 (1)	0 (0)
	Drinking alcohol	34 (32)	30 (28)	26 (25)	11 (10)
	Your job	25 (24)	43 (41)	27 (26)	4 (4)

Note: * participants who stated that they are current smokers *n* 13.

Table 8.6: Participants' comments about the healthy lifestyle intervention.

Major themes	Sub-themes
Positive opinions of intervention activities	Feeding provision (15 comments) Support from MO and PTI (2 comments) Physical activity provision (1 comment) Feasibility (1 comment)
Negative opinions of intervention activities	Feeding provision (11 comments) Chefs (8 comments)
Recommendations for future changes onboard RN ships	Food (14 comments) Chefs (4 comments) Health promotion (1 comment)

Q4: Did the implemented intervention conform to the key components of a WSA?

Data from Chapter 6, the end-deployment semi-structured interviews, intervention resource list (Appendix 28), and UHC reports indicated that the healthy lifestyle intervention conformed with all 10 key features of a WSA[68] (Table 8.7).

Table 8.7: Conformation of the intervention with the key components of a WSA.

Feature	Evidence
Identifying a system	• Principles of whole system working informed the intervention design and implementation (Chapter 6)
Capacity building	• Intervention resource list (Appendix 28) • Nutrition education brief delivered to chefs (end-deployment interviews) • Continuous support from INM provided to UHC (UHC reports)
Creativity and innovation	• UHC consulted about intervention logframe and were in charge of intervention implementation (Chapter 6) • Personnel from the different mess decks became healthy lifestyle representatives on the UHC (subsection 8.5.1 Q1)
Relationships	• UHC met monthly to develop and maintain effective relationships between intervention deliverers, users and Command (UHC reports) • UHC reports sent to the INM and Fleet Catering WO (UHC reports)
Engagement	• The ideas and preferences of the intervention target users informed the development and delivery of the intervention (Chapter 6) • Personnel from the different mess decks became healthy lifestyle representatives on the UHC (subsection 8.5.1 Q1)
Communication	• UHC met monthly and produced posters of the UHC reports that were displayed to help develop and maintain effective communication between intervention deliverers, users and Command (UHC reports) • INM met with the ship's UHC, Command, LO, NAAFI manager and the food supplier pre-deployment to enable effective communication within the system (Appendix 28)
Embedded actions and policies	• UHC met monthly and produced a monthly action grid so that intervention activities aligned with the intervention outcomes and objectives; thus the Armed Forces Weight Management Policy (UHC reports)
Robust and sustainable	• Intervention logframe details clear strategies to resource existing and new intervention activities and staff (Appendix 19)
Facilitative leadership	• UHC consulted about intervention logframe and were in charge of intervention implementation (Chapter 6) • The Second Sea Lord endorsed the healthy lifestyle intervention[281]
Monitoring and evaluation	• Evaluation framework presented at Figure 6.3 • Intervention evaluation plan presented at Table 8.2

Q5: Was the intervention feasible and sustainable?

The following factors were discussed during the end-deployment semi-structured interviews that related to the feasibility and sustainability of the intervention: intervention activities were feasible, factors enabling the feasibility of the intervention, factors limiting the feasibility of the intervention and sustainability of the intervention. Table 8.8 presents these themes and associated sub-themes derived from the intervention deliverers' accounts.

Table 8.8: Intervention deliverers' comments about the feasibility and sustainability of the healthy lifestyle intervention.

Major themes	Sub-themes
Intervention activities were feasible	Food Physical activity Health promotion and education
Factors enabling feasibility of intervention	Extra finance Extra resource materials
Factors limiting feasibility of intervention	Experience and skills of chefs Number of chefs Workload of chefs Equipment Personnel Resupply of feeding provision
Sustainability of intervention	Resources Policy Leadership Nutrition education Provision

Comments were made on the feasibility of the intervention activities delivered onboard the ship. The chefs, MO, PTI, and NAAFI manager agreed that the intervention activities to improve the healthiness of the nutrition and physical activity environments onboard the ship were feasible. The chefs, LO, MO and PTI commented that the intervention activities were feasible due to the extra resources provided for the intervention. This included the increase in the DMR to support the provision of healthy food choices and the provision of health promotion and education resources for the chefs and ship's company.

Comments were made that the feasibility of the intervention was dependent on the chefs. Comments specifically related to the requirement of strong leadership to ensure that the chefs were motivated, the impact of inadequate staffing levels, the intervention increasing the workload of the chefs, and the impact of the lack of experience and skills of the chefs on the intervention. The chefs, MO and PTI noted that the feasibility of the intervention was dependent on the availability of equipment to deliver the intervention activities and personnel's behaviours and preferences. This included discussions about the need to provide personnel with choice, but that *"ultimately it is all down to individual choice whether someone chooses to eat healthily or unhealthily"* (chef, semi-structured interview). The NAAFI manager, MO and PTI also said that, whilst deployed, resupplying the NAAFI stocks with healthy snacks was difficult due to these items being typically expensive.

All interviews commented on the sustainability of the intervention. Topics raised included the required resources to deliver the intervention, specifically the need to ensure: sufficient numbers of experienced chefs, a continuation in the uplift of the DMR to support the provision of healthy choices, funding to support health promotion activities, the Galley has the right equipment to provide healthy menus, healthy options are available on the Galley and NAAFI picking lists, standardised health promotion and education resources are available for chefs and UHC, and suitable measurement equipment is provided to ships to support the WMP. The MO, PTI and Fleet Catering WO suggested that for the intervention to be sustainable policy changes were needed. This included making changes to the MOD catering and dining policy to ensure that healthy options are provided, to the UHC terms of reference and the NAAFI payment system. The MO, PTI and chefs also commented on the need for strong leadership, at all levels of the system both onboard the ship and at HMS Temeraire, to drive and support the intervention. The chefs, NAAFI manager and Fleet Catering WO all suggested that nutrition education needs to be provided to all RN chefs, LO, NAAFI managers and RN personnel in general. After reflecting on the intervention activities the chefs, NAAFI manager, MO and PTI made suggestions for what to include in the future feeding and physical activity provision onboard ship. Specific comments included: the NAAFI deploying with more healthy options that are difficult to resupply at sea, updating the Fleet physical activity challenges and providing more emphasis on adventurous training, promoting healthy options to ensure they are chosen, providing a salad bar a few times a week and not serving puddings every night.

Q6: Was the intervention affordable?

To support the intervention the Fleet Catering WO secured an extra 19% supplement for the feeding provision, detailed as the ‘submarine patrol supplement’. The supplement is not typically provided to ships at sea, only submarines. As a result of the supplement, according to the catering balance, by the end of the 6-months the ship’s catering account was in credit by £1076.33. If the supplement had not been provided the account would have been in debit by over £22,000. No other costs were calculated for intervention activities and resources.

Q11: How successful was the WMP?

Data from the UHC reports, intervention resource list and end-deployment semi-structured interviews with the MO and PTI highlighted that a WMP was delivered throughout the deployment, one-fifth of the ship’s company (n=49) attended the WMP over the deployment and attended 75% of sessions, and 60% of participants classified at ‘any risk’ of obesity related ill health engaged in the WMP. There was also an increase in resources to support the WMP (see Appendix 28). In terms of outcomes, at end-deployment, 65% of participants in the WMP achieved a weight loss greater than 3% of their initial weight and 61% achieved a weight loss greater than 5% of their initial weight. Mean weight loss was 5.2 (4.7)% of initial weight[282].

8.5.3 Outcome evaluation

Q7: To what extent has the intervention achieved its objective?

At pre-deployment 26% of participants (n=27) were classified as being at 'any risk' of obesity related ill health. Although this reduced to 23% (n=24) at end-deployment the reduction was not statistically significant. When changes in NICE risk classification were compared over the deployment 12% of participants (n=12) improved; 4% (n=4) deteriorated; and, 84% (n=87) did not change (Table 8.9).

Table 8.9: Change in NICE risk classification over the deployment, n=103.

		End-deployment (n)			
		No risk	**Increased risk**	**High risk**	**Very high risk**
Pre-deployment (n)	**No risk**	72	4	0	0
	Increased risk	7	1	0	0
	High risk	0	1	6	0
	Very high risk	0	1	3	8

Note: green, improvement; blue, no change; red, deterioration.

Q8: To what extent has the intervention achieved its outcomes?

Seventy-five participants (73%) completed food diaries at both pre- and end-deployment. Mean daily EI was lower end-deployment compared with pre-deployment ($P<0.001$; Table 8.10). The proportion of total EI from carbohydrates was higher and from protein and saturated fat was lower pre-deployment than end-deployment ($P<0.001$; Table 8.10). Total sugar and dietary fibre intake was higher pre-deployment than end-deployment ($P<0.01$; Table 8.10). There were no differences in the proportion of total EI from total fat, salt intake or the proportion of participants who consumed a dietary protein supplement over the deployment (Table 8.10).

The proportion of participants who met the dietary recommendation for percentage of EI from saturated fat and total sugar intake was lower and higher, respectively, at end-deployment compared with pre-deployment (n=75, 21% vs. 48%, X^2 (1)=11.8, $P<0.01$; 81% vs. 44%, X^2 (1)=22.3, $P<0.001$). Furthermore, the proportion of participants who met the dietary recommendation for starchy foods and fluid was lower and higher, respectively, at end-deployment compared with pre-deployment (n=92, 42% vs. 57%, X^2 (1)=4.3, $P<0.05$; 39% vs. 21%, X^2 (1)=6.7, $P<0.01$). There were no other statistically significant differences in the proportion of participants meeting dietary recommendations over the deployment (Table 8.11). The change in pre- and end-deployment prudent diet quartiles were not statistically different. Over the deployment, 21% of participants (n=15) improved; 16% (n=11) deteriorated; and, 63% (n=44) showed no change (Table 8.12).

Table 8.10: Dietary intake over the deployment, n=75.

Variable (units)	Statistic	Pre-deployment	End-deployment
Energy (kcal)	Mean (SD)	2328 (597)	2021 (569)***
Percentage of EI:			
Protein (%)	Median (IQR)	19 (16-22)	21 (18-23) ###
Carbohydrate (%)	Mean (SD)	37 (6)	34 (7) ***
Total fat (%)	Mean (SD)	41 (5)	42 (6)
Saturated fat (%)	Mean (SD)	11 (2)	13 (2) ***
Sugar (g)	Mean (SD)	86.5 (38.6)	65.0 (33.3) ***
Dietary fibre (g)	Mean (SD)	20.1 (6.9)	17.7 (6.1) **
Salt (g)	Mean (SD)	7.3 (2.2)	7.8 (2.4)
Protein supplement used	% (n)	28 (21)	35 (26)

Note: * P<0.05, ** P<0.01, *** P<0.001 Paired samples T-test, difference to pre-deployment; ### P<0.001 Wilcoxon Signed Rank Test, difference to pre-deployment.

Table 8.11: Proportion of participants meeting dietary recommendations over the deployment.

	Variable	n	Pre-deployment % (n)	End-deployment % (n)
	Percentage of EI:	75		
1	Carbohydrate >50%		1 (1)	1 (1)
2	Total fat <35%		7 (5)	12 (9)
3	Saturated fat <11%		48 (36)	21 (16) **
4	Sugar <90 g		44 (33)	81 (61) ***
5	Dietary fibre >23 g		28 (21)	16 (12)
6	Salt <6 g		32 (24)	21 (16)
7	Fruit and vegetables: ≥5 portions a day	91	47 (43)	54 (50)
8	Starchy foods: consumed at every meal		57 (52)	42 (38) *
9	Fish: 2 portions a week		12 (11)	17 (15)
10	Red and processed meat: <90 g per day		1 (1)	3 (3)
11	Dairy: 2-3 portions a day		17 (15)	8 (7)
12	Fluid: 8 glasses a day		21 (19)	39 (35) **

Note: * P<0.05, ** P<0.01, *** P<0.001 Pearson chi-square test, difference to pre-deployment.

Table 8.12: Change in prudent diet score over the deployment, n=70.

		End-deployment (n)			
		1-3	4-6	7-9	10-12
Pre-deployment (n)	1-3	30	14	0	0
	4-6	11	14	1	0
	7-9	0	0	0	0
	10-12	0	0	0	0

Note: green, improvement; blue, no change; red, deterioration.

Eighty-five participants (83%) completed physical activity diaries both pre- and end-deployment. There were no statistically significant differences in the mean time participants undertook doing the seven activities (sleeping, sitting, relaxing, standing, light activity, moderate activity and intensity) over the deployment (Figure 8.1).

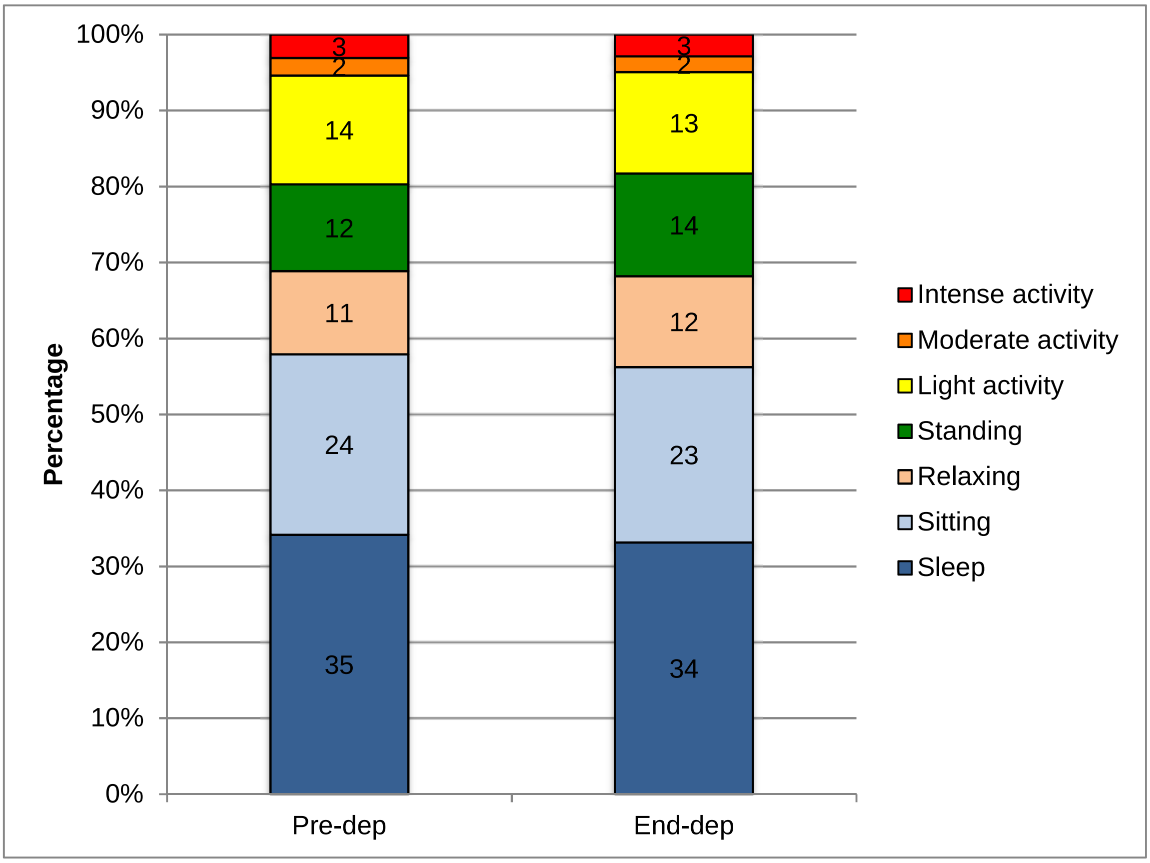

Figure 8.1: Physical activity levels over the deployment, n=85.
Note: P>0.05 Paired samples t test, difference to pre-deployment.

EE, but not PAL was lower at end-deployment compared with pre-deployment (P<0.05; Table 8.13). Furthermore, there were no differences in the proportion of participants with a PAL above 1.75 between pre- and end-deployment (59% vs. 54%). Comparing changes in the proportion of participants with a PAL above 1.75 over the deployment, 12% (n=10) improved; 16% (n=14) deteriorated; and, 72% (n=61) showed no change. A higher proportion of participants reported being a member of a sport or exercise group or club onboard the ship at end-deployment compared with pre-deployment (n=92, 50% vs. 26%, X^2 (1)=11.2, P<0.01).

Table 8.13: PAL and EE over the deployment, n=85.

Variable	Statistic	Pre-deployment	End-deployment
PAL	Median IQR 95% CI range	1.8 1.6-2.0 1.7-1.9	1.8 1.6-2.0 1.7-1.9
EE	Mean (SD) Range 95% CI	3461 (870) 2028-7313 185	3354 (836) † 2045-7434 178

Note: † P<0.05 Paired samples t test, difference to pre-deployment.

At pre-deployment 74% of participants (n=76) were classified as being at 'no risk' of obesity related ill health. Although this increased to 77% (n=79) at end-deployment, the reduction was not statistically significant (Figure 8.2). When changes in NICE risk classification were compared over the deployment 12% of participants (n=12) reduced their risk; 4% (n=4) increased their risk; and, 84% (n=87) showed no change (Table 8.9).

Q9: To what extent has the intervention created a healthier nutrition environment?
Data from Chapter 5 and the end-deployment semi-structured interview with the NAAFI manager indicated a 149% increase in sugar-free beverages available, 24% reduction in sugar sweetened beverages available, 4% increase in confectionary and packet sweet snack items available in the smallest standard single serve portion size available, and a 50% increase in 'healthy' snacks/meal alternatives available. There was no change in the absolute number of sugar containing beverage options available in no more than a 330 ml portion size, confectionary and packet sweet snack items exceeding 250 kcal per item, or savoury snacks available only in packet sizes of 30 g or less. The NAAFI manager indicated that certain items, including crisps and nuts in packet sizes of 30 g or less, could not be sourced as they were not available on the picking list. The NAAFI manager also said the layout of the shop was changed so that healthy options were placed at the front.

An additional 24 healthy food items were added to the CPL for the ship to procure pre-deployment. These included chickpeas, lentils and other beans and pulses; wholemeal frozen baguettes; frozen berries; dried fruit; nuts; tinned peaches in natural juice; wholemeal flour; brown rice and butternut squash.

Compliance of the vessel menus with the 15 AFFBS ranged between 67% and 93% (Table 8.14). On average the menus were 148% healthier compared with the menus analysed in Chapter 5. In terms of the 15 AFFBS, nine standards were achieved for all eight months; one was achieved for seven months; three standards for five months; one for three months; and one for one month. The two standards with the lowest compliance were ‘starchy food cooked/prepared with fat/oil are not provided more than once per day across lunch/dinner’ and ‘a portion of milk/ dairy foods are provided at every meal’.

Data from the end-deployment semi-structured interview with the LO indicated that healthy foods were resupplied throughout the deployment, which enabled healthy menus to be provided. This was supported by the evidence in Table 8.14 demonstrating that the menus were healthier compared with those in Chapter 5. Furthermore, as discussed in subsection 8.5.2 Q1 there was an increase in health education and promotion materials that were accessible throughout the 9-month deployment.

Table 8.14: Compliancy of menus with AFFBS over the deployment.

AFFBS	Chapter 5	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Compliancy per AFFBS over deployment (%)
At least 5 portions of fruit and vegetables are provided every day										**100**
Vegetables cooked in fat/oil or served in a cream/cheese sauce are not provided more than once per meal										**71**
At least one-third of starchy food options are non-potato										**100**
At least 25% of non-potato starchy options are wholegrain or high-fibre versions										**100**
At least 50% of breakfast cereal options are high-fibre										**100**
Starchy food cooked/prepared with fat/oil is not provided more than once per day across lunch/dinner										**14**
No more than 50% of breakfast cereal options are high in total sugar										**100**
Main course options made with pastry are not provided more than once per day										**100**
At least two portions of fish are provided per week										**100**
At least one portion of oily fish is provided per week										**71**
At least one vegetarian main course option per day contains either: eggs, beans, peas, lentils or vegetable-based sources of protein										**71**
Processed meat products are not provided more than once per day across lunch/dinner										**100**
A portion of milk/ dairy foods are provided at every meal										**43**
At least 50% of the dessert options available are based on fruit										**86**
Tap water is visible and freely available										**100**
Compliancy per time point (%)	**33**	**87**	**80**	**87**	**93**	**87**	**87**	**67**	**67**	

Note: green, compliant; red, non-compliant.

Q10: To what extent has the intervention created a healthier physical activity environment?

Data from the end-deployment semi-structured interview with the MO and PTI, end-deployment questionnaires and the intervention resource list (Appendix 28) indicated there was an increase in health education and promotion materials that were accessible throughout the 9-month deployment; an increase in cardiovascular and strength training exercise equipment pre-deployment; and an increase in the provision of PTI delivered classes and sport throughout the 9-month deployment. Further detail is presented at subsection 8.5.2 Q1.

Q12: Has there been equitable distribution of improvements in intervention outcomes based on gender and rank?

Males were more likely to experience no change in prudent diet score compared with females over the deployment (69% vs. 22%, X^2 (2)=7.3, P<0.05; Table 8.15), but rank was not associated with change in prudent diet score. Furthermore, there were no differences in the proportion of participants with a PAL >1.75 or participants' change in NICE risk classification based on gender or rank (Table 8.15).

Table 8.15: Proportion of participants meeting intervention outcomes based on gender and rank.

		Gender		Rank		
		Males % (n)	**Females % (n)**	**Officers % (n)**	**SRs % (n)**	**JRs % (n)**
Prudent diet score	**Improvement**	18 (11)	44 (4)	20 (3)	17 (3)	24 (9)
	No change	69 (42)	22 (2) *	60 (9)	67 (12)	62 (23)
	Deterioration	13 (8)	33 (3)	20 (3)	17 (3)	14 (5)
Physical activity level >1.75	**Improvement**	11 (8)	18 (2)	12 (2)	9 (2)	13 (6)
	No change	73 (54)	64 (7)	65 (11)	73 (16)	74 (34)
	Deterioration	16 (12)	18 (2)	24 (4)	18 (4)	13 (6)
NICE risk classification	**Improvement**	10 (9)	23 (3)	11 (2)	19 (5)	9 (5)
	No change	86 (77)	77 (10)	84 (16)	73 (19)	90 (52)
	Deterioration	4 (4)	0 (0)	5 (1)	8 (2)	2 (1)

Note: * P<0.05 Pearson chi-square test, difference to males.

Q13: Were there any differences in outcome measures between the 'intervention' and 'control' ship?

At pre-deployment there were no differences between the intervention and control ship based on gender, rank, age or NICE risk classification (P>0.05). There were no differences in participants' change in prudent diet score, NICE risk classification or the proportion of participants with a PAL >1.75 between the intervention and control ship (Table 8.16).

Table 8.16: Proportion of participants meeting intervention outcomes based on ship.

		Ship	
		Intervention % (n)	Control % (n)
Prudent diet score	Improvement	21 (15)	23 (12)
	No change	63 (44)	55 (29)
	Deterioration	16 (11)	23 (12)
Physical activity level >1.75	Improvement	12 (10)	9 (6)
	No change	72 (61)	61 (39)
	Deterioration	17 (14)	30 (19)
NICE risk classification	Improvement	12 (10)	23 (16)
	No change	72 (61)	70 (50)
	Deterioration	17 (14)	7 (5)

Note: P>0.05 Pearson chi-square test, difference between ships.

Q14: Did the intervention lead to changes in knowledge, self-efficacy, intention to change, barriers to change and perceptions of social support?

When combined a higher proportion of participants were in the action and maintenance stages of dietary change and a lower proportion were in the pre-contemplation and contemplation stages of dietary change at the end-deployment time point compared with pre-deployment (P<0.001; Figure 8.2).

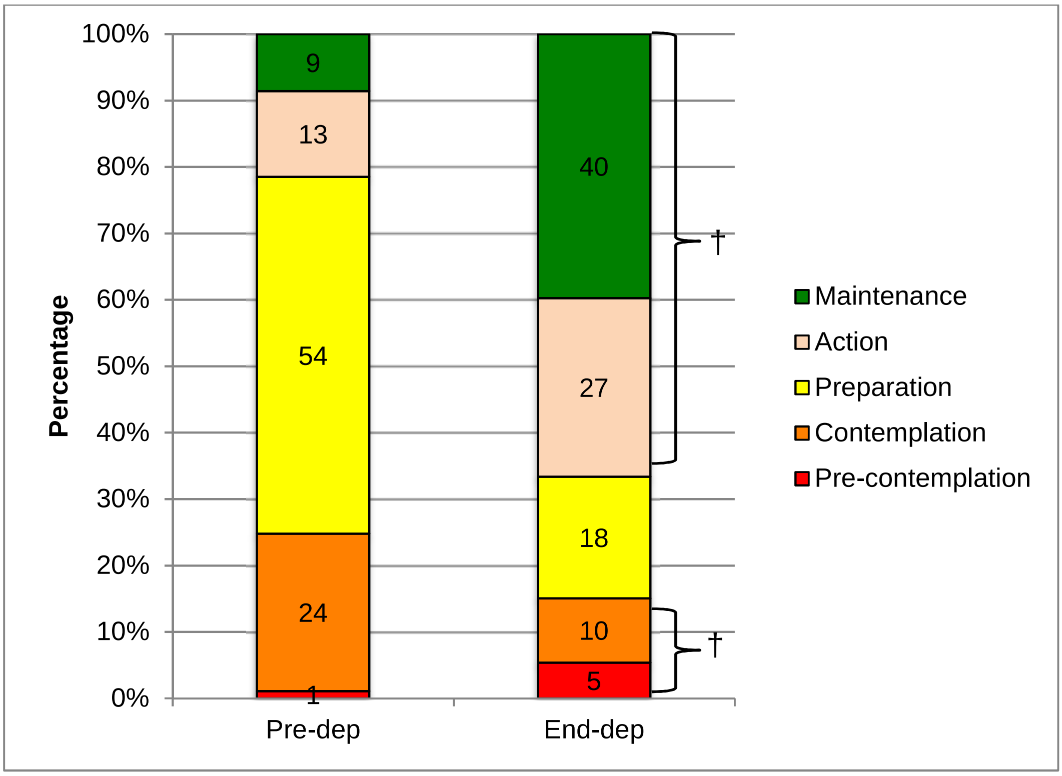

Figure 8.2: Dietary stage of change over the deployment, n=93.
Note: † P<0.001 Pearson chi-square test, difference to pre-deployment.

Similarly, a higher proportion of participants were in the action and maintenance stages of physical activity change and a lower proportion were in the pre-contemplation and contemplation, and preparation stages of dietary change at end-deployment compared with pre-deployment (P<0.001; Figure 8.3).

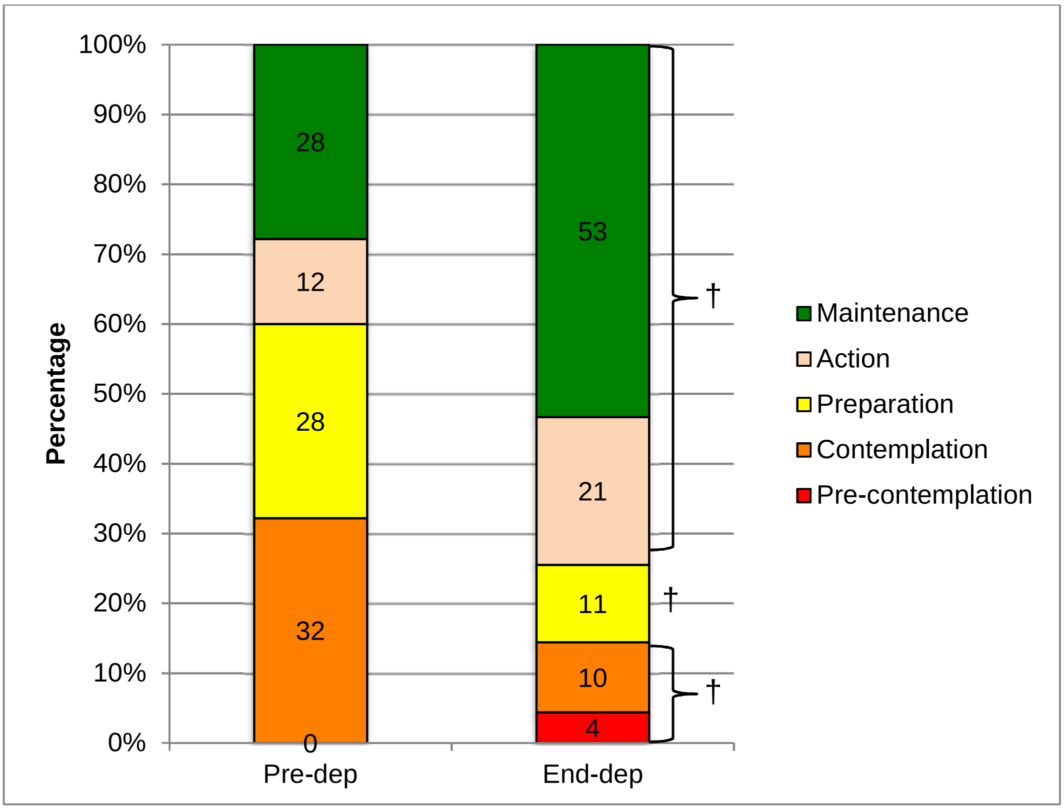

Figure 8.3: Physical activity stage of change over the deployment, n=90.
Note: † P<0.001 Pearson chi-square test, difference to pre-deployment.

Of the three participants who indicated they were going to give up smoking within the next month at pre-deployment, all had stopped smoking at end-deployment. One participant who indicated that they were going to give up smoking either within the next year also stopped smoking at the end-deployment time point. One participant who indicated that they were going to give up smoking over the deployment remained a smoker at the end-deployment time point.

There was no change in the mean score for how confident participants were that they could eat a healthy balanced meal or that they could take part in exercise or physical activity in the proposed difficult situations over the deployment (Table 8.17).

Table 8.17: Diet and physical activity self-efficacy over the deployment, n=91.

Variable	Statistic	Pre-deployment	End-deployment
Self-efficacy: diet	Mean (SD)	2.0 (0.5)	2.0 (0.6)
Self-efficacy: physical activity	Mean (SD)	2.1 (0.7)	2.1 (0.6)

Note: P>0.05 Paired samples t-test, difference to pre-deployment for diet and physical activity; 1, not at all confident; 2, moderately confident; 3, very confident.

The mean score for frequency during the past month that participants received encouragement to make healthy food choices, be physically active or make healthy drinking (alcohol) did not differ over the deployment (Table 8.18).

Table 8.18: Diet, physical activity and alcohol social support over the deployment.

Variable	Statistic	n	Pre-deployment	End-deployment
Social support: diet	Mean (SD)	92	2.5 (0.9)	2.3 (1.2)
Social support: physical activity	Mean (SD)	91	2.6 (1.1)	2.7 (1.2)
Social support: alcohol	Median (IQR)	93	2.0 (1.0-2.0)	1.0 (1.0-2.0)

Note: P>0.05 Paired samples t-test, Wilcoxen signed rank test, difference to pre-deployment for diet, physical activity and alcohol; 1, never; 2, rarely; 3, sometimes; 4, often; 5, very often.

Nutrition knowledge of participants increased over the deployment (P<0.01; Table 8.19). Changes ranged from a decrease of 28% to an increase of 51%. Physical activity knowledge of participants and the percentage of participants who correctly reported the alcohol guidelines and the hazards of smoking did not change over the deployment (Table 8.19).

Table 8.19: Nutrition, physical activity, smoking and alcohol knowledge over the deployment.

Variable	Statistic	n	Pre-deployment	End-deployment
Nutrition knowledge (%)	Mean (SD)	88	55 (10)	57 (10) **
Physical activity knowledge (%)	Median (IQR)	92	76 (68-80)	76 (69-80)
Smoking knowledge	% (n)	85	97 (82)	99 (84)
Alcohol knowledge	% (n)	94	42 (39)	33 (31)

Note: ** P<0.01 Paired samples t test, difference to pre-deployment.

Participants were more likely to cite *"I'm active enough"* and less likely to cite *"too fat/ overweight"* as barriers to being more physically active at end-deployment compared with pre-deployment (Table 8.20). Similar to the pre-deployment results, *"I don't have time"* (48%) and *"no motivation"* (29%) were the most frequently cited barriers at end-deployment.

Table 8.20: Barriers to physical activity over the deployment, n=92.

Barrier	Pre-deployment (% [n])	End-deployment (% [n])
I don't have time	61 (56)	48 (44)
No motivation	30 (28)	29 (27)
I need to rest and relax in my spare time	23 (21)	22 (20)
Can't be bothered	20 (18)	17 (16)
There are no suitable facilities	16 (15)	20 (18)
I don't put priority on physical activity	16 (15)	8 (7)
I've got young children to look after	14 (13)	Not applicable
There is no-one to do it with	13 (12)	8 (7)
I don't enjoy physical activity	9 (8)	11 (10)
Too fat/ overweight	8 (7)	1 (1) †
I'm not the sporty type	7 (6)	3 (3)
I can't afford it	7 (6)	2 (2)
My health is not good enough	5 (5)	5 (5)
I might get injured or damage my health	5 (5)	7 (6)
I'm active enough	3 (3)	11 (10) *
I'm too old	3 (3)	3 (3)
Traffic is too heavy	3 (3)	Not applicable

Note: * P<0.05 Pearson chi-square test, difference to pre-deployment; † P<0.05 Fisher's exact test, difference to pre-deployment.

Q15: Did the intervention lead to changes in other health behaviours?

Fifteen percent (n=17) of participants were current smokers at pre-deployment. Of the 13 current smokers at pre-deployment who were measured at end-deployment time point, 46% (n=6) had stopped smoking by end-deployment. Five participants, one of whom did not have a smoking history, became smokers by end-deployment. There were no differences in the proportions of smokers over the deployment for those measured at pre- and end-deployment (n=93, 14% vs. 13%).

The proportion of participants who consumed alcohol '2+ times a week' over the deployment fell (P<0.05; Figure 8.4). The number of units that participants consumed on a typical day when they were drinking did not differ over the deployment. However, there was a reduction in the proportion of participants who reported binge drinking over the deployment (n=94, 57% vs. 72%, X^2 (1)=4.6, P<0.05). When comparing changes in binge drinking behaviours over the deployment, 24% of participants (n=23) reduced; 10% (n=9) increased; and, 66% (n=62) did not change their frequency of binge drinking (Table 8.21).

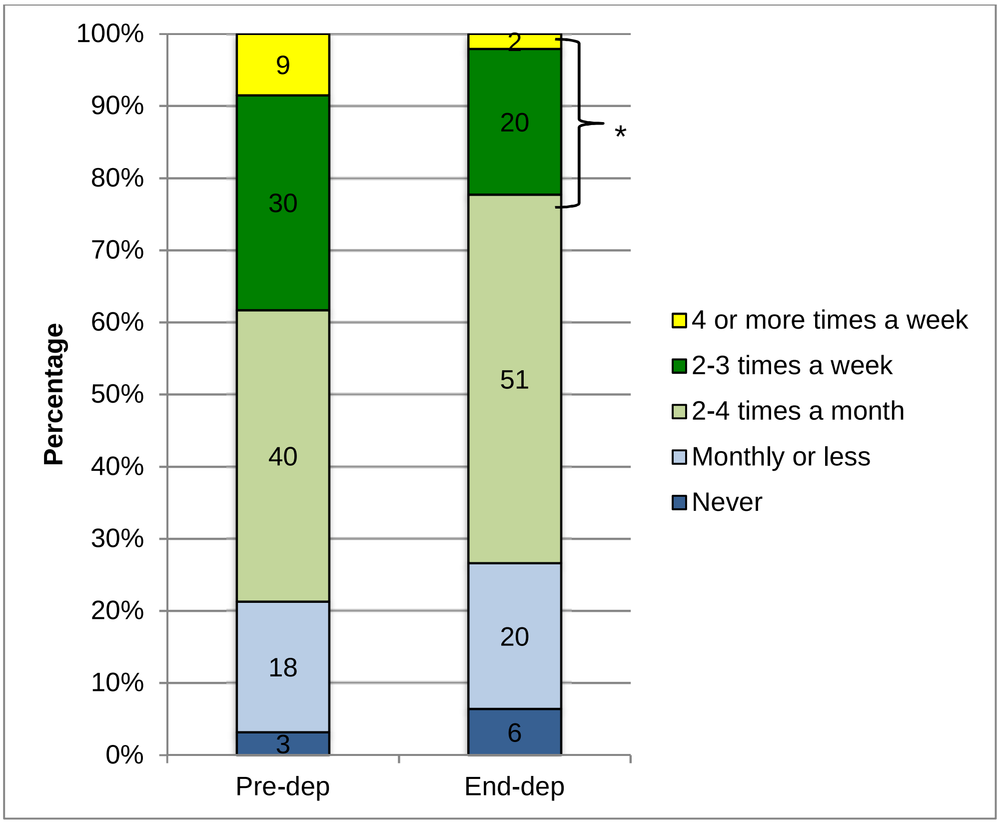

Figure 8.4: Alcohol consumption frequency over the deployment, n=94.
Note: * P<0.05 Pearson chi-square test, difference to pre-deployment.

Table 8.21: Change in binge drinking behaviour over the deployment, n=94.

		End-deployment (n)	
		Yes	**No**
Pre-deployment (n)	**Yes**	45	23
	No	9	17

Note: green, improvement; blue, no change; red, deterioration.

8.6 Step five: justifying conclusions

8.6.1 Process evaluation

On the whole the evidence suggests that the intervention conformed with the key features of a WSA[68] and was implemented as intended. Of the 38 intervention activities only two activities had no evidence to support they had been implemented; and six activities had evidence to support they had been implemented throughout the deployment, but potentially not with the frequency intended. During the deployment modifications were made to the intervention by the UHC. These included the provision of additional intervention activities and the inclusion of healthy lifestyle representatives on the UHC. The latter was to enable these representatives the opportunity to provide feedback on the intervention and ideas for future activities on behalf of their peers. Thus, empowering the ship's company as a whole by enabling creativity and innovation and giving them ownership of the intervention.

According to the intervention deliverers, the intervention activities to improve the healthiness of the nutrition and physical activity environment onboard ship were feasible. This was due to the extra resource provided for the intervention, including an increase in the DMR and the provision of both health promotion and education resources. Factors impacting on intervention feasibility included: strong leadership for the chefs; adequate staffing levels in Catering Services; the burden of the intervention on the chefs' workloads; chefs' experience and skills; and the ability to resupply healthy foods whilst deployed.

A major problem encountered during the deployment was the change of a member of the intervention delivery team. The new member did not understand the need for the intervention activities in their area and was not initially supportive of the intervention, showing resistance. This challenge highlighted the need for parties involved in setting up the system to ensure that any new delivery team members be adequately informed about the context of the system.

Intervention deliverers noted that to be sustainable the intervention required changes in the MOD catering and dining policy to ensure that healthy options have to be provided; a continuation in the uplift of the DMR to support the provision of healthy choices, without which the intervention would not have been affordable; changes to the NAAFI payment system; an increase in the number of healthy options on the Galley and NAAFI picking lists; changes to the UHC terms of reference; sufficient numbers of experienced chefs; nutrition education provided to Catering Services and personnel in general; funding to support health promotion activities; adequate equipment in the Galley to support the provision of healthy choices; standardised health promotion and education resources; and suitable measurement equipment to support the WMP. The intervention deliverers also highlighted the need for strong leadership at all levels of the system to drive and support the intervention, which is a key component of a WSA. When considering what improvements could be made to the intervention, intervention deliverers suggested that the NAAFI should deploy with more healthy options that are difficult to resupply at sea; the Fleet challenges should be updated; healthy options should be marketed well; a salad bar should be provided a few times a week; and puddings should not be served every night.

In terms of reach, the intervention successfully reached the target population (i.e. individuals classified at ‘any risk’ of obesity related ill health), with 96% of those at ‘any risk’ reporting that they participated in at least one intervention activity over the deployment. Furthermore, 60% of those classified at ‘any risk’ participated in the WMP, which provided tailored advice and support to enable them to make healthier lifestyle choices. The reasons why the other participants classified at any risk did not participate in the WMP were not explored. It is interesting to note that there was limited participation in some of the intervention activities regardless of NICE risk classification. For example, less than half of the participants undertook exercise classes and only a third undertook nutrition initiatives during the deployment. This lack of engagement with the intervention activities might help to explain the limited success in improvements in health behaviours discussed in subsection 8.6.2.

Satisfaction of the ship’s company with the intervention activities varied. Over three-quarters of participants agreed that the intervention helped them to improve their health. Furthermore, the majority of participants agreed that the intervention helped them to; gave them more opportunity to; made them more motivated to; and changed the way they felt about being physically active. In terms of eating healthily, just over half of participants agreed that the intervention activities helped them to; gave them more opportunity to; made them more motivated to; and changed the way they felt about eating healthily. Thus, suggesting that intervention activities that targeted physical activity were more successful compared with activities that targeted healthy eating. This was supported by the free text comments, where although 15 comments related to positive opinions about changes that were made to the feeding provision, 11 comments related to negative opinions about the changes. Furthermore, a number of comments referred negatively about the skills, knowledge and attitudes of the chefs; and the majority of comments about recommendations for future changes onboard RN ships related to increasing the healthiness of the feeding provision and improving the attitudes and knowledge of the chefs. However, as described at section 3.1 numerous factors interact to influence an individual’s food choice decisions; thus, it is unlikely that intervention activities targeting healthy eating would be acceptable to all personnel.

8.6.2 Outcome evaluation

Overall, in terms of changes in the physical measurements, health-related behaviours and psychosocial variables of RN personnel onboard the “intervention ship” over the deployment, there were improvements in 13 variables; deteriorations in eight; and no significant changes in 22 (see Appendix 25). The primary objective of the healthy lifestyle intervention was to reduce the prevalence of obesity onboard the intervention ship over the deployment. Although the prevalence of participants classified as being at any risk of obesity related ill health reduced from 26% to 23%, this reduction was not statistically significant, suggesting that the intervention did not achieve its primary objective. Nevertheless, 12% of participants experienced an improvement in NICE risk classification over the deployment. These individuals will have experienced an improvement in health status and hence a reduction in risk of developing co-morbidities associated with obesity[39]. This is of value not only to the individuals concerned, but also to the ship and the RN as an organisation due to the health, economic and occupational implications of obesity described at section 1.3. Furthermore, if the reduction in risk of obesity related ill health of 3% was seen across a greater number of ships (i.e. a larger sample size) this would be considered a meaningful change. Thus, the intervention has potential for some benefit to both the individual and the organisation.

There are a number of reasons that might explain why the intervention did not achieve its primary objective. These include: sampling bias; volunteer bias; the improvements in the healthiness of the environment not being enough to have an effect; that individuals might not have had any intentions to lose weight over the deployment; other psycho-social factors that were not explored (e.g., whether the participants agreed with the type of intervention approach); that the intervention duration was not long enough; or, a Type II error due to the sample size. According to Prochaska's transtheoretical model of the five stages of change[220], individuals' weight loss intentions may affect weight loss outcomes[221], and therefore may have affected the effectiveness of the intervention. Participant's stage of readiness for weight loss was not measured pre-deployment. However, it can be assumed that participants enrolled on the WMP were intending to lose weight over the deployment and changes in weight loss of those on the WMP exceeded the Department of Health best practice guidance for Tier-2 services[283]. The mean weight loss was 5.2 (4.7)% of initial weight[282], which is a clinically meaningful weight loss[273]. This finding suggests that the WMP as an intervention activity, which was delivered as part of the wider healthy lifestyle intervention, was successful. However, as participants were not followed up and measured when back alongside the long-term effects of the WMP are unknown.

The participants consumed less energy and derived a lower proportion of their total EI from carbohydrates and saturated fat, and a higher proportion of their total EI from protein at the end of the deployment compared with pre-deployment. Compared with the MDRV for active duty[79], the proportion of energy from carbohydrates was lower, and the proportion of energy from total fat, saturated fat and protein was higher across the deployment. Although there was a reduction in sugar intake over the deployment there was also a reduction in dietary fibre intake. The mean salt and dietary fibre intake were higher and lower, respectively, at both time points compared with the recommendations for the UK population[236,237]. In terms of compliance with the government's healthy eating guidelines, there was a reduction and increase in the proportion of participants who met the recommendation for starchy foods and fluid, respectively, over the deployment. The prudent diet score did not change over the deployment. However, over one-fifth of participants improved their score indicating that the intervention had beneficial effects for some individuals. In summary, the dietary data indicated that overall participants' were not achieving a healthy balanced diet across the deployment regardless of the healthy lifestyle intervention.

Participants spent a similar amount of time undertaking the seven types of activities over the deployment and there was no change in PAL. There was however a reduction in EE over the deployment that due to no change in PAL can be attributed to a reduction in weight. There was no change over the deployment in the proportion of participants with a PAL below the desirable value of 1.75 or more to reduce the risk of becoming overweight[271] (59% and 54% at pre- and end-deployment, respectively). However, a higher proportion of participants reported being a member of a sport or exercise group or club onboard the ship at end-deployment than pre-deployment, indicating that personnel were engaging more in organised exercise over the deployment. In summary, the physical activity data indicated that overall participants' were not active enough to reduce the risk of becoming overweight across the deployment regardless of the healthy lifestyle intervention.

Changes in the proportions of participants who were in the different stages of change for dietary, physical activity and smoking behaviours were observed over the deployment. At end-deployment a higher proportion of participants were in the action and maintenance stages of dietary and physical activity change compared with pre-deployment. These findings were supported by the results reported in the process evaluation, which suggested that the majority of participants engaged with the physical activity intervention activities and agreed that the intervention helped them to be more active. In terms of dietary change, these findings were less supported by the results reported in the process evaluation, which suggested that around a third of participants engaged with the nutrition initiatives and around a half agreed that the intervention helped them to eat more healthily. The stages of change data were contradictory to both the physical activity and food diary data, which indicated no change in participants' activity levels and both positive, negative and no changes in participant's dietary intakes at end-deployment. It is possible that this disparity may be due to the diaries only capturing self-reported activity levels and dietary intake over a short duration (4-days) at two discrete time points. Or potentially the stages of change questions may not provide a reliable method of assessing intentions in this population. Of the five participants who indicated that they were going to give up smoking over the deployment four had stopped smoking by end-deployment suggesting that the smoking cessation support provided was successful.

There were no changes in self-efficacy or social support related to diet, physical activity or alcohol behaviours over the deployment. Although there were some differences in the proportion of participants citing specific barriers to being more physically active between pre- and end-deployment, overall, at both times the most frequently cited barrier was *"I don't have time"*. This finding suggests that Command need to support personnel to make time for physical activity during a deployment. Although the increase in the nutrition knowledge of the participants over the deployment was of statistical significance the mean change was only 2.2 (6.8)%. As discussed in subsection 7.4.4 this equates to participants answering between one and two extra questions correctly. Thus, the improvement shown might be due to measurement error or just due to chance rather than an improvement in knowledge *per se*. Additionally, there were no improvements in participants' knowledge of physical activity guidelines, alcohol guidelines or the hazards of smoking over the deployment. Although for the latter, over 97% of participants correctly reported the hazards of smoking at pre-deployment. Overall, the findings suggest that more could be done to improve the nutrition and alcohol knowledge of personnel.

Although there were no statistically significant differences in the proportion of smokers over the deployment, 46% of participants who indicated that they were current smokers at pre-deployment had stopped smoking by the end of the deployment. This evidence and the data presented in the process evaluation suggest that the smoking cessation support that these individuals received was effective. Interestingly, five participants commenced smoking over the deployment. Previous research, which has also documented an association between military deployment and smoking initiation and recidivism, suggests that the occupational stress experienced during a deployment may be a contributing factor[284]. However, the reasons for smoking were not explored in the present study

Although the frequency that participants consumed alcohol '2+ times a week' reduced over the deployment there were no differences in the number of units that participants consumed when they drank alcohol. Of note, the proportion of participants who reported binge drinking over the deployment decreased by 15%. In contrast, previous research in the UK Armed Forces has reported that the prevalence of heavy drinking is higher during overseas deployments[272,279]. However, as over half of the sample reported binge drinking at end-deployment the evidence suggests that there is a culture of drinking in the RN that still needs to be addressed.

Other than male participants being more likely to experience no change in prudent diet score over the deployment than females, changes in prudent diet score, NICE risk classification or the proportion of participants with a PAL value of 1.75 or more did not differ based on gender or rank. Thus, demonstrating that the effects of the intervention were equitable based on gender and rank. As the intervention did not target participants based on gender or rank this is a positive finding. However, when examining the data from the ‘intervention’ and ‘control’ ships there were no differences in changes in the outcome variables over the deployments. This suggested that the healthy lifestyle intervention was not effective at improving personnel’s dietary intake, physical activity behaviours or NICE risk classification compared with what ordinarily happened at sea.

Overall, the evidence suggests that the intervention created a healthier nutrition environment onboard the ship over the deployment. Additional healthy food items were added to the CPL for the ship to procure pre-deployment, and healthy foods were resupplied throughout the deployment. These activities enabled healthier menus to be produced and provided. Over the deployment the menus complied with between 67% and 93% of the AFFBS, where on average they were 148% healthier compared with those produced before the intervention. As the menus were not fully compliant with the standards over the deployment it is evident that there was still scope for improvement. It is interesting to note that the last two menus analysed (i.e. September and October 2015), had the lowest levels of compliance. The reasons for this were not explored during the evaluation; however, possible explanations are that it was because of the chefs writing the menus, those signing off the menus or because of the foods available. A potential solution would be for the UHC to have access to a tool to analyse the nutrition content of the menus at any time. Any reduction in compliance could then be discussed with Catering Services. In the NAAFI shop, there was an increase in healthy and a reduction in less healthy foods and beverages. Although the evidence suggests that there was a move towards a healthier environment, as the provision was not fully compliant with the GBSF over the deployment, again there was scope for improvement. It was reported that healthy options were placed at the front of the counter. Previous research has shown that manipulating food position can positively influence food selection, sales and consumption[285]. However, this could not be assessed, as the sales figures from the NAAFI were unavailable during the intervention evaluation.

The evidence also suggests that the intervention successfully created a healthier physical activity environment onboard the ship over the deployment. There was an increase in the number of type of cardiovascular and strength training exercise equipment pre-deployment; an increase in the provision of PTI delivered classes and sport; and an increase in health education and promotion materials that were accessible throughout the deployment.

8.6.3 Factors facilitating or inhibiting the implementation of the intervention

Factors that facilitated the implementation of the healthy lifestyle intervention included: a strong UHC with forceful leadership from the MO to drive the intervention throughout the deployment; a supportive Fleet Catering WO who secured an increase in the DMR for the intervention, the support of the food supplier and importantly the support of the Second Sea Lord who endorsed the intervention thus gaining Command buy in; the hierarchical structure of the RN; the closed/controlled environment of the intervention ship; support from the majority of the ship's company to improve the healthiness of the ship's nutrition and physical activity environment; and importantly the support provided by the INM throughout the entire process.

Factors that inhibited the implementation of the intervention included: the lack of strong leadership in Catering Services; a manpower shortage in Catering Services onboard the ship; the experience and skills of the chefs; the resistance of the new member of the intervention delivery team who joined the ship during the intervention; the negative effects on health behaviours of port stops and mid-deployment leave when participants left the controlled environment of the ship; lack of support from certain members of the ship's company, in particular the SR some of whom were resistant to change and difficult to engage; and a lack of healthy items on the NAAFI picking list to resupply with during the deployment. Furthermore, it must be considered that although hypothetically the environment onboard a warship during a deployment provides an ideal opportunity to improve the dietary and physical activity behaviours of personnel using a WSA, the main aim of the ship during that time is as an operational asset to protect the nation's interests. As such, the objective of delivering a healthy lifestyle intervention would not have been a primary objective of the ship at all times throughout the deployment.

8.6.4 Comparison with other WSAs to obesity

To the author's knowledge there are no comparable WSAs to obesity that have been applied in a military context. Thus, comparisons have been made between the current intervention and interventions delivered in a civilian context. A recent systematic review of WSAs targeting obesity and other complex public health and societal issues[73], identified 12 studies on either obesity or healthy lifestyles that met the 10 Garside et al.[68] features for a WSA. Of these, three reported health and wellbeing outcomes, of which: positive effects on nutrition and physical activity environments were reported in an evaluation of the 'Central California Regional Obesity Prevention Program'[286]; mixed effects on health and wellbeing outcomes, with no reduction in obesity prevalence in an evaluation of 'Healthy Towns' in a UK city[287]; and improvements in waist measurements and BMI of children, and positive improvements in health behaviours of children, parents and teachers in an evaluation of ‘Health Heroes’ that was a whole school approach to healthy weight in the UK[288]. Thus, the healthy lifestyle intervention evaluated in this Chapter could be assumed to be as effective as the California and Healthy Towns initiatives, but not as successful as the Health Heroes initiative. This difference might be explained due to the latter initiative receiving significantly more financial and human resource compared to the current intervention.

Of the 12 studies in the systematic review[73], ten reported process outcomes, with facilitators to implementing a WSA being: the development of strong partnerships[286,289-293]; engagement of the local community[286,291,292,294] and taking time to establish good working relationships[292]; strong leadership buy-in[290,292,294,295]; the development of a shared vision, values and commitment[289,290,292]; sufficient financial support and resources[289,292,295,296]; the importance of evaluation in informing future practice and wider learning[286,287,296]; embedding initiatives within a broader policy context[286,290,295]; and good governance[290,295]. The factors described above echo the many lessons learned from the evaluation presented in this chapter.

8.6.5 Recommendations

The evidence suggests that a ‘top-down’ ‘bottom-up’ approach is needed that incorporates strong leadership at all levels of the system as well as community involvement. As with the present intervention, future interventions need to create opportunities for interaction and exchange between Command and intervention deliverers, and intervention deliverers and the ship’s company (i.e. the community). It is essential that the community are involved in defining and finding solutions for the problem the intervention aims to address, and has some responsibility and control over the intervention. This was achieved in this study by including the intervention ship’s company and UHC in the design and implementation of the intervention and the addition of healthy lifestyle representatives on the UHC. Additionally, interventions need to ensure sufficient financial support and resource, but also be dynamic by drawing upon the resources available, build capacity, and adjust and adapt over time. Ideally the intervention should be embedded in the organisation such that it becomes routine practice.

The evidence suggests specific improvements that should be made at the policy and institutional levels to facilitate the delivery of future interventions. At the policy level the intervention deliverers suggested a need for a permanent increase in the DMR to support the provision of healthy menus onboard vessels across the Fleet. However, it is unclear whether this is actually needed or whether the RN could use its purchasing power to improve the nutritional quality of the food procured and hence improve the healthiness of the menus without an increase in cost. The evidence suggested that changes are needed to the MOD catering and dining policy to mandate that menus be compliant with the AFFBS. Furthermore, as the NAAFI provision was not fully compliant with the voluntary GBSF, it would be beneficial for the NAAFI to be mandated to meet the standards. At the institutional level suggested improvements included: changes to the NAAFI payment system; ensuring adequate manpower in Catering Services; the provision of standardised health promotion and education resources for interventions; changes to UHC terms of reference for the inclusion of healthy lifestyle representatives; an update of the Fleet physical activity challenges; an increase in the number of healthy options on the NAAFI and Galley provisions lists; the provision of nutrition education to Catering Services and personnel in general; funding to support health promotion activities; adequate equipment in the Galley to support the provision of healthy choices; and the provision of suitable measurement equipment to support the WMP.

8.6.6 Limitations of the evaluation

The evaluation had a number of limitations. First, not all stakeholders were involved in the planning or delivery of the evaluation because additional resource was not available to support the evaluation. As such, the evaluation findings may potentially be ignored, criticised or resisted by these individuals and groups. However, the Fleet Catering WO and ship's UHC, who were deemed to be key stakeholders, were invited to engage in the whole evaluation process.

Second, although the intervention evaluation was evidence-based and included formative, process and outcome components it did not include an economic evaluation. Thus, the cost-effectiveness of the intervention could not be determined.

Third, due to the nature of the setting in which this research was undertaken, only 90% of the study sample were measured at the end of the deployment, which equated to 43% of the whole ship's company. Furthermore, whilst the study sample was representative of the demographics of the whole ship's company it could not be determined whether the sample was representative in terms of their NICE risk classification, health behaviours or psychosocial factors. Moreover, as the sample was a convenience sample there may be a risk of volunteer bias. These factors may limit the reliability of the results of this study. Additionally, the study sample represented 48% of the ship's company, meaning that 52% of personnel onboard the ship did not engage with the study. However, these individuals will have engaged in the healthy lifestyle intervention as the intervention was delivered to the whole ship's company. The reasons for non-engagement were not explored.

Fourth, due to limited resource available for the evaluation, the methods could not be piloted. Furthermore, the evaluation design involved comparing differences in outcome measures between an ‘intervention’ and ‘control’ ship, where the ships were deployed at different time points and for different lengths of time. As described in subsection 7.2.1 due to the real-life setting of this research programme, it was not possible for a control and intervention group to be on the same ship, as such this was the best method to determine differences between personnel receiving an intervention with what happens to RN personnel ordinarily at sea. Participants were therefore not blinded as to whether they received the intervention or not. As presented at subsection 8.5.3 there were no differences between the two ships based on gender, age, rank or NICE risk classification at the pre-deployment time point suggesting limited selection bias.

Fifth, there were limitations regarding the measurement tools used to collect the data on participant’s health behaviours and psychosocial factors. As these tools used self-report methods they may have caused recall or reporting bias. However, as discussed in subsection 7.2.4 both the measurement tools have been previously validated. The methods used to assign PAR values might have led to both under- and over-estimations of PAL and EE. The methods used to determine the reach of the intervention activities involved participants filling out a free text box; thus requiring engagement with the questionnaire. The data from the semi-structured interviews were coded, analysed and themes identified by the author only. This process meant that the main perspective expressed from these data is the author’s. Last, despite the creation of a healthier food and physical activity environment onboard the ship this did not translate into positive changes in dietary intake and physical activity levels. It is possible that this disparity may be due to the food and physical activity diaries and deployment questionnaires only capturing self-reported behaviours over a short duration at discrete time points over the deployment. It may also be due to the evaluation methods not being sufficiently robust. Although the results suggested that the environment had become healthier a more comprehensive analysis, for example, comparing the nutritional content of the menus with the mandatory GBSF[239], may not have shown similar successes.

Finally, when participants were grouped according to their gender or rank the resultant small sample sizes may have increased the likelihood of a Type II error (i.e. a false-negative) and reduced the power of the study (i.e. the probability of observing an effect in the sample).

8.7 Step six: disseminating and using findings

The findings were disseminated to the stakeholders through a series of briefs, and study participants were provided with individual feedback forms detailing their changes in physical measurements over the deployment. The dissemination of the findings led to a series of actions being undertaken to support future healthy lifestyle interventions both in the RN and across Defence. These are detailed at section 9.4.

8.8 Conclusion

In conclusion, the evidence presented in this evaluation suggests that a WSA can be applied to successfully improve the healthiness of the nutrition and physical activity environment onboard a RN warship. Although the intervention did not demonstrate significant positive effects on risk of obesity related ill health, dietary intake or physical activity levels, a number of individuals experienced an improvement in health status and a reduction in risk of developing co-morbidities associated with obesity, which is of value not only to the individuals concerned, but also to the ship and the RN as an organisation.

The evidence suggests that a 'top-down' 'bottom-up' approach is needed which incorporates strong leadership at all levels of the system and community involvement. Future interventions need to create opportunities for interaction and exchange between Command and intervention deliverers, and intervention deliverers and the community. Where it is essential that the community are involved in defining and finding solutions for the specific problem that an intervention aims to address and have some responsibility and control over the intervention. Additionally, future interventions need to be dynamic by drawing upon the resources available, building capacity, and adjusting and adapting over time. Ideally interventions should be embedded in the organisation and policy context such that they become routine practice.

The next Chapter integrates the findings from this programme of research in the context of the research aim and questions and discusses the public health relevance of the findings with respect to the RN fleet (i.e. all vessels), the RN as a whole, the UK Armed Forces and the civilian population.

9. General discussion

9.1 Chapter overview

Given the problem of obesity in the RN[30-37] and the evidence that supports taking a systems approach to tackle obesity[66,68,71-73,297,298], this thesis presented the findings from a programme of research that aimed to evaluate whether a WSA could be undertaken to create a healthier environment onboard a RN ship to facilitate RN personnel to adopt or maintain prudent health behaviours, and whether such an approach could reduce the prevalence of obesity. The research entailed six studies using multiple data collection methods to inform the development and implementation of a healthy lifestyle intervention and rigorously evaluate it. To the author's knowledge this is the first programme of research to explore the effectiveness of applying a WSA, which targets obesity, in a military context.

This chapter presents a summary and discussion of the main findings in the context of the research aim and questions, and the public health relevance of the findings with respect to the RN Fleet (i.e. all vessels), the RN as a whole, the UK Armed Forces and the UK civilian population. This will be followed by a discussion of the strengths and limitations of the research, a consideration of the implications of the findings for future research, and recommendations for the RN for delivering future health promotion interventions. Finally, the chapter ends with the author's overall conclusions of the thesis.

9.2 Summary of main findings

As a result of this programme of research, four main findings emerged:

1. There is a need for a healthy lifestyle intervention to reduce the prevalence of obesity in the RN, to improve RN personnel's dietary and physical activity behaviours, and create a healthier environment onboard RN vessels.
2. The intervention should take a multi-component, multi-level, WSA.
3. A WSA can be applied to successfully improve the healthiness of the environment onboard a RN ship.
4. Strong leadership buy-in, community involvement and sufficient financial support and resource are essential components for delivering an effective WSA.

These themes are elaborated upon below.

9.2.1 There is a need for a healthy lifestyle intervention

As discussed in Chapter 1 the RN is not exempt from the obesity epidemic[30-37]. This was further supported by the findings presented in Chapter 3 whereby 29% of participants were classified as being at 'any risk' of obesity related ill health. Moreover, the findings presented in Chapters 7 and 8 indicated that prior to an overseas operational deployment 34% and 26% of RN personnel onboard two RN ships were classified at risk. Overall, the findings indicated that obesity is a problem for the RN.

In agreement with previous literature[18,19] the dietary intake of RN personnel measured onboard a RN ship was not compliant with the government's healthy eating guidelines (Chapter 7)[80]. Participants derived a higher proportion of their total EI from total fat, saturated fat and protein; and a lower proportion from carbohydrates, compared with the MDRVs[79]. Furthermore, participants consumed less dietary fibre and more salt compared with the UK population recommendations[236,237], less than half of the participants consumed at least five portions of fruit and vegetables a day, less than a third consumed two portions of fish a week, and less than one in ten met the dietary recommendations for red and processed meat or consumed 2-3 portions of dairy products per day. This pattern of unhealthy dietary behaviours was also reported in the findings presented in Chapter 3, where the first two dietary patterns identified in the PCA, that explained the largest percentage of variation in dietary intake were 'high-fat' and 'processed' Overall, the findings indicated that personnel were typically consuming unhealthy diets.

Although most of the participants measured in the study presented at Chapter 3 reported being physically active, 13% percent reported they were either inactive or moderately inactive. Furthermore, in the study reported at Chapter 7, although the median PAL for the participants at pre-deployment exceeded the recommendation of a desirable PAL value of 1.75 or more to reduce the risk of becoming overweight[271], 33% had a PAL below this value. Overall, the findings indicated that a large proportion of personnel were not being active enough to stay healthy.

In Chapter 5 a cross-sectional study was undertaken onboard a representative sample of eight RN vessels to determine whether the physical activity and nutrition environments onboard the vessels supported healthy physical activity and dietary choices. All vessels, except HMS Vigilant (the submarine), had at least one dedicated space for exercise equipment onboard and provided a wide range of equipment. Furthermore, all vessels except HMS Atherstone and HMS Vigilant had a PTI onboard who delivered a range of activities for the ships' company. All vessels were compliant with the dietary guidelines for energy and dietary fibre, but none were compliant with the dietary guidelines for percentage of EI derived from protein, total fat, saturated fat or carbohydrates, or salt. Furthermore, compliance with AFFBS was poor ranging between 20-40% for each vessel. The provision of foods and drinks in the NAAFI shop and vending machines was typically unhealthy. These findings supported the results presented in Chapter 4 that indicated that the most frequently cited barrier to eating more healthily onboard vessels was related to the availability of healthy foods in the Galley and NAAFI shop. Overall, the findings indicated that the physical environment onboard RN vessels did not support healthy dietary choices, but did support healthy physical activity choices.

In summary, the data presented in Chapters 1 to 5 confirmed that there was a need for a healthy lifestyle intervention to reduce the prevalence of obesity in the RN, to improve RN personnel's dietary and physical activity behaviours, and to create a healthier environment onboard RN vessels.

9.2.2 The intervention should take a multi-component, multi-level WSA

It was suggested in Chapter 1 that due to the multifaceted aetiology of obesity and the complex relationships that exist between individuals, groups, and their environments, obesity must be tackled using a multifaceted approach, which addresses the whole system. Thus, the SEM of health behaviour[77] – the theory-based framework which forms the basis of a WSA – was proposed as the conceptual basis for the healthy lifestyle intervention.

The findings of the systematic review undertaken in Chapter 2, which aimed to evaluate the effectiveness of environmental-based interventions aimed at improving the dietary and physical activity behaviours of adults in institutions, further supported the use of a socio-ecological approach. The findings of the mixed methods study presented in Chapter 4, which explored barriers and enablers to prudent health behaviours, demonstrated the interaction between intrapersonal factors, organisational factors, the physical environment, and policy factors on the health behaviours of RN personnel onboard the intervention ship. Furthermore, the results of the study presented at Chapter 5 indicated that to improve the healthiness of the physical environment onboard RN vessels, interventions that take a multi-component multi-level WSA are required.

In summary, the data presented in Chapters 1 to 5 suggested that the healthy lifestyle intervention should take a multi-component, multi-level WSA.

9.2.3 A WSA can be applied to successfully improve the healthiness of the environment onboard a RN ship

The evidence presented in Chapter 8, which described an evaluation of the healthy lifestyle intervention, demonstrated that the intervention was implemented as intended and conformed with the key features of a WSA[68], that is it recognised a public health system, built capacity, supported local creativity and innovation, developed effective relationships, enhanced community engagement, improved communication, embedded actions and policies, was robust and sustainable, had facilitative leadership and was monitored and evaluated.

The evidence suggested that the intervention successfully created a healthier nutrition environment onboard the ship over the deployment. Specifically, additional healthy food items were added to the core provisions list for the ship to procure pre-deployment, and healthy foods were resupplied throughout the deployment. These enabled healthier menus to be created and produced throughout the deployment. Over the deployment the menus complied with between 67% and 93% of the AFFBS, where on average the menus were 148% healthier compared with those produced before the intervention (Chapter 5). In the NAAFI shop, there was an increase in healthy and a reduction in less healthy foods and beverages. It was also reported that healthy options were placed at the front. However, it must be noted that although the measurement methods used demonstrated improvements in the nutrition environment a more robust approach would have been desirable and might not have yielded such positive results. For example, by measuring changes in the nutritional content of the food provision and the menus against the mandatory GBSF[239]. Furthermore, as the menus and the NAAFI provision were not fully compliant with the standards over the deployment it was evident that there was still scope for improvement.

The evidence suggested that the intervention successfully created a healthier physical activity environment onboard the ship over the deployment. This was achieved through the provision of additional exercise equipment, an increase in the delivery of exercise classes and sport, and an increase in the availability and accessibility of health education and promotion materials.

In summary, the findings presented in Chapter 8 suggested that a WSA can be applied to successfully improve the healthiness of the nutrition and physical activity environment onboard a RN ship over a deployment.

9.2.4 Strong leadership buy-in, community involvement and sufficient financial support and resource are essential components for delivering an effective WSA

The evidence presented in the healthy lifestyle intervention evaluation (Chapter 8) indicated that the intervention deliverers considered that strong leadership buy-in was essential for intervention feasibility and sustainability. At the organisational level the intervention was endorsed by the Second Sea Lord[281] which, due to the hierarchical structure of the RN, ensured that external stakeholders (i.e. Defence and Navy Logistics and Infrastructure, HMS Temeraire, NAAFI and the food supplier) were supportive of the intervention. At the community level the evaluation findings suggested that a strong UHC facilitated the implementation of the intervention that included forceful leadership from the MO to drive the intervention throughout the deployment. However, the findings also detailed that a lack of strong leadership in Catering Services reduced the feasibility of the intervention.

The findings presented in Chapter 8 indicated that the implementation of the intervention was facilitated by the support from the majority of the ship's company (i.e. the community) to improve the healthiness of the ship's nutrition and physical activity environment. The ship's company and the UHC were involved in all stages of the intervention planning and implementation. This ensured that they had responsibility and control over the intervention. Personnel from each mess deck on the ship became healthy lifestyle representatives on the UHC. These representatives had the opportunity to provide feedback on intervention activities and ideas for future activities; thus increasing community involvement.

According to the intervention deliverers the intervention was feasible. It was suggested that this was due to the extra resource provided for the intervention, including an increase in the DMR, and the provision of health promotion and education resources from the INM. In the semi-structured interviews the intervention deliverers described factors that affected the feasibility and sustainability of the intervention. Overall, the findings indicated that in addition to sufficient financial support, ensuring adequate manpower and material resources to support the intervention are required.

In summary, the findings from the evaluation of the healthy lifestyle intervention presented at Chapter 8 suggest that strong leadership buy-in at all levels of the system to drive and support the intervention; community involvement during the planning and implementation of the intervention; and sufficient financial support and resource are essential components for delivering an effective WSA.

9.3 Discussion of the findings

9.3.1 RQ1: Is there a need for a healthy lifestyle intervention in the RN?

As discussed in subsection 9.2.1 the findings presented in Chapters 1 to 5 confirmed the need for a healthy lifestyle intervention to reduce the prevalence of obesity, improve RN personnel's health behaviours and to create healthier physical and social environments on a RN vessel. This was unexpected in an organisation that stipulates body composition and fitness standards at entry and requires individuals to pass an annual fitness test (section 1.2). This suggests that these policies are insufficient to prevent obesity and poor health behaviours and need to be reviewed to clarify expectations of personnel to maintain their health throughout their enlistment. However, when considering that the causes of obesity are complex and multifaceted, that RN personnel are recruited from the general civilian population where obesity is a growing problem[24], and that they are exposed to obesogenic environments[54], may be the problem of obesity is to be expected.

9.3.2 RQ2: What should the integral components and theoretical approach of the healthy lifestyle intervention be?

As discussed in subsection 9.2.2 the findings presented in Chapters 1 to 5 suggested that the healthy lifestyle intervention should take a multi-component, multi-level, WSA. The intervention activities detailed in the logframe presented at Appendix 19 aimed to: increase availability and accessibility to healthy foods and physical activities, restrict availability and accessibility to less healthy foods, improve existing and introduce new health promotion services and health promotion and education activities, empower the UHC to lead the healthy lifestyle intervention, and build capacity through training the chefs. Thus, taking a cross-disciplinary, multi-agency, multi-level approach, which reflects the strategies typically employed in the interventions reviewed in Chapter 2, and is cognisant with a WSA[66].

Following a review of the factors that facilitated and inhibited the implementation of the healthy lifestyle intervention, detailed at subsection 8.6.3, the evaluation findings suggested that: a ‘top-down’ ‘bottom-up’ approach is needed that incorporates strong leadership buy-in at all levels of the system to drive and support the intervention, involves the community in defining and finding solutions for the problem and gives them some responsibility and control over the intervention, creates opportunities for interaction and exchange between Command and intervention deliverers, and intervention deliverers and the community; ensures sufficient financial support and resource, but is also dynamic by drawing upon the resources available; builds capacity; adjusts and adapts over time; and ideally is embedded in the organisation such that it becomes routine practice.

Similar to the present intervention, a number of programmes delivering WSAs to target obesity and other complex public health and societal issues have also identified: strong leadership buy-in[290,292,294], engagement of the local community[286,291,292,294], creating opportunities for communication through the development of strong partnerships[286,289-293], sufficient financial support and resources[289,292,296], and embedding initiatives within a broader policy context[286,290] as key facilitators to implementing a WSA. Furthermore, recent guidance published by PHE as part of the WSO programme emphasises the importance of securing senior level engagement and buy-in and resource to implement the approach, community involvement, creating opportunities for communication, building local capacity, adapting over time and embedding the approach[297,298].

As described at subsection 9.2.4 at the organisational level the intervention was endorsed by the Second Sea Lord[281], which due to the hierarchical structure of the RN ensured that key stakeholders were supportive of the intervention. The hierarchical structure of the military is a unique feature that can both facilitate and impede leadership buy-in at all levels of the system (e.g., if one individual in the chain of Command is not supportive then this is likely to filter down). Programmes being delivered in civilian settings are less likely to possess this feature. Thus, applying a WSA successfully in a military environment might be more readily achieved compared with a civilian context. In addition to Senior Command buy-in, at the community level, a strong UHC facilitated the implementation of the healthy lifestyle intervention. This included forceful leadership from the MO to drive the intervention throughout the deployment that was enabled due to their rank (i.e. being an Officer in a position of authority), their role and their personality and motivation. The findings also detailed that a lack of strong leadership in Catering Services impacted on the feasibility of the intervention. Thus further highlighting the importance of leadership throughout all levels of the system.

Although in the main there was strong leadership buy-in for the healthy lifestyle intervention, both from senior Naval Command and also onboard the ship, this does not necessarily translate across Defence or even to other units in the RN. If Defence is going to create a culture that supports healthy behaviours effective leadership is needed at all levels of the system. Senior leaders across the UK Armed Forces need to endorse and prioritise action to improve the health of personnel, as leadership commitment and support can achieve buy-in and support from other levels of the organisation and importantly direct necessary resources. However, achieving this is made difficult in the military due to personnel changing job roles every 2-3 years. Thus, there is no consistency in leadership over time. This has meant that individual units have prioritised health promotion activities based on the interests of its Command. Due to wanting to achieve results during their posting, action has typically targeted quick-fix problems rather than problems such as obesity that require a long-term approach to tackle them.

Because of the hierarchical nature of the RN as an organisation, a hard paternalism approach could be taken to force or coerce personnel to adopt or maintain prudent health behaviours. In the present intervention this approach was taken by restricting access to unhealthy foods and drinks onboard. However, because personnel do not live exclusively onboard ship health behaviours may regress when they are not onboard. Furthermore, the impact that food has on morale in the military should not be underestimated[248]. As such, whether an approach that combines both hard and libertarian paternalism would both be better and more alike the current government obesity strategy[299] which aims to create healthier environments that empower individuals to make healthier choices needs to be considered.

Over recent years due to the manning deficit, Senior Naval Command has recognised that the success of the Service firmly rests upon the quality of its people. This has resulted in the development of a Naval Service health and wellbeing strategy – released in September 2019 – which aims to improve deployability and employability, facilitate physical and mental resilience, prevent injury and illness, and promote lifelong healthy behaviours. The strategy aims to improve the health of personnel through taking an integrated approach that considers all the pillars of health. Whether the strategy and associated programme actually achieve results is yet to be seen. However, unless significant financial support and resource is provided it seems unlikely. One solution that could be taken to improve senior leadership buy-in for health across Defence is by making changes to senior leaders terms of reference to make personnel in a position of command accountable for their unit's health. In addition to passing the annual fitness test personnel could be mandated to pass their annual body composition test, an approach that has been undertaken by the US military. Thus, leaders could be made accountable by ensuring the healthiness of their unit's environment but also through ensuring the healthiness of individual personnel. Furthermore, health education and promotion training could be included in Command courses to increase awareness and provide context relevant guidance and support.

Inherent to most community-based interventions is the notion of community involvement, based on the view that behaviour change is more likely when the individuals affected by a specific problem are involved in both defining and finding solutions for the problem[208,209]. Previous research suggests that the successful implementation of an intervention and, indeed, its effectiveness is dependent upon levels of acceptability[210]. This includes the acceptability of the intervention to the target users and the intervention deliverers. Thus, as described at subsection 9.2.4 the ship's company and UHC were involved in all stages of the intervention planning and implementation. This was a key feature of the WSA as it ensured that the community had responsibility and control over the intervention, which was important so not to negatively impact on morale. Similarly, opportunities for interaction and exchange between Command and intervention deliverers, and intervention deliverers and the community were created and facilitated by myself and the UHC during the intervention planning, implementation and evaluation stages. Community involvement and better communication could be achieved in other military units through the coordination of UHCs, which include personnel who would be the likely deliverers of an intervention. However, unless changes are made to UHC terms of reference for the inclusion of healthy lifestyle representatives other methods would be required to identify the views and opinions of the target population. This could be achieved through using the HWES used in Chapter 4. In a civilian context, community involvement could be achieved through the involvement of community health champions.

Because behaviour change is more likely when the individuals affected by a specific problem are involved in both defining and finding solutions for the problem[208,209], whether RN personnel believe that obesity, or unhealthy dietary and physical activity behaviours are a problem, and how they think this should be solved, needs to be considered. As these factors do not influence an individual's employability status or promotional opportunities, they potentially may be of no concern to them. Previous research undertaken with RN personnel demonstrated that the perceived norm in the RN for managing one's weight is by engaging in exercise[222], suggesting that RN personnel are less interested in managing weight through dietary behaviours. As such, if healthy foods were to be provided in military units whether these will be chosen and how uptake can be increased needs to be considered.

As described at subsection 9.2.4 additional resource was made available for the intervention, namely an increase in the DMR and the provision of health promotion and education resources from the INM. The intervention deliverers considered these were key to supporting the feasibility of the intervention. Although the dissemination of the evaluation findings led to the development of further resource to support future healthy lifestyle interventions both in the RN and across Defence, the increase in the DMR was only available for the intervention. It is unclear whether this additional funding is needed to support the provision of healthy menus. Previous research has shown that changes in the diets of UK adults needed to meet the Eatwell Guide do not necessarily result in an increase in the price of diets[300]. Furthermore, potentially the RN could use its purchasing power to improve the nutritional quality of the food procured and hence improve the healthiness of the menus without an increase in cost. A number of additional factors relating to financial, human and material resource were described as impacting on the sustainability of the intervention. Thus, for the intervention approach to be delivered onboard other RN vessels, sufficient financial support, ensuring adequate manpower and material resources are required. Strong senior leadership buy-in is essential to achieve this increase in resource across the organisation. Similarly, this requirement of sufficient resource is applicable to the delivery of WSA in military land bases and in a civilian context.

One of the key features of the healthy lifestyle intervention was building capacity. This included: providing a nutrition education brief to the chefs, training the MO and PTI to take anthropometric measurements accurately, and the provision of continuous support from the INM to the UHC. Although the evaluation did not include a cost-effectiveness analysis, drawing upon the existing human resource onboard the ship would reduce the costs of the intervention. As the dissemination of the intervention findings lead to the development of further training for personnel from the Logistics (i.e. the chefs) and Medical branches, the intervention has already built capacity for future interventions being delivered across the RN. Methods to build capacity should be considered as an important feature of any intervention, as it can reduce costs.

Two key factors enabled the healthy lifestyle intervention to adjust and adapt over time. That is: the UHC, which should implement, monitor and evaluate the intervention; and community involvement, through the addition of healthy lifestyle representatives on the UHC. This ensured that the intervention remained relevant to the target users and any negative features could be improved. As discussed previously, across other military establishments UHCs could take a similar role and in a civilian setting community health champions could liaise between the community and stakeholders and intervention deliverers.

9.3.3 RQ3: What is the impact of the healthy lifestyle intervention on the healthiness of the physical environment onboard the intervention ship?

As discussed in subsection 9.2.3 based on the measurement methods used the findings presented in Chapter 8 suggested that a WSA can be applied to successfully improve the healthiness of the nutrition and physical activity environment onboard the intervention ship. In addition to strong leadership buy-in and the hierarchical structure of the RN, a key feature that facilitated this was the closed environment of the ship. As the intervention facilitator, I was able to work with the key stakeholders (i.e. Catering Services onboard the ship, the Fleet Catering WO, the NAAFI shop, the food supplier, HMS Temeraire and the UHC) to successfully develop and implement the intervention that aimed to improve the healthiness of the environment. Achieving this in a military establishment on land would present a greater degree of difficulty due to the increased number of stakeholders, with some having commercial interests. Achieving this in a civilian context could prove even more difficult. However it is achievable as the evaluation of the ‘Central California Regional Obesity Prevention Program’ that applied a WSA to prevent obesity in a community setting, reported that the programme successfully increased access to healthy food and physical activity opportunities over the three year programme through neighbourhood engagement, inclusive partnerships and local policy-making[286].

9.3.4 RQ4: What is the impact of the healthy lifestyle intervention on personnel’s dietary and physical activity behaviours, and obesity classification?

When looking at the study population as a whole the findings presented in subsection 8.5.3 indicated that participants’ were not achieving a healthy balanced diet and were not being active enough to reduce the risk of becoming overweight across the deployment, regardless of the healthy lifestyle intervention. Furthermore, there was no statistically significant change in the prevalence of participants classified as being at any risk of obesity related ill health over the deployment. As discussed in subsection 8.6.2 there are a number of reasons that may explain why the intervention did not achieve its objectives. It could be assumed that due to participants’ behaviours not changing they were either not engaging with the changes that had been made to improve the healthiness of the environment, the changes were not sufficient to have an effect, the intervention duration was not long enough, or there were limitations in the evaluation methodology. Although the findings presented at subsection 8.5.2 indicated that participants were generally satisfied with the intervention there was limited participation in some of the intervention activities. This lack of engagement might help to explain the limited success in improvements in health behaviours. Additionally, although the findings suggested that the intervention successfully created a healthier environment, perhaps the changes were insufficient to change behaviours. A more rigorous approach to improving the nutrition provision, such as ensuring the nutritional quality of the food provision was fully compliant with the GBSF, might have yielded more positive changes in behaviour. Furthermore, as the intervention activities focused around making changes at the policy, physical environment and organisational levels of the SEM it is possible that the lack of activities specifically targeted at the inter-personal and intra-personal levels may have negatively impacted on behaviour change. Also, it is possible that the intervention time frame was not enough to first successfully change the system and second to successfully change personnel's behaviours. Recent research evaluating the effects of applying WSA targeting obesity in community settings suggests that programmes need to be realistic and allow sufficient time for change[301,302]. In both the 'Go-Golborne'[301] and 'Being Active Eating Well'[302] programmes this was over three years, which was considerably longer than the 9-month deployment of the intervention ship.

It is simplistic to think that the intervention would change the behaviours of the entire study sample. As discussed at subsection 8.6.2 participants might not have had any intentions to lose weight over the deployment, which may have impacted weight loss outcomes[221]. Although this could not be verified in the study reported in Chapter 8, as participant's stage of readiness for weight loss was not measured, participant's stage of dietary and physical activity changes were measured. At pre-deployment the majority of participants were in the contemplation and preparation stages. At end-deployment a higher proportion of participants were in the action and maintenance stages of change. These findings suggest that participants had changed by the end-deployment time point, but this was not observed in the food and physical activity diaries. As discussed previously this disparity may be due to the diaries and only capturing behaviours over a short duration at discrete time points. It may also be due to the evaluation methods not being sufficiently robust. Or potentially the stages of change questions may not provide a reliable method of assessing intentions in this population.

Even though the mean data did not demonstrate a significant positive effect, 12% of participants experienced an improvement in obesity risk classification, 21% experienced an improvement in prudent diet score, and 12% experienced an improvement in achieving a PAL above 1.75. These individuals may have experienced an improvement in health status and hence a reduction in risk of developing co-morbidities associated with obesity [39]. This is of value to the individual, but also to the ship and the RN as an organisation due to the health, economic and occupational implications of obesity. Changes in weight loss achieved on the WMP exceeded the Department of Health best practice guidance for Tier-2 services[283], with 65% of participants achieving a weight loss greater than 3% and 61% of participants achieving a weight loss greater than 5% at 9-months. The mean weight loss was 5.2 (4.7)% of initial weight[282], which is deemed to be a clinically meaningful weight loss[273]. This was more successful compared with the outcomes of a WMP delivered across UK Armed Forces land establishments – the DOfit – where the mean weight loss was 2.4 (6.1)% of initial weight, with 33% of participants achieving a weight loss greater than 3% and 11% of participants achieving a weight loss greater than 5% at 12-months[303]. Reasons why the WMP delivered onboard the ship was more successful compared with the DOfit may include that the WMP was part of a WSA healthy lifestyle intervention involving multi-level multi-component activities, the intervention had strong leadership buy-in, the motivation and passion of the MO and PTI who delivered the WMP, programme adherence, the unique closed environment of the ship, and possibly the duration of the WMP. Although hypothetically the RN could have used an individual-level or traditional weight management approach to treat obesity such as the DOfit, this would not prevent obesity.

It is important to consider that RN personnel do not exclusively live in a military environment. As such, dietary behaviours may regress when personnel are exposed to the wider environment. This was observed in the study presented in Chapter 8, where port stops and mid-deployment leave had negative effects on personnel’s health behaviours and weight outcomes. To counteract this a strategy used on the intervention ship was to offer behaviour change workshops to personnel prior to these key events to provide them with strategies to manage difficult situations. According to the MO these proved successful. However, this would be difficult to achieve on a land establishment where personnel are based between sea deployments. This is because individuals at a land establishment are exposed to the external nutrition and physical activity environments on a daily basis. Thus, it is important that any healthy lifestyle intervention delivered on a military land establishment be delivered with at least an awareness, but ideally in partnership with, action being undertaken in the local community setting. This would ensure consistency of messaging, hopefully leading to better outcomes.

It is interesting to consider that RM personnel, who are part of the same Naval Service as RN personnel and thus are exposed to the same physical environment, do not share the problem of obesity[36]. This may partly be explained due to the physical demands of RM personnel's roles being higher compared with RN personnel's, meaning that fitness test standards for entry and Service are higher. But, there are also other factors at play. The RM ethos is different to that of the RN. RM personnel have a sense of social unity being unified by their commando role. From my experience of working with both groups of personnel there are differences in social norms, including that the norm in the RM is to be physically fit and a healthy weight. This is not the case for the RN. Possible solutions could be increasing the standard of the RNFT, incentivising performance on the test or making the PFS compulsory. However, these factors do not address intrinsic motivators and thus, might not yield long-term change.

9.4 Research strengths and limitations

9.4.1 Strengths of the research

To the author's knowledge this is the first programme of research to explore the effectiveness of applying a WSA, which targets obesity, in a military context. The research was split into three sections: (i) a health needs assessment, identifying the health priorities of the RN, determining effective and acceptable intervention strategies and activities, and identifying the theoretical approach of the intervention; (ii) clarifying the intervention goal, objectives, outcomes, outputs, activities and inputs; and (iii) an evaluation of the intervention. This iterative, systematic and rigorous research approach ensured that the healthy lifestyle intervention was evidence-based both in terms of its theoretical approach and its components. Furthermore, as the framework for evaluating the intervention was based on the CDC's Center TRT's evaluation framework[260]; the evaluation was also evidence-based. According to Garside et al.[68] and Bagnall et al.[73] features of successful WSAs include local monitoring and evaluation; thus the inclusion of a rigorous evaluation is a key strength of the research programme.

A further strength of the research programme was that five of the six studies were undertaken in a real-life setting. This resulted in study findings that were military context relevant. The study findings not only informed the development and implementation of the healthy lifestyle intervention, but also led to the recognition among Senior Command that obesity was a problem in the RN that needed to be tackled. Furthermore, the dissemination of the evaluation findings led to a series of actions being undertaken to support the future delivery of healthy lifestyle interventions both in the RN and across Defence. These included:

- Update to the terms of reference for UHCs in Book of Reference 51. This included the addition of healthy lifestyle representatives on the members list and the provision of example agendas;

- Working with the NAAFI UK manager to increase the range of healthy snacks and beverages available on the picking list;
- Development of a nutrition labelling system in the Galley for healthy choices and extra funds to support them;
- Improving the nutrition education provided to RN chefs, including providing continuing professional development workshops to chefs at the three Naval bases and the development of an accredited Association for Nutrition Level 2 course in Catering;
- Introduction of health promotion education to Medical Assistants and improving the health promotion education provided to New Entry MOs;
- Development of standardised health promotion and education materials for UHC to use. This included the development of a UHC health promotion toolkit and the provision of digital resources on the NAVYfit online portal;
- Further development of Defence Nutrition Advisory Service nutrition education resources for military personnel and their families and the development of a specific range of factsheets to support health practitioners delivering WMP; and
- Development of a chef toolkit with guidance for chefs on how to improve the healthiness of the feeding provision onboard vessels and a range of healthy recipes.

Additionally resources that were developed for the WMP were used to inform the development of the DOfit (see subsection 9.3.4). Furthermore, the research provided the evidence to Senior Command that something needs to be done to improve the health of the RN and provided the impetus to develop the Naval Service Health and Wellbeing Strategy and Programme.

A further strength of this research is its transferability to other institutional and workplace settings (e.g., NHS, Police, prisons and other government departments). This is because these settings also have semi-closed/ closed environments and similarly have a hierarchical leadership structure that draws parallels to the RN.

9.4.2 Limitations of the research

This programme of research was tasked by Navy Command Logistics and Infrastructure and was undertaken in a real-life setting. As such, the design of five of the six studies included in the thesis was constrained (Chapters 3, 4, 5, 7 and 8), as the studies had to be operationalised in context. Thus, the research was not methodologically pure.

Limitations of the research methods used in the empirical Chapters and the intervention evaluation are presented in detail in the discussion sections of each Chapter. In summary, limitations of the systematic review presented at Chapter 2 related to: the search strategy; sources of bias; and the inability to undertake a meta-analysis due to the heterogeneity of the study designs, interventions and outcome measures. Limitations of the studies reported in Chapters 3, 4, 5, 7 and 8 related to: the inability to determine causal relationships due to the cross-sectional research design used (Chapter 3); the measurement tools used, including that not all data were used; data analysis methods used; sources of bias (selection, performance, attrition, measurement, response and reporting); and the effect of small sample sizes increasing the likelihood of Type II errors and reducing the power of the studies. Furthermore, there were a number of limitations of the intervention evaluation framework presented at Chapters 6 and 8. Including that not all stakeholders were involved in the planning or delivery of the evaluation. Finally, although the evaluation of the intervention was evidence-based and included a formative, process and outcome evaluation it did not include an economic evaluation. Thus, the cost-effectiveness of the intervention could not be determined. Furthermore, the effectiveness of the individual intervention activities was not assessed (e.g., the chef training). Thus, the unique contribution of the individual activities could not be ascertained.

9.5 Implications for future research

Based on the findings and limitations of this research, future studies might be conducted in the following areas to improve understanding in the subject. The study undertaken in Chapter 5 evaluated the healthiness of the physical environment onboard RN vessels, which are likely to be different to that of a land establishment. Thus, future research would benefit from evaluating the healthiness of the environment at land establishments across the UK Armed Forces. Where in addition to measuring the nutrition, physical activity and health promotion/education environments it would be beneficial to identify what aspects of the organisational culture of the establishment facilitates or inhibits healthy behaviours. Furthermore, the evaluation should take into account the surrounding area around an establishment where personnel might access food and undertake physical activity. This would better enable healthy lifestyle interventions to be tailored to the environments in which they will be delivered in the UK Armed Forces. Moreover, the evaluation would benefit from taking a more robust approach to the menu analysis by measuring the nutritional content of the menu ingredients against the mandatory GBSF[239].

Additionally, future research should evaluate whether the WSA that was developed, implemented and evaluated in this research programme is transferrable to a military land establishment. This is important to understand, as the environment on a land establishment is different to that of a ship. For example, a land establishment would have more stakeholders with commercial interests, a greater degree of complexity to the leadership structure, and an open/ semi-closed environment compared with the closed environment of a ship. In addition to increasing the availability of healthier food options, to create a healthy nutrition environment future interventions need to focus more effort on restricting the availability of unhealthy foods and drinks. This could be achieved by ensuring that the procurement meets the GBSF, something that was not achieved in the present study. Furthermore, it would be beneficial for future research to include a cost-effective analysis, which was not included in the study presented in Chapter 8. Such a study would provide better learning to determine whether to roll out the WSA across the rest of UK Armed Forces and would be more transferrable to other institutional settings. Additionally, due to the small sample size in the study reported in chapter 8 future research could be undertaken with more vessels, for example using a cluster-randomised design, to increase the power of the study.

It would also be beneficial to undertake research to better understand why the present intervention did not successfully change personnel's behaviours. Through understanding what would motivate personnel to improve their health behaviours and what intervention approach (e.g., libertarian paternalism or hard paternalism) would be acceptable, future interventions may prove more successful.

From the author's experience, over recent years there have been changes in the eating behaviours of RN personnel, in terms of where they choose to dine. In the past, personnel would typically dine communally in a Mess. Whereas, due to the increased availability and accessibility of convenience food some personnel now dine in their cabins (private room). This will potentially impact on the diet quality of personnel but also on their mental health due to the lack of socialisation. Thus, future research could also investigate whether changes in the social context of eating has had a detrimental impact on the health and wellbeing of RN personnel.

9.6 Conclusions

The aim of this research was to evaluate whether a WSA could be taken to create a healthier environment onboard a RN ship, which facilitates RN personnel to adopt or maintain prudent health behaviours, and whether such an approach could reduce the prevalence of obesity amongst personnel. This is the first programme of research to explore the effectiveness of applying a WSA, which targets obesity, in a military context.

First, the research found that there was a need for a healthy lifestyle intervention to reduce the prevalence of obesity amongst RN personnel, to address imprudent dietary and physical activity behaviours, and to improve the healthiness of the physical environment onboard RN vessels. Second, the research confirmed that the intervention should take a multi-component, multi-level WSA. The evaluation of the intervention highlighted that a WSA can be applied to successfully improve the healthiness of the nutrition and physical activity environment onboard a RN ship. Although mean changes in obesity classification, and dietary and physical activity behaviours were not statistically significant, some individuals did experience improvements. These individuals will have experienced an improvement in health status and hence a reduction in risk of developing co-morbidities associated with obesity. This is of value not only to the individuals concerned, but also to the ship and the RN as an organisation.

Strong leadership buy-in across all levels of the system, community involvement and sufficient financial support and resource were essential components contributing to intervention feasibility and sustainability. These features should be incorporated into the design of future healthy lifestyle interventions.

This research has provided an original contribution to the knowledge of the prevalence of obesity and health behaviours of RN personnel; personnel's barriers and facilitators to prudent health behaviours; personnel's needs, ideas and preferences for a healthy lifestyle intervention; and the healthiness of the physical environment onboard RN vessels. The implications from this research are not only of benefit to the RN, but to other military bases and institutional settings.

9.7 Recommendations

First, recommendations are provided below to inform future interventions that aim to tackle obesity in any setting. Second, specific recommendations are provided for the RN to facilitate the implementation of future interventions onboard RN vessels.

9.7.1. General recommendations

- Interventions should take a 'top-down' 'bottom-up' approach incorporating strong leadership, ownership and responsibility at all levels of the system.
- Interventions should create opportunities for interaction and exchange between senior leadership and intervention deliverers, and intervention deliverers and the community.
- Communities should be involved in defining and finding solutions for the specific problem that an intervention aims to address, and they have some responsibility and control over the intervention.
- Interventions should have sufficient financial support and resource, but also draw upon existing resource. Furthermore, they should build capacity by drawing upon existing resource (e.g., training chefs).
- Interventions should adjust and adapt over time to ensure that they remain relevant to the target users and that any negative feature can be improved.

- Intervention planning should incorporate a SWOT analysis and the development of a logframe to guide intervention implementation and evaluation.
- Interventions should include monitoring and evaluation to ensure that they are continuously refined and developed, as they become embedded in the organisation as routine practice.
- An evaluation framework should be developed and employed for intervention evaluation.

9.7.2. Specific recommendations for the RN

At the policy level:

- Defence and Navy Logistics and Infrastructure should explore whether a permanent increase in the DMR is required to support the provision of healthy menus onboard all RN vessels.
- The MOD catering and dining policy should be amended to mandate that vessel menus are compliant with the AFFBS and explore whether making the GBSF mandatory improves the healthiness of the menus and personnel's dietary intake.
- The NAAFI should be mandated to ensure its provision is compliant with the voluntary GBSF.
- Navy Command should consider whether its' senior leaders terms of reference should be amended to make them accountable for their unit's health.
- Changes should be made to the NAAFI payment system to encourage healthy behaviours.

At the organisational level:

- Navy Command should ensure adequate manpower in Catering Services onboard vessels to support the delivery of healthier menus.
- Navy Command Logistics and Infrastructure should ensure that vessels have adequate equipment in the Galley to support the provision of healthy choices.
- Navy Command Logistics and Infrastructure and the NAAFI should explore options for increasing the number of healthy food and drink items on the provisions lists.
- UHCs should assess whether the menu and NAAFI provision onboard vessels meets the AFFBS and GBSF, and take action as required.
- Standardised evidence-based health promotion and education resources, such as those provided in the intervention, should be developed and provided to all vessels.
- Navy Command should consider how best to provide military specific nutrition education to Catering Services and RN personnel in general.
- HMS Temeraire should consider updating the Fleet physical activity challenges.

- Navy Command should consider how sufficient funding could be provided to enable UHCs to support deliver health promotion and education activities.
- Navy Command should provide vessels with suitable measurement equipment to support the WMP.

Appendix 1: Search strategy

Embase and Medline

Institutional setting

1. military.mp. or Military Personnel/
2. armed forces.mp.
3. air force.mp. or airforce.mp or Air Force/
4. army.mp.
5. navy.mp.
6. sailor*.mp.
7. marine*.mp.
8. submarine*.mp.
9. soldier*.mp. or Soldier/
10. Ships/
11. ship*.mp.
12. Prisons/
13. prison*.mp.
14. maritime.mp.
15. offshore.mp. or off shore.mp
16. oil platform.mp.
17. oil rig.mp.
18. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17

Health Behaviour/Health Outcome

19. Feeding behavior/
20. Eating/
21. (feeding or eating).mp
22. food adj3 (habit* or preference* or intake).mp
23. eating adj3 (habit* or preference* or behavio* or choice).mp
24. (food or nutrition or healthy eating or healthy diet).mp
25. Diet/ or diet.mp
26. Diet therapy/
27. intake adj3 (fat* or sugar* or salt*).mp
28. reduc* adj3 (fat* or sugar* or salt*).mp
29. Fruit/ or fruit.mp
30. Vegetables/ or vegetables.mp
31. Exercise/

32. (exercise or physical activit* or fitness or sedentary behavio*).mp
33. Health behavior/
34. Overweight/
35. (overweight or obes* or body composition or body mass index or BMI or body fat distribution or body fat or fat percentage).mp
36. Body constitution/
37. Body composition/
38. Body weight changes/
39. (body weight changes or weight loss or weight reduction).mp
40. (energy expenditure or energy intake or energy balance).mp
41. 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40

Intervention

42. Intervention study/
43. (intervention or program* or campaign).mp
44. Food availability/
45. (calorie* or portion* or packag* or label* or traffic light or food availability or food price or healthy options or health prompting or food supply or food access* or point of purchase or point of choice).mp
46. Catering services/
47. Environment/
48. Environmental change/
49. (canteen* or cafeteria* or restaurant* or vending machine* or cater* or food services or choice architecture or environmental intervention or built environment or environment or eating environment or environment* change).mp
50. (nutrition policy or food policy or physical activity policy or policy or policy change).mp
51. Health education/
52. Health promotion/
53. Social norms/
54. Physical education/
55. Interpersonal communication/
56. Information dissemination/
57. Social marketing/
58. (health education or health promotion or nutritional education or communication or information or physical education or social marketing or guidance or recommend* or resources or norms or nudging).mp

59. 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58
60. 18 and 41 and 59
61. limit 60 to (English language and adult <18 to 64 years>)

PsycINFO and CINAHL

Institutional setting

1. military or Military Personnel/
2. armed forces
3. air force or airforce
4. army
5. navy
6. sailor*
7. marine*
8. submarine*
9. soldier*
10. ship*
11. Prisons/
12. prison*
13. maritime
14. offshore or off shore
15. oil platform
16. oil rig
17. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16

Health Behaviour/Health Outcome

18. Eating behavior/
19. feeding or eating
20. food N3 (habit* or preference* or intake)
21. eating N3 (habit* or preference* or behavio* or choice)
22. food or nutrition or healthy eating or healthy diet
23. diet
24. intake N3 (fat* or sugar* or salt*)
25. reduc* N3 (fat* or sugar* or salt*)
26. fruit or vegetables
27. Exercise/
28. exercise or physical activit* or fitness or sedentary behavio*
29. Health behavior/
30. Overweight/ or Body size/ or Body weight/ or Weight loss/

31. overweight or obes* or body composition or body mass index or BMI or body fat distribution or body fat or fat percentage
32. body weight changes or weight loss or weight reduction
33. Energy expenditure/
34. energy expenditure or energy intake or energy balance
35. 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34

Intervention

36. Intervention/
37. intervention or program* or campaign
38. Food preferences/
39. calorie* or portion* or packag* or label* or traffic light or food availability or food price or healthy options or health prompting or food supply or food access* or point of purchase or point of choice
40. Environment/
41. canteen* or cafeteria* or restaurant* or vending machine* or cater* or food services or choice architecture or environmental intervention or built environment or environment or eating environment or environment* change
42. nutrition policy or food policy or physical activity policy or policy or policy change
43. Health education/
44. Health promotion/
45. Social norms/
46. Physical education/
47. Interpersonal communication/
48. Information dissemination/
49. Social marketing/
50. health education or health promotion or nutritional education or communication or information or physical education or social marketing or guidance or recommend* or resources or norms or nudging
51. 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50
52. 17 and 35 and 51
53. limit 52 to (English language and adult <18 to 64 years>)

Cochrane Library

Institutional setting

1. Military Personnel/

2. military or armed forces or air force or airforce or army or navy or sailor* or marine* or submarine* or soldier* or ship* or prison* or maritime or offshore or off shore or oil platform or oil rig
3. Ships/
4. Prisons/
5. 1 or 2 or 3 or 4

Health Behaviour/Health Outcome

6. Feeding behavior/
7. Eating/
8. feeding or eating or food or nutrition or healthy eating or healthy diet or diet
9. food NEAR/3 (habit* or preference* or intake)
10. eating NEAR/3 (habit* or preference* or behavio* or choice)
11. Diet/
12. intake NEAR/3 (fat* or sugar* or salt*)
13. reduc* NEAR/3 (fat* or sugar* or salt*)
14. Fruit/
15. fruit or vegetables
16. Vegetables/
17. Exercise/
18. exercise or physical activit* or fitness or sedentary behavio*
19. Health behavior/
20. Overweight/
21. overweight or obes* or body composition or body mass index or BMI or body fat distribution or body fat or fat percentage
22. Body constitution/
23. Body composition/
24. Body weight changes/
25. body weight changes or weight loss or weight reduction
26. energy expenditure or energy intake or energy balance
27. 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26

Intervention

28. intervention or program* or campaign
29. calorie* or portion* or packag* or label* or traffic light or food availability or food price or healthy options or health prompting or food supply or food access* or point of purchase or point of choice
30. Environment/

31. canteen* or cafeteria* or restaurant* or vending machine* or cater* or food services or choice architecture or environmental intervention or built environment or environment or eating environment or environment* change
32. nutrition policy or food policy or physical activity policy or policy or policy change
33. Health education/
34. Health promotion/
35. Social norms/
36. Physical education and training/
37. Information dissemination/
38. Social marketing/
39. health education or health promotion or nutritional education or communication or information or physical education or social marketing or guidance or recommend* or resources or norms or nudging
40. 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39
41. 5 and 27 and 40

ProQuest Dissertations & Theses

Institutional setting

1. Military Personnel/ or Ships/ or Prisons/
2. military or armed forces or air force or airforce or army or navy or sailor* or marine* or submarine* or soldier* or ship* or maritime or prison* or offshore or off shore or oil platform or oil rig
3. 1 or 2

Health Behaviour/Health Outcome

4. Eating behavior/ or Diet/ or Fruits/ or Vegetables/ or Exercise/ or Health behavior/ or Body composition/
5. feeding or eating or food or nutrition or healthy eating or healthy diet or diet or fruit or vegetables or exercise or physical activit* or fitness or sedentary behavio* or overweight or obes* or body composition or body mass index or BMI or body fat distribution or body fat or fat percentage or body weight changes or weight loss or weight reduction or energy expenditure or energy intake or energy balance
6. food NEAR/3 (habit* or preference* or intake) or eating NEAR/3 (habit* or preference* or behavio* or choice) or intake NEAR3 (fat* or sugar* or salt*) or reduc* NEAR/3 (fat* or sugar* or salt*)
7. 4 or 5 or 6

Intervention

8. intervention or program* or campaign or calorie* or portion* or packag* or label* or traffic light or food availability or food price or healthy options or health prompting or food supply or food access* or point of purchase or point of choice or canteen*

or cafeteria* or restaurant* or vending machine* or cater* or food services or choice architecture or environmental intervention or built environment or environment or eating environment or environment* change or nutrition policy or food policy or physical activity policy or policy or policy change or health education or health promotion or nutritional education or communication or information or physical education or social marketing or guidance or recommend* or resources or norms or nudging

9. Health education/ or Health promotion/ or Physical education/ or Interpersonal communication/ or Information dissemination/ or Social marketing/
10. 8 or 9
11. 3 and 7 and 10
12. limit 11 to (English language)

Web of Science/ Scopus

Institutional setting

1. military or armed forces or air force or airforce or army or navy or sailor* or marine* or submarine* or soldier* or ship* or maritime or prison* or offshore or off shore or oil platform or oil rig

Health Behaviour/Health Outcome

2. eating behavio* or feeding or eating or food or nutrition or healthy eating or healthy diet or diet or fruit or vegetables or exercise or physical activit* or fitness or sedentary behavio* or overweight or obes* or body composition or body mass index or BMI or body fat distribution or body fat or fat percentage or body weight changes or weight loss or weight reduction or energy expenditure or energy intake or energy balance or exercise or health behavio*
3. food NEAR3 (habit* or preference* or intake) or eating NEAR3 (habit* or preference* or behavio* or choice) or intake NEAR3 (fat* or sugar* or salt*) or reduc* NEAR3 (fat* or sugar* or salt*)
4. 2 or 3

Intervention

5. intervention or program* or campaign or calorie* or portion* or packag* or label* or traffic light or food availability or food price or healthy options or health prompting or food supply or food access* or point of purchase or point of choice or canteen* or cafeteria* or restaurant* or vending machine* or cater* or food services or choice architecture or environmental intervention or built environment or environment or eating environment or environment* change or nutrition policy or food policy or physical activity policy or policy or policy change or health education or health promotion or nutritional education or communication or information or

physical education or social marketing or guidance or recommend* or resources or norms or nudging

6. 1 AND 4 AND 5
7. limit 6 to (English language)

Search strategy alterations for the different databases

- adj3 – replaced with N3 for CINAHL and PsycINFO; replaced with NEAR/3 for Web of Science, ProQuest and Cochrane Library; replaced with W/3 for Scopus
- .mp was removed from the searches for CINAHL, PsycINFO, ProQuest, Web of Science (TOPIC was left as the search area), Scopus (TITLE-ABS-KEY left as search area), Cochrane Library (ti,ab,kw left as the search area)
- Phrase searching was used for CINAHL, PsycINFO and Web of Science – all search terms were enclosed in quotation marks (e.g. “environment”)

Appendix 2: Demographics questionnaire

Date: …………….. **Service No:…………..Study ID: …………**

Please tick the answer that applies or fill in the blank space

1. Gender: **M** ☐
F ☐

2. Date of Birth: **___/___/19__**

3. Ethnicity:

White	☐	**Bangladeshi**	☐	**Asian other**	☐
Black Caribbean	☐	**Indian**	☐	**Any other**	☐
Black African	☐	**Pakistani**	☐		
Black other	☐	**Chinese**	☐		

4. Rank:

Officer (e.g. Lt, Cdr)	☐
Senior Rate (e.g. CPO, WO)	☐
Junior Rate (e.g. AB, LH)	☐

5. Rank: **………………………**

6. Trade:

Administration	☐	**Information and Technology**	☐
Aircrew	☐	**Medical Nursing and Healthcare**	☐
Catering and Hospitality	☐	**Scientific**	☐
Engineering and Mechanics	☐	**PTI**	☐

7. Current Place of Work: **…………….**

8. Duration at Current Place of Work: **………**

9. Duration in Royal Navy: **………**

10. Deployment History: **Date of last Deployment: ………….**
Length of Deployment: …………….
Base/ Ship during Deployment: …………..

11. Highest Level of Educational Attainment:

Primary School	☐	**Technical or Trade Certificate**	☐
Secondary School	☐	**Diploma**	☐
O Levels/ GCSEs	☐	**Degree**	☐
A Levels	☐	**Post-graduate Degree**	☐

Appendix 3: Food frequency questionnaire

Date: …………….. **Study ID: …………**

Now I am going to ask you how often **over the past 6 months** you have eaten or drank particular foods. Please circle or tick the appropriate answer for each food.

	Food and Amounts	Average Use in the Past 6 Months									
		Never	Less than once/ month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
1.	Chips	0	1	2	3	4	5	6	7	8	9
2.	Fast food (any food from a fast-food restaurant)	0	1	2	3	4	5	6	7	8	9
3.	Pizza (any topping)	0	1	2	3	4	5	6	7	8	9
4.	Fried breakfast	0	1	2	3	4	5	6	7	8	9
5.	High-fat dairy products (e.g. whole milk, cream, cheese, yoghurt, butter)	0	1	2	3	4	5	6	7	8	9
6.	Red meat (e.g. steak, lamb, bacon, pork)	0	1	2	3	4	5	6	7	8	9
7.	Processed meat (e.g. sausages, processed lunch meats, hot dogs)	0	1	2	3	4	5	6	7	8	9
8.	Salty snacks (medium serving - e.g. crisps, corn chips, snack mixes, pretzels)	0	1	2	3	4	5	6	7	8	9
9.	Savoury pastry products (e.g. sausage rolls, meat pies, Cornish pasty)	0	1	2	3	4	5	6	7	8	9
10.	Gravy or Sauces (e.g. mayonnaise, ketchup)	0	1	2	3	4	5	6	7	8	9
11.	Chocolate (one 50 g bar)	0	1	2	3	4	5	6	7	8	9
12.	Sweets (e.g. Haribo, wine gums, fruit pastilles)	0	1	2	3	4	5	6	7	8	9
13.	Sweet baked goods (e.g. donuts, cookies, pastries, muffins, cakes, flapjack)	0	1	2	3	4	5	6	7	8	9
14.	Biscuits (e.g. one digestive)	0	1	2	3	4	5	6	7	8	9
15.	Cake/ Sponge Pudding (medium serving)	0	1	2	3	4	5	6	7	8	9
16.	High-fat dairy desserts (e.g. custard, ice cream)	0	1	2	3	4	5	6	7	8	9
17.	Non-diet fizzy drinks (e.g. coke, lemonade)	0	1	2	3	4	5	6	7	8	9
18.	Non-diet squash/cordial	0	1	2	3	4	5	6	7	8	9
19.	Energy drinks (e.g. red bull, lucozade sport, Relentless)	0	1	2	3	4	5	6	7	8	9
20.	Bottled Milkshake (e.g. Frijj, Yazoo, Mars)	0	1	2	3	4	5	6	7	8	9
21.	Alcoholic drinks (any)	0	1	2	3	4	5	6	7	8	9
22.	White bread (one slice)	0	1	2	3	4	5	6	7	8	9
23.	White rice	0	1	2	3	4	5	6	7	8	9

	Food and Amounts	Never	Less than once/ month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
		Average Use in the Past 6 Months									
24.	Pasta (e.g. spaghetti, macaroni)	0	1	2	3	4	5	6	7	8	9
25.	Whole grains (e.g. brown rice, bulgar, oats, oat bran, quinoa)	0	1	2	3	4	5	6	7	8	9
26.	Lentils	0	1	2	3	4	5	6	7	8	9
27.	High fibre breakfast cereals (e.g. muesli, branflakes, weetabix, porridge, shredded wheat)	0	1	2	3	4	5	6	7	8	9
28.	Cereal bars (e.g. Nutrigrain, Alpen)	0	1	2	3	4	5	6	7	8	9
29.	Fresh fruit (one fruit/ medium serving – e.g. banana, apple, grapes)	0	1	2	3	4	5	6	7	8	9
30.	Fruit juice (100% fruit juice)	0	1	2	3	4	5	6	7	8	9
31.	Vegetables (cooked and fresh - excluding potatoes)	0	1	2	3	4	5	6	7	8	9
32.	Green Salad (e.g. lettuce, cucumber, celery)	0	1	2	3	4	5	6	7	8	9
33.	Boiled, mashed and jacket potatoes (one egg size potato)	0	1	2	3	4	5	6	7	8	9
34.	Beans (e.g. baked, kidney)	0	1	2	3	4	5	6	7	8	9
35.	Nuts (e.g. peanuts, brazil nuts, cashew nuts)	0	1	2	3	4	5	6	7	8	9
36.	Seeds (e.g. sunflower, pumpkin)	0	1	2	3	4	5	6	7	8	9
37.	Reduced-fat dairy products (e.g. skimmed milk, reduced fat yoghurts)	0	1	2	3	4	5	6	7	8	9
38.	Eggs (one egg - all preparations)	0	1	2	3	4	5	6	7	8	9
39.	Fish (not in batter/crumbs)	0	1	2	3	4	5	6	7	8	9
Which is the main spreading fat you have used for example on bread or vegetables?											
40.	Spreading fat (teaspoon) ____________________	0	1	2	3	4	5	6	7	8	9

Additional Dietary Questions

41.1 Which types of milk have you used regularly in drinks and added to breakfast cereals etc over the past six months?

1. Whole pasteurised
2. Semi skimmed pasteurised (include 1% milks)
3. Skimmed pasteurised
4. Whole UHT
5. Semi-skimmed UHT
6. Skimmed UHT
7. Other
8. None (go to question 42.1)

Milk A ☐ Other (specify) ________________________

Milk B ☐ Other (specify) ________________________

Milk C ☐ Other (specify) ________________________

41.2 On average over the past 6 months how much of each milk have you consumed per day?

Milk A ☐ pints

Milk B ☐ pints

Milk C ☐ pints

42.1 Have you added sugar to tea and coffee or breakfast cereals in the past 6 months?

0. No (go to question 43.1) ☐
1. Yes

42.2 Approximately how many teaspoons of sugar have you added each day? ☐

43.1 Have you been on a particular kind of diet during the last 6 months?

a. Not on a special diet ☐
b. A slimming diet you have decided for yourself ☐
c. A slimming diet prescribed by a doctor or medical practitioner ☐
d. A cholesterol-lowering diet ☐
e. A vegetarian diet (i.e. you do not eat red meat, poultry or fish, but do eat milk and milk products) ☐
f. A vegan diet (i.e. you do not eat any animal products) ☐
g. Other “medical diet” – please provide details below: ☐

____

43.2 Approximately how long have you been on this particular kind of diet?

☐ Months ☐ Weeks

43.3 Approximately how many times have you been on a weight reducing diet for longer than one month? ☐ Times

Appendix 4: General practice physical activity questionnaire[155].

General Practice Physical Activity Questionnaire

Department of Health, 2006

Date: …………….. **Study ID: …………**

1. Please tell us the type and amount of physical activity involved in your work. Please tick one box that is closest to your present work from the following five possibilities:

		Please mark one box only
a	I spend most of my time at work sitting (such as in an office)	
b	I spend most of my time at work standing or walking. However, my work does not require much intense physical effort (e.g. shop assistant, hairdresser, security guard, childminder, etc.)	
c	My work involves definite physical effort including handling of heavy objects and use of tools (e.g. plumber, electrician, carpenter, cleaner, hospital nurse, gardener, postal delivery workers etc.)	
d	My work involves vigorous physical activity including handling of very heavy objects (e.g. scaffolder, construction worker, refuse collector, etc.)	

2. During the ***last week*** at work and during your leisure time, how many hours did you spend on each of the following activities?

Please mark one box only on each row

		None	**Some but less than 1 hour**	**1 hour but less than 3 hours**	**3 hours or more**
a	Physical exercise such as swimming, jogging, aerobics, football, tennis, gym workout etc.				
b	Cycling, including cycling to work and during leisure time				
c	Walking, including walking to work, shopping, for pleasure etc.				
d	Housework/Childcare				
e	Gardening/DIY				

3. How would you describe your usual walking pace? Please mark one box only.

Slow pace (i.e. less than 3 mph)		Steady average pace	
Brisk pace		Fast pace (i.e. over 4mph)	

Appendix 5: Smoking and alcohol histories questionnaire[156].

(Adapted from: Hardy CJ, Palmer BP, Muir KR et al. Smoking history, alcohol consumption and systemic lupus erythematosus: a case control study. Ann Rheum Dis 1998;57: 451-455).

Date: …………….. **Study ID: …………**

* Please delete as appropriate in the following questions:

1. **What is your smoking status?**

Never smoked	Yes / No *
Ex-smoker	Yes / No *
… Date stopped smoking:	____ / ____ / ____ (DD / MM / YY)
Current Smoker*	Yes / No *

Current smoker is defined as a person that smokes cigarettes, cigars, pipes or roll ups.

2. **Number of cigarettes:**

0 (non-smoker)	Yes / No *
1 – 10	Yes / No *
11 – 20	Yes / No *
over 21	Yes / No *

Other (pipe, cigar, roll up) give answer here
…………………………………………………

3. **How long have you been smoking for?**

…………………………………………………..

4. **Approximately how many units of alcohol do you consume during a normal week?**

… where 1 unit = 1 small glass of wine, ½ pint of beer, 1 shot of spirit.

0	Yes / No *
1 – 5	Yes / No *
6 – 10	Yes / No *
11 – 15	Yes / No *
16 – 20	Yes / No *
More than 21	Yes / No *

Thank-you

Appendix 6: Food choice questionnaire[157].

Food Choice Questionnaire – Steptoe, Pollard and Wardle, 1995.

Date: …………….. **Study ID: ………..**
Please tick the answer that applies

It is important to me that the food I eat on a typical day:		*Not important at all*	*A little important*	*Moderately important*	*Very important*
1	…is easy to prepare				
2	…contains no additives				
3	…is low in calories				
4	…tastes good				
5	…contains natural ingredients				
6	…is not expensive				
7	…is low in fat				
8	…is familiar to me				
9	…is high in fibre and roughage				
10	…is nutritious				
11	…is easily available in the mess, shops and supermarkets				
12	…is good value for money				
13	…cheers me up				
14	…smells nice				
15	…can be cooked very simply				
16	…helps me cope with stress				
17	…helps me control my weight				
18	…has a pleasant texture				
19	…is packaged in an environmentally friendly way				
20	…comes from countries I approve of politically				
21	…is like the food I ate when I was a child				
22	…contains lots of vitamins and minerals				
23	…contains no artificial ingredients				
24	…keeps me awake and alert				
25	…looks nice				

26	…helps me relax				
27	…is high in protein				
28	…takes no time to prepare				
29	…keeps me healthy				
30	…is good for my skin/teeth/hair/nails etc				
31	…makes me feel good				
32	…has the country of origin clearly marked				
33	…is what I usually eat				
34	…helps me to cope with life				
35	…can be bought in the mess or shops close to where I live or work				
36	…is cheap				

Appendix 7: FFQ and FCQ method development

F1. During the method development phase of the study the test-retest reliability of a Food Frequency Questionnaire (FFQ, Appendix 3), which was developed specifically for the study, was assessed. Additionally, a group interview was conducted to assess the applicability of the Food Choice Questionnaire (FCQ, Appendix 6), which was used to assess motives for food choice [161].

F2. The FFQ (Appendix 3) focused on foods and beverages that have previously been correlated with overweight and obesity in an adult population. The FFQ aimed to identify eating behaviours in Royal Navy (RN) personnel and to examine whether those eating behaviours were different depending upon whether an individual was a healthy weight, overweight or obese (as determined by BMI and waist circumference) according to the World Health Organization and National Institute for Health and Care Excellence classifications [28,145]. The FFQ asked individuals to consider their average use of 40 food-items over the past six months, there were also additional dietary questions concerning milk and added sugar consumption.

F3. A cohort of 30 RN personnel (15 males; 15 females), volunteered to participate in the FFQ test-retest reliability study from the Institute of Naval Medicine RN population. The sample consisted of 13 Officers, 7 Senior Rates and 10 Junior Rates. A project brief was provided to the volunteers, which included a full description of the study. It was explained that participation in the study was voluntary and that personnel did not need to provide a reason if they chose not to participate. An opportunity was given for personnel to ask questions, either in the group or in private, of the project team. Written informed consent was obtained from all participants before data collection commenced.

F4. Following initial briefings, volunteers completed the FFQ under controlled classroom conditions on two occasions, separated by a week, in January 2012.

F5. To evaluate the test-retest reliability of the FFQ, Pearson Product Moment correlation coefficients and Spearman Signed Rank tests were calculated for each of the questionnaire items. An item was not deemed reliable if its test-retest correlation was r=0.3 or lower. Excellent reliability was taken as items, r=0.9 with the possibility that items may be very good, r=0.8; moderate, r=0.7; or poor, r=0.4.

F6. Following the completion of the FFQ on two occasions, Spearman's Signed Rank and Pearson Product Moment correlation coefficients revealed that: *n* 7 items had excellent reliability (r=0.9), *n* 12 items had very good reliability (r=0.8), *n* 15 items had moderate reliability (r=0.7) and *n* 6 items had an acceptable reliability (r=0.5) (Table 3F1). The questionnaire was deemed reliable and no subsequent changes were made.

Table 3F1: Spearman's Signed Rank Correlation Coefficients for the 40 FFQ Items

Question No.	Question Item	r	Question No.	Question Item	r
1	Chips	0.8	**21**	Alcohol	0.8
2	Fast food	0.7	**22**	White bread	0.9
3	Pizza	0.9	**23**	White rice	0.9
4	Fried breakfast	0.8	**24**	Pasta	0.8
5	High fat dairy	0.9*	**25**	Whole grains	0.6
6	Red meat	0.9	**26**	Lentils	0.8
7	Processed meat	0.7	**27**	High fibre breakfast cereals	0.8
8	Salty snacks	0.8*	**28**	Cereal bars	0.7
9	Savoury pastries	0.7	**29**	Fresh fruit	0.8
10	Gravy/sauces	0.6	**30**	Fruit juice	0.8
11	Chocolate	0.9	**31**	Vegetables	0.7
12	Sweets	0.7	**32**	Green salad	0.7
13	Sweet baked goods	0.7	**33**	Potatoes	0.6
14	Biscuits	0.7	**34**	Beans	0.7
15	Cakes	0.5	**35**	Nuts	0.8
16	High fat dairy desserts	0.6	**36**	Seeds	0.8
17	Non-diet fizzy drinks	0.6	**37**	Reduced fat dairy	0.7
18	Non-diet squash	0.9	**38**	Eggs	0.7
19	Energy drinks	0.7	**39**	Fish	0.8
20	Bottled milkshake	0.7	**40**	Spread	0.7

Note: * Pearson Product Moment correlation coefficient

F7. A cohort of four male RN personnel volunteered to participate in a group interview to test the applicability of the FCQ to the context of the RN, from the INM RN population.

F8. A project brief was provided, and written informed consent was obtained as detailed at paragraph F3, after which volunteers completed the FCQ under controlled classroom conditions, in March 2012. Upon completion, a member of the project team interviewed the group to identify if the questionnaire was missing any motives that affected their personal motives for food choice. The interview was recorded and was transcribed to verify whether the questionnaire needed to be adapted for use in the main study.

F9. Upon transcription of the group interview, it was clear that all participants thought that there were no motives missing from the FCQ that affected their personal motives for food choice. However, participants thought that two of the questions could be better phrased to make them more relevant. Minor alterations were subsequently made to questions 11 and 35 (Table 3F2).

Table 3F2: Amendments made to FCQ.

Question	Before	After
11	…is easily available in shops and supermarkets	…is easily available in the **mess**, shops and supermarkets
35	…can be bought in the shops close to where I live or work	…can be bought in the **mess** or shops close to where I live or work

Appendix 8: Correlations between food-items and motives for food choice.

Item	Health	Mood	Convenience	Sensory Appeal	Natural Content	Price	Weight Control	Familiarity	Ethical Concern
Chips	-.18***	.02	-.02	.04	-.22***	.02	-.27***	.06	-.09**
Fast food	-.16***	.03	.11**	.01	-.21***	.08*	-.15***	.08*	-.07*
Pizza	-.11**	.05	.06	.01	-.15***	.08*	-.12***	.08*	-.01
Fried breakfast	-.02	.01	-.03	-.06	-.08*	.00	-.20***	.01	-.07*
High-fat dairy	-.10**	-.02	.03	.08*	-.04	.07*	-.17***	-.01	-.05
Red meat	-.10**	-.05	-.10**	.01	-.06	-.06	-.17***	-.06	-.10**
Processed meat	-.17***	-.05	-.01	.01	-.21***	.05	-.21***	.02	-.14***
Salty snacks	-.20***	-.01	.03	.06*	-.21***	.05	-.19***	.03	-.12***
Savoury pastries	-.19***	-.02	.00	-.02	-.19***	.05	-.22***	.03	-.09**
Gravy/ sauces	-.09**	.02	.02	.07*	-.16***	.05	-.11**	-.02	-.05
Chocolate	-.11***	.08**	.06*	.05	-.09**	-.01	-.12***	-.03	-.01
Sweets	-.16***	.03	.03	.02	-.15***	.02	-.11***	-.06	-.09*
Sweet baked goods	-.09**	.10**	.08*	.05	-.04	.06	-.13***	.04	.05
Biscuits	-.04	.11**	.04	.07*	.00	.06	-.04	.02	.04
Cakes	-.04	.06*	-.00	.03	-.04	.03	-.10**	.04	.02
High-fat dairy desserts	-.04	.04	-.02	.01	-.06	.01	-.12***	.01	-.02
Non-diet fizzy drinks	-.24***	-.02	.03	.02	-.27***	.05	-.26***	.05	-.12***
Non-diet squash	-.10**	.02	.01	.03	-.18***	.03	-.14***	-.01	-.08*
Energy drinks	-.04	.05	.06*	-.11**	-.13***	.05	-.09**	.03	-.08*
Bottled milkshake	-.03	.04	.07	-.06	-.06	.04	-.08*	.05	.03
Alcohol	-.11***	-.08*	-.09**	-.02	-.07*	-.07*	-.12***	-.16***	-.04
White bread	-.18***	-.02	-.00	.06	-.21***	.03	-.18***	.03	-.09**
White rice	-.04	.02	-.01	.05	-.03	-.01	-.09**	.01	-.01
Pasta	-.02	.04	-.03	.06	.00	.03	-.08*	.01	.01
Whole grains	.24***	.03	-.05	-.07*	.22***	-.02	.12***	-.06	.08*

* p<0.05, ** p<0.01, *** p<0.001 Kendall's tau test

Appendix 8: Correlations between food-items and motives for food choice continued

Item	Health	Mood	Convenience	Sensory Appeal	Natural Content	Price	Weight Control	Familiarity	Ethical Concern
Lentils	.14***	.07*	-.03	.03	.17***	-.06	.05	-.02	.15***
High-fibre breakfast cereals	.14***	.04	-.00	-.01	.13***	-.02	.13***	-.01	.05
Cereal bars	.08*	.10**	.01	-.03	.07*	-.03	.09**	-.02	.04
Fresh fruit	.20***	-.04	-.02	-.02	.21***	-.07*	.19***	-.07*	.09**
Fruit juice	.00	.03	-.03	.00	.03	-.11**	-.06*	-.02	.00
Vegetables	.19***	-.03	-.14***	-.03	.20***	-.12***	.07*	-.13***	.08*
Green salad	.20***	.04	-.07*	-.04	.19***	-.10**	.16***	-.04	.05
Potatoes	.02	.04	-.01	.03	.00	-.03	-.05	-.03	.03
Beans	-.01	.02	-.02	-.02	-.03	-.02	-.09**	-.05	-.01
Nuts	.18***	.08*	-.02	-.04	.21***	-.08*	.02	-.04	.09*
Seeds	.24***	.06	-.01	-.03	.27***	-.08*	.08*	-.04	.12**
Reduced-fat dairy	.11***	.01	.02	.03	.11***	-.04	.22***	-.05	.06*
Eggs	.15***	-.02	-.09**	-.12***	.11**	-.05	-.02	-.10**	-.01
Fish	.16***	.03	-.08**	-.04	.16***	-.04	.05	-.11**	.06

* p<0.05, ** p<0.01, *** p<0.001 Kendall's tau test

Appendix 9: Extra result tables

Table 9a: Physical activity levels of participants based on age group, rank and NICE risk classification, *n* 599.

Physical activity level	Age 18-24 years % (n)	Age 25-34 years % (n)	Age ≥35 years % (n)	Officers % (n)	SRs % (n)	JRs % (n)	No increased risk % (n)	Any increased risk % (n)
Inactive	4 (9)	6 (14)	11 (16)	5 (7)	9 (10)	6 (22)	6 (26)	7 (13)
Moderately inactive	6 (12)	3 (8)	9 (13)	5 (6)	5 (5)	6 (22)	5 (21)	7 (12)
Moderately active	20 (40)	19 (46)	14 (22)	17 (23)	15 (16)	19 (69)	18 (76)	18 (32)
Active	70 (140)	72 (178)	66 (101)	73 (96)	72 (79)	68 (244)	71 (301)	67 (118)

Table 9b: Smoking history of participants based on gender, age group and NICE risk classification, *n* 598.

Smoking history	Males % (n)	Females % (n)	Age 18-24 years % (n)	Age 25-34 years % (n)	Age ≥35 years % (n)	No increased risk % (n)	Any increased risk % (n)
Never smoked	59 (185)	61 (174)	62 (123)	59 (146)	48 (90)	63 (265)	53 (94)
Ex-smoker	21 (67)	20 (58)	14 (28)	23 (56)	22 (41)	19 (81)	25 (44)
Current smoker	19 (61)	19 (53)	24 (48)	18 (44)	12 (22)	18 (76)	22 (38)

Table 9c: Alcohol history of participants based on age group, rank and NICE risk classification, *n* 590.

Units of alcohol consumed per week	Age 18-24 years % (n)	Age 25-34 years % (n)	Age ≥35 years % (n)	Officers % (n)	SRs % (n)	JRs % (n)	No increased risk % (n)	Any increased risk % (n)
None	13 (25)	17 (41)	13 (19)	4 (12)	14 (15)	17 (58)	14 (60)	14 (25)
1-5	40 (79)	42 (102)	36 (55)	17 (48)	39 (43)	41 (145)	42 (174)	35 (62)
6-10	25 (50)	20 (48)	27 (41)	12 (34)	28 (31)	21 (74)	23 (97)	24 (42)
11-15	12 (24)	12 (30)	11 (17)	7 (19)	12 (13)	11 (39)	11 (47)	14 (24)
16-20	6 (11)	5 (11)	9 (14)	4 (12)	5 (6)	5 (18)	6 (25)	6 (11)
21+	4 (8)	4 (9)	4 (6)	1 (3)	3 (3)	5 (16)	3 (11)	7 (12)

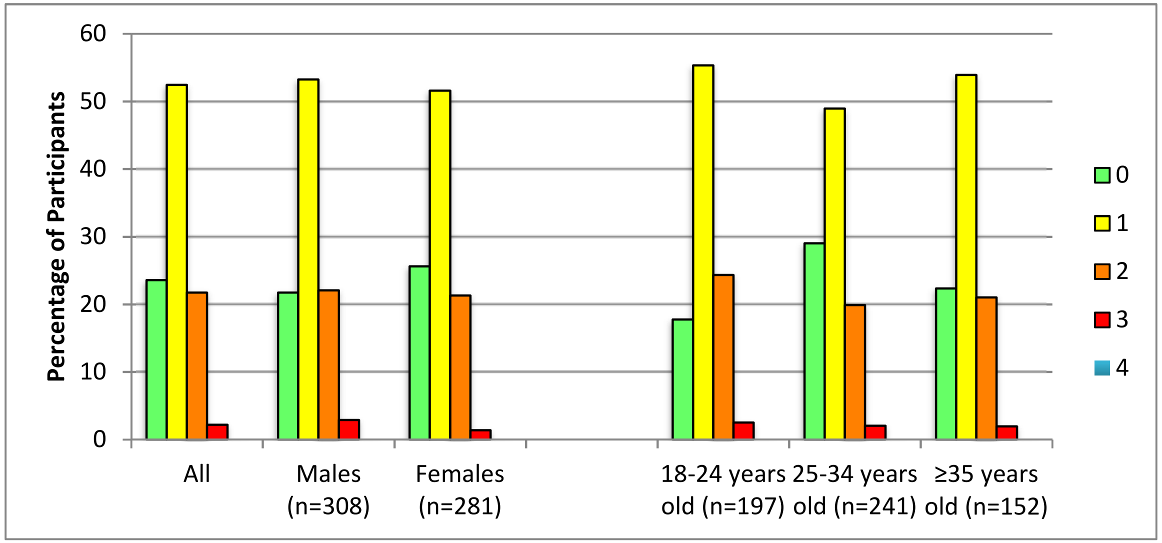

Figure 9a: Multiple lifestyle risk factors of participants based on gender and age group, *n* 589.
Note: risk factors: smoking, low consumption of fruit and vegetables, consumption of alcohol in excess of government guidelines and physical inactivity.

Appendix 10: Health at Work Employee Survey[216].

Adapted from British Heart Foundation Health at Work Employee Survey

We would like you to have the opportunity to have your say on the development of a new healthy lifestyle intervention onboard HMS Duncan

Please take a few minutes to fill in this questionnaire. **The information you provide will help us develop a programme to suit your needs**

Your participation is completely voluntary and **all responses will be anonymous**

About Your General Health

1. How would you describe your general health?

Very poor 1☐ Poor 2☐ Fair 3☐ Good 4☐ Very good 5☐

2. How would you describe the following when you are at work?

	Very poor	Poor	Fair	Good	Very good
Energy levels	1☐	2☐	3☐	4☐	5☐
Mood	1☐	2☐	3☐	4☐	5☐
Concentration	1☐	2☐	3☐	4☐	5☐
Stress levels	1☐	2☐	3☐	4☐	5☐

3. On average how many hours do you work each day? …… hours a day

4. Does your work involve shift patterns outside 9am to 5pm? Yes 1☐ No 2☐

5a. Are you trying to lose body weight at the moment? Yes 1☐ No 2☐

5b. If you answered yes, how are you doing this? *(Please tick all that apply)*

1☐ More exercise
1☐ Low fat diet
1☐ Low carbohydrate diet
1☐ Eating less
1☐ Low calorie diet
1☐ Other (please specify) _______________

6. Which of the following changes (if any) do you plan to make over the next 6 months? *(Please tick all that apply)*

1☐ Stop smoking
1☐ Increase physical activity levels
1☐ Eat a more balanced diet
1☐ Drink less alcohol
1☐ Other (please specify) ______________

Physical Activity

1a. In a typical week **during your last deployment**, how many days did you spend walking continuously for at least 10 minutes at a time?

On ….... **days** a week

1b. In total, how much time did you spend walking in a typical week **during your last deployment**?

…….. **hours** a week

2a. In a typical week **during your last deployment**, on how many days did you do any kind of manual handling tasks, loaded transit around the ship or moving equipment?

On ….... **days** a week

2b. On those days, on average, how long did you spend doing these things on each day?

…….. hours

3a. In a typical week **during your last deployment**, on how many days did you take part in any sport or activity **onboard ship**? (*e.g. running, sports or working out in the gym*)

On ….. days a week

3b. On those days, on average, how long were you active for each day?

……. minutes

4a. At the moment, what would prevent you from becoming more active **onboard ship during your next deployment**? *(Please tick all that apply)*

1☐ Injury
1☐ There is no-one to do it with
1☐ I can't afford it
1☐ There are no suitable facilities
1☐ I need to rest and relax in my spare time
1☐ Can't be bothered
1☐ I don't put priority on physical activity
1☐ I might get injured or damage my health
1☐ Other (please specify) _______________
1☐ My health is not good enough
1☐ I'm active enough
1☐ I'm too old
1☐ I don't have time
1☐ No motivation
1☐ Too fat/overweight
1☐ I don't enjoy physical activity
1☐ I'm not the sporty type

4b. Which of the following best describes you? *(Please tick only **ONE**)*

1☐ I am not interested in pursuing a healthy lifestyle or being physically active
2☐ I have recently been thinking about becoming regularly active
3☐ I am intending to become regularly active within the next six months
4☐ I have recently changed my behaviour and I am active on a regular basis
5☐ I have been regularly active for at least six months

5a. Thinking about your job, in general would you say that in your job you are?

4☐ Very physically active
3☐ Fairly physically active
2☐ Not very physically active
1☐ Not at all physically active

5b. **On an average day** at work, are you mainly …

- 3☐ Standing up
- 2☐ Sitting down
- 1☐ Walking about

6a. Please list the physical activities that you regularly took part in **onboard ship during your <u>last</u> deployment** (once a week or more)

____

6b. Why did you take part in these activities? (*Please tick whichever ones apply to you)*

- 1☐ To get fit
- 1☐ To be with friends
- 1☐ To relieve stress
- 1☐ To lose weight
- 1☐ To improve my health
- 1☐ Other (please specify) ________________
- 1☐ To be part of a team
- 1☐ To compete
- 1☐ To feel good
- 1☐ My MO referred me

Diet

1a. During a typical week **during your <u>last</u> deployment**, on how many days did you consume 5 portions or more of fruit and vegetables?

Remember that fresh, frozen and tinned fruits and vegetables all count, but fruit juice and dried fruit only count as 1 portion per day each, regardless of the amount you have. Potatoes are counted as starchy foods, not as vegetables.

On ______ days a week

1b. During a typical week **during your <u>last</u> deployment**, on how many days did you have an "unhealthy" snack food or drink? (e.g. *fizzy drinks, cakes and biscuits, sweets or crisps*)

On ______ days a week

1c. During a typical week **during your <u>last</u> deployment**, on how many days did you have 8 glasses of fluid? (e.g. *water, tea, coffee, fruit juice or squash*)

On ______ days a week

1d. During a typical week **during your <u>last</u> deployment**, on how many days did you have <u>more than</u> 2 to 3 units of alcohol if you are a woman, or more than 3 to 4 units of alcohol if you are a man?

There is one unit of alcohol in each of these drinks:

- A half pint of normal strength beer; *A pint of beer would therefore count as 2 standard drinks.*
- A half a standard (175 ml) glass of wine; *A large 250 ml pub glass of wine about 3 standard drinks.*
- A small single measure of spirits;
- A 50 ml pub measure of fortified wine (such as sherry or port).

On ______ days a week

2. During a typical week **during your <u>last</u> deployment**, on how many days did you:

- **a.** eat breakfast? On ______ days
- **b.** skip lunch because of work commitments? On ______ days
- **c.** eat and/or drink during a work meeting? On ______ days
- **d.** take part in 'team-led' eating, e.g. a biscuit bin or birthday cakes? On ______ days
- **e.** use the NAAFI to buy snack foods? On ______ days
- **f.** eat a meal at your desk? On ______ days
- **g.** make use of the Galley/Wardroom? On ______ days
- **h.** eat lunch/dinner from the NAAFI? On ______ days

3a. At the moment, what would prevent you from introducing more healthy foods into your diet onboard ship **during your <u>next</u> deployment**? *(Please tick all that apply)*

1☐ Special dietary needs
1☐ Family dietary preferences
1☐ Cost of healthy foods
1☐ Work commitments
1☐ Lack of nutritional knowledge
1☐ Dislike of healthy foods
1☐ Lack of food storage/ preparation areas onboard
1☐ Lack of healthy eating choices in the Galley
1☐ Lack of healthy eating choices in the NAAFI
1☐ Poor health
1☐ Other (please specify) _______________

3b. Which of the following best describes you? *(Please tick one box only)*

1☐ I am not interested in pursuing a healthy diet
2☐ I have recently been thinking about changing my diet
3☐ I am intending to change my diet within the next six months
4☐ I have recently been following a healthy eating plan
5☐ I have been following a healthy eating plan for at least six months
99☐ I have special dietary needs that prevent me from changing my diet

Smoking

1. Have you ever smoked a cigarette, cigar or pipe?
1☐ Yes
2☐ No

2. Do you smoke cigarettes, cigar or pipe nowadays?
1☐ Yes
2☐ No

2a. If yes, approximately what age did you start? _____ years old

2b. If no, how long ago did you stop smoking?
1☐ Less than one month
2☐ One to six months
3☐ Seven months to one year
4☐ Over a year

3. If you are presently a smoker, approximately how many cigarettes do you smoke each day?

1☐ 1 – 5
2☐ 6 – 10
3☐ 11 – 20
4☐ 21+

4. If you smoke cigarettes, how soon after waking do you smoke your first cigarette?

1☐ Less than five minutes
2☐ 5-14 minutes
3☐ 15-29 minutes
4☐ 30 minutes or longer

5. Which of the following statements best describes you? *(Please tick one)*

5☐ I intend to give up smoking within the next month
4☐ I intend to give up smoking within the next 6 months
3☐ I intend to give up smoking within the next year
2☐ I intend to give up smoking, but not in the next year
1☐ I have no intention of giving up smoking

6. If you want to stop smoking in the next month, would you like any of the following types of support? ***(please tick all that apply)***

1☐ A pamphlet about smoking cessation
1☐ Information about NHS stop smoking service
1☐ An appointment with a smoking cessation trained MO or MA
1☐ A stop smoking group session held in my workplace
1☐ I do not want any support

Intervention Ideas…

1. If the following initiatives were offered onboard ship **during your next deployment**, how likely would you be to take part or use them?

	Extremely unlikely	Fairly unlikely	Undecided/ Don't know	Fairly likely	Extremely likely
Recipes and tips for healthy eating	1☐	2☐	3☐	4☐	5☐
Cookery classes	1☐	2☐	3☐	4☐	5☐
Nutrition courses and qualifications	1☐	2☐	3☐	4☐	5☐
Talks, presentations and workshops on healthy eating by health professionals, dietitians or nutritionists	1☐	2☐	3☐	4☐	5☐
Talks and presentations on physical activity by health professionals	1☐	2☐	3☐	4☐	5☐
Access to health promotion materials such as leaflets and posters promoting healthy eating	1☐	2☐	3☐	4☐	5☐
Access to weekly healthy eating messages via email and/or bulletin boards	1☐	2☐	3☐	4☐	5☐
Access to weekly physical activity messages via e-mail and/or bulletin boards	1☐	2☐	3☐	4☐	5☐
On-ship taster sessions run by the ships' PTI	1☐	2☐	3☐	4☐	5☐
Selection of healthy refreshments in meeting rooms – for example, water and fresh fruits	1☐	2☐	3☐	4☐	5☐
Health and fitness assessments and/or health screening	1☐	2☐	3☐	4☐	5☐
Self-check facilities, e.g. weighing scales and tape measures available in a private area	1☐	2☐	3☐	4☐	5☐
Weight management programmes	1☐	2☐	3☐	4☐	5☐
Healthy meal choices available in the Galley/ Wardroom	1☐	2☐	3☐	4☐	5☐
Healthy meal options in the NAAFI (e.g. sandwiches, pasta and salads)	1☐	2☐	3☐	4☐	5☐
Healthy snack options available in the NAAFI (e.g. fruit, nuts, yoghurts)	1☐	2☐	3☐	4☐	5☐
On-site facilities (e.g. food preparation and storage areas for ship's company use)	1☐	2☐	3☐	4☐	5☐
A lunchtime activity group (e.g. circuits, body pump)	1☐	2☐	3☐	4☐	5☐
After work activity clubs (e.g. football or badminton)	1☐	2☐	3☐	4☐	5☐
On-ship activity classes (e.g. yoga, aerobics, circuits)	1☐	2☐	3☐	4☐	5☐
Participation in local or national healthy eating events	1☐	2☐	3☐	4☐	5☐
Team or individual activity challenges	1☐	2☐	3☐	4☐	5☐
Team or individual '*Eat well!* challenges'	1☐	2☐	3☐	4☐	5☐
Ships' company leagues, ladders and competitions	1☐	2☐	3☐	4☐	5☐
A stop smoking group	1☐	2☐	3☐	4☐	5☐
Other ______________________	1☐	2☐	3☐	4☐	5☐

About You

1. Gender: [1]☐ Male [2]☐ Female

2. Age group: ☐ Under 21 ☐ 21 – 30 ☐ 31 – 40
☐ 41 – 50 ☐ 51 – 60 ☐ 60+

3. Rank: ________________

4. Would you be interested in becoming involved in our healthy lifestyle intervention onboard your ship **during your next deployment**?

[1]☐ Yes [2]☐ No

Please list any other **ideas** you have about what could be improved on HMS Duncan to support those wanting to make healthy choices.

Ideas which have previously been suggested include:

- Delivering a 'Military Performance' nutrition brief Pre-Deployment
- Body monitoring programme (body weight, waist circumference and skinfolds) to assess changes over the deployment
- Providing fruit or yoghurts instead of a pudding on some days of the week
- Improving the weight management programme

What do you think? *We value your opinion*.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

THANK YOU FOR FILLING OUT THIS SURVEY

Your input will help us to ensure the success of our Healthy Lifestyle Intervention.

Appendix 11: Focus group discussion guide.

Proposed prompts for Focus Group Discussions

Healthy Eating

- What do you think healthy eating is?
- What foods do you think RN personnel need to eat to stay fit and healthy?
- What has the biggest influence on the foods that you eat onboard ship?
- How much of an influence do you think your family, peers and colleagues have on what you eat onboard ship?
- Is there anything that limits your ability to consume a healthy diet onboard ship?
- How do you feel about the foods that are available in the Galley/Wardroom and the NAAFI?
- What do you think could support/encourage healthy eating onboard ship?
- Would you like to receive nutrition education onboard ship? If so, how?
- Further prompts: what changes would you like to be made to the feeding provision in the Galley/Wardroom to support/encourage healthy eating? What changes would you like to be made to the feeding provision in the NAAFI to support/encourage healthy eating?

Physical Activity

- Do you know how much exercise health experts recommend undertaking each week?
- What has the biggest influence on the amount of physical activity/exercise you undertake onboard ship?
- How much of an influence do you think your family, peers and colleagues have on how much physical activity/exercise you undertaken onboard ship?
- Is there anything that limits your ability to undertake regular physical activity/exercise onboard ship?
- What do you think could support/encourage regular physical activity/exercise onboard ship?
- Would you like to receive materials and resources to support/encourage your participation in regular physical activity/exercise onboard ship? If so, how?

Current Health Related Activities

- What health related activities does your ship currently offer?
- Prompt: this can include the feeding provision, the exercise and support offered and anything else you think relevant.
- How helpful/effective do you find these activities? What do you think of these options?

Contact Methods

- If your ship was going to run a programme to help personnel lead a healthier lifestyle while they were on deployment, what sort of programme do you think would work best?
- Further prompts: and how would you like it to be delivered? Who by?
- How often would you like to participate/received updates?

Neutral prompts

- Could you tell me more about that?
- What makes you say that?
- Why do you think that?
- What do you think about that?

Appendix 12: Focus group and HWES coding matrix.

Name	Files	References
Organisational Factors	0	0
Organisational Factors\Belief about the organisation	1	2
Organisational Factors\Chefs	4	30
Organisational Factors\Chefs\Intervention ideas	0	0
Organisational Factors\Chefs\Intervention ideas\Chefs and menus	2	16
Organisational Factors\Chefs\Intervention ideas\Cooking methods	1	4
Organisational Factors\Chefs\Intervention ideas\Nutrition education	2	2
Organisational Factors\Chefs\Intervention ideas\Opinion of intervention ideas	3	7
Organisational Factors\Chefs\Previous interventions	1	1
Organisational Factors\Food procurement and storage	4	22
Organisational Factors\Health promotion	1	3
Organisational Factors\Health promotion\Intervention ideas	0	0
Organisational Factors\Health promotion\Intervention ideas\Health promotion	4	20
Organisational Factors\Health promotion\Intervention ideas\Health promotion\Incentives	2	13
Organisational Factors\Health promotion\Intervention ideas\Health promotion\Opinion of intervention ideas	1	8
Organisational Factors\Health promotion\Intervention ideas\Nutrition education	4	9
Organisational Factors\Health promotion\Intervention ideas\Nutrition education\Content	4	16
Organisational Factors\Health promotion\Intervention ideas\Nutrition education\Coverage	2	7
Organisational Factors\Health promotion\Intervention ideas\Nutrition education\Deliverer	3	12
Organisational Factors\Health promotion\Intervention ideas\Nutrition education\Delivery method	3	13
Organisational Factors\Health promotion\Intervention ideas\Nutrition labelling	3	20
Organisational Factors\Health promotion\Intervention ideas\Weight management support	3	16
Organisational Factors\Health promotion\Intervention ideas\Weight management support\Opinions of intervention ideas	1	7
Organisational Factors\Health promotion\Opinion about nutrition advice	1	5
Organisational Factors\Health promotion\Previous interventions	2	13
Organisational Factors\Meal timings	3	16
Organisational Factors\Meal timings\Intervention ideas	1	4
Organisational Factors\Physical activity provision	4	21
Organisational Factors\Physical activity provision\Intervention ideas	5	44
Organisational Factors\Physical activity provision\Intervention ideas\Opinion of intervention ideas	2	10
Organisational Factors\Physical activity provision\Opinion about PTI	3	9
Organisational Factors\Physical activity provision\Opinions and perceptions about	4	6
Organisational Factors\Physical activity provision\Previous interventions	3	5

Name	Files	References
Physical Environment	0	0
Physical Environment\Galley	0	0
Physical Environment\Galley\Belief about feeding provision	2	2
Physical Environment\Galley\Intervention ideas	0	0
Physical Environment\Galley\Intervention ideas\Beliefs and opinions about	5	18
Physical Environment\Galley\Intervention ideas\Increase or improve healthy options	4	24
Physical Environment\Galley\Intervention ideas\Increase or improve healthy options\Breakfast	4	23
Physical Environment\Galley\Intervention ideas\Increase or improve healthy options\Dessert	2	6
Physical Environment\Galley\Intervention ideas\Increase or improve healthy options\Drinks	2	6
Physical Environment\Galley\Intervention ideas\Increase or improve healthy options\Evening meal	2	12
Physical Environment\Galley\Intervention ideas\Increase or improve healthy options\Fruit	2	11
Physical Environment\Galley\Intervention ideas\Increase or improve healthy options\Lunch	2	15
Physical Environment\Galley\Intervention ideas\Increase or improve healthy options\Sauces and dressings	2	9
Physical Environment\Galley\Intervention ideas\Increase or improve healthy options\Stand easy and 4 o clockers	2	7
Physical Environment\Galley\Intervention ideas\Reduce number of options	1	11
Physical Environment\Galley\Intervention ideas\Reduce portion sizes	1	2
Physical Environment\Galley\Intervention ideas\Restrict unhealthy options	5	35
Physical Environment\Galley\Intervention ideas\Restrict unhealthy options\Starchy foods	3	6
Physical Environment\Galley\Opinion about previous interventions	5	31
Physical Environment\Galley\Opinions of feeding provision	0	0
Physical Environment\Galley\Opinions of feeding provision\Healthy options are provided	4	21
Physical Environment\Galley\Opinions of feeding provision\Like specific foods	2	5
Physical Environment\Galley\Opinions of feeding provision\Presentation of food	1	8
Physical Environment\Galley\Opinions of feeding provision\Provision is unhealthy	5	30
Physical Environment\Galley\Opinions of feeding provision\Salads	1	3
Physical Environment\Galley\Opinions of feeding provision\Too much food	1	2
Physical Environment\Galley\Perception about feeding provision	3	3
Physical Environment\Galley\What the current provision is	0	0
Physical Environment\Galley\What the current provision is\Breakfast	4	35
Physical Environment\Galley\What the current provision is\Fruit	2	2
Physical Environment\Galley\What the current provision is\Lunch and Dinner	4	31
Physical Environment\Galley\What the current provision is\Midnight meal	1	1
Physical Environment\NAAFI shop	0	0
Physical Environment\NAAFI shop\Current provision	3	14
Physical Environment\NAAFI shop\Intervention ideas	5	18
Physical Environment\NAAFI shop\Opinions and beliefs about	4	34

Name	Files	References
Physical Environment\NAAFI shop\Previous interventions	1	1
Physical Environment\Physical activity provision	3	5
Physical Environment\Physical activity provision\Intervention ideas	3	11
Physical Environment\Physical activity provision\Opinions of	4	9
Policies	0	0
Policies\Food budget	1	3
Policies\Food budget\Barrier to healthy eating	4	9
Policies\Food budget\Intervention ideas	4	12
Policies\Food budget\Intervention ideas\Belief about intervention ideas	1	2
Policies\Food budget\Opinions on DMR	4	9
Policies\NAAFI shop	2	4
Policies\PFS	4	17
Policies\PFS\Intervention ideas	4	16
Policies\PFS\Intervention ideas\Negative opinion	1	13
Policies\PFS\Intervention ideas\Preferences for PFS	1	1
Psychological Factors	0	0
Psychological Factors\Determinants	0	0
Psychological Factors\Determinants\Food choice	0	0
Psychological Factors\Determinants\Food choice\Familiarity	1	1
Psychological Factors\Determinants\Food choice\Food availability	4	14
Psychological Factors\Determinants\Food choice\Food availability\Chefs	4	16
Psychological Factors\Determinants\Food choice\Food availability\Food preparation facilities	2	3
Psychological Factors\Determinants\Food choice\Food placement and labelling	2	6
Psychological Factors\Determinants\Food choice\Health	2	2
Psychological Factors\Determinants\Food choice\Lifestyle	3	4
Psychological Factors\Determinants\Food choice\Price	1	2
Psychological Factors\Determinants\Food choice\Sensory appeal	2	13
Psychological Factors\Determinants\Food choice\Weather	2	2
Psychological Factors\Determinants\Getting takeaways	3	6
Psychological Factors\Determinants\Undertaking physical activity	0	0
Psychological Factors\Determinants\Undertaking physical activity\Internal factors	3	23
Psychological Factors\Determinants\Undertaking physical activity\Organisational factors	4	44
Psychological Factors\Determinants\Undertaking physical activity\Physical environment	3	7
Psychological Factors\Determinants\Undertaking physical activity\Socio-cultural factors	2	8
Psychological Factors\Determinants\Using the NAAFI	2	8
Psychological Factors\Feeding requirements_beliefs and opinions	4	30
Psychological Factors\Past experience	2	3
Psychological Factors\Personnel's behaviours	0	0
Psychological Factors\Personnel's behaviours\Diet_beliefs, opinions and perceptions	4	27
Psychological Factors\Personnel's behaviours\Physical activity_beliefs, opinions and perceptions	4	13
Psychological Factors\Personnel's knowledge_opinions	2	5

Appendix 13: Physical activity and nutrition environment assessment tool.

Background Information

1. Ship: ………………………………...
2. Assessment Date: ……………………
3. Location: ………………………………
4. Ships company (n): Alongside …………… Deployed ……………
5. Females (n): ………………
6. Officers (n): …….. Senior Rates (n): ……… Junior Rates (n): …………
7. Departments: ..………………………………………………………………………
8. Messes (n): ……………………..
9. Mess Decks (n): …………
10. Galleys (n): …………
11. Typical working patterns:

    Alongside: ………………….. Deployed: ………………

12. Average length of deployment: …………………

Other Information:

13. What is the DMR? Alongside: ………………….. Deployed: ………………

Nutrition Environment

1. Meal times
   a. Alongside: Breakfast ………………. Lunch ……………… Dinner ……………….
   b. Deployed: Breakfast ………………. Lunch ……………… Dinner ……………….
2. Length of meal times: Breakfast ………… Lunch ……………… Dinner ……………….
3. Stand Easy:
   a. Times: ………………………………………………………….
   b. Where do personnel typically go?...
   c. Feeding provision: ……………………………………………….
4. Menu cycle (weeks): ………………..
5. Provision:

Provision	Wardroom	SR Mess	JR Mess	Details
Is salt on the tables?	Y N	Y N	Y N	
Is a healthy meal choice available?	Y N	Y N	Y N	
Is this identified on the menu?	Y N	Y N	Y N	
Is this identified at the servery?	Y N	Y N	Y N	
How many main meal choices at lunch?				

How many main meal choices at dinner?				
Are the healthy options placed at the front?	Y N	Y N	Y N	
Is there a vegetarian option?	Y N	Y N	Y N	
Are there themed meals?	Y N	Y N	Y N	
Are there any health education/ promotion posters?	Y N	Y N	Y N	

6. What is the alcohol policy? ……...
7. What on-site facilities are available? (e.g. fridge, kettle, squash)

8. Food provision at meal times (check against menus)

Breakfast
Lunch
Dinner

9. What alcohol is available?

10. What options are typically popular in the Galley?
    a. Whilst alongside: ……………………………………………………………………………………………
    b. Whilst deployed: ……………………………………………………………………………………………

11. What improvements could be made to the Galley **provision** to encourage healthier eating behaviours?

12. What improvements could be made to the Galley **marketing/ health education/ promotion materials** to encourage healthier eating behaviours?

13. What communication methods are available to promote a healthy lifestyle?

14. What food/snacks do personnel usually bring aboard alongside/ during deployment?

15. Are there dry runs ashore whilst deployed? Y N
16. Use of healthy ingredients and cooking practices?

………

17. Reasonable portion sizes in the Galley?

………

18. Procurement figures over a specified time for each food ordered – kg:
    a. Foods: meat, fish, milk & dairy, fruit & desserts, vegetables, starchy foods, breakfast cereals, sandwiches, ready meals, soup, stock, cooking sauces, biscuits, cakes, oils, spreads

Physical Activity Environment

1. How frequently do the ship's company exercise?
    a. Alongside: ……………………
    b. Deployed: ……………………..
2. What equipment is available in the gym?

Equipment	Yes/No	How many?	Details
Treadmill	Y N		
Rowing Machine	Y N		
Stepper	Y N		
Cross trainer	Y N		
Bike	Y N		
Spinning bike	Y N		
Free weights	Y N		
Mats	Y N		
Olympic bar	Y N		
Heaves/ dipping bar	Y N		

Punch bag	Y N		
Power bag	Y N		

3. Are activities undertaken on the flight deck? Y N
   a. Details……….
4. Is there a TV in the gym? Y N
5. Is there music in the gym? Y N
6. What **improvements** could be made to the facilities/ equipment to encourage more personnel to use them more?

7. What other **improvements/support** could be given to help personnel to exercise more?

NAAFI

1. Opening hours: ……………………………………………………………………………………..

   a. Same hours during deployment? ………………………………………………………………

2. Provision (check against list, measure against GBS)

3. Are meal deals available? ………………………………………………………………………….

4. Are healthy snacks available? ……………………………………………………………………..

5. Are there special promotions to encourage healthy eating? ………………………………...

6. Are there special promotions on high-fat/high-sugar snacks? ………………………………

7. Is nutrition information available? ……………………………………………………………….

8. What are the most popular items?

   a. Whilst alongside: ……………………………………………………………………………..

   b. Whilst deployed: ……………………………………………………………………………...

9. Are the prices of healthy options comparable to or cheaper than less healthy options?

   ………………………………………………………………………………………………………

10. Are vending machines available?

11. What improvements could be made to the NAAFI **provision** to encourage healthier eating behaviours?

12. What improvements could be made to the NAAFI **marketing/ health promotion materials** to encourage healthier eating behaviours?

Health Education/ Promotion

1. Are any of the following workplace health initiatives offered/ provided?

Health Initiative		Yes/No		If Yes… When?		**Details** *(Nutrition, PA, Alcohol, Smoking)*
i.	Activity groups/ classes	Y	N	Alongside	Deployed	
ii.	Activity taster sessions	Y	N	Alongside	Deployed	
iii.	Team challenges	Y	N	Alongside	Deployed	
iv.	Leagues	Y	N	Alongside	Deployed	
v.	Health promotion materials	Y	N	Alongside	Deployed	
vi.	Presentations on healthy eating	Y	N	Alongside	Deployed	
vii.	1-2-1 support nutrition	Y	N	Alongside	Deployed	
viii.	1-2-1 support physical activity	Y	N	Alongside	Deployed	
ix.	Weight management programme	Y	N	Alongside	Deployed	

x.	Awareness days/ participation in national events	Y N	Alongside Deployed	
xi.	Health screening e.g. BCM	Y N	Alongside Deployed	
xii.	Smoking cessation support	Y N	Alongside Deployed	
xiii.	Advertising/sponsorship for food/drink or fitness/sports	Y N	Alongside Deployed	
xiv.	Prize funds for health initiatives	Y N	Alongside Deployed	
xv.	Notice boards	Y N		

Appendix 14: Assumptions of menu analysis.

Meal	Provision	Assumption
Breakfast	Cereals	Provided for 100% of population
	Cooked breakfast – bacon, sausage, baked beans, plum tomatoes, eggs to order, extra	Provided for 100% of population with 50% fried eggs and 50% poached eggs
	Toast and preserves	Provided for 100% of population with 75% white bread, 25% wholemeal bread, 50% butter, 50% margarine, 50% jam
Lunch	Soup of the day	Provided for 100% of population
	Main choice meat/fish	Provided for 55% of population
	Main choice vegetarian	Provided for 5% of population
	Potato choice	Provided for 60% of population
	Vegetable choice	Provided for 60% of population
	Jacket potato with filling	Provided for 10% of population
	Salad bar	Provided for 15% of population
	Baguette	Provided for 15% of population
	Fresh fruit	Provided for 100% of population
	Bread	Provided for 100% of population with 75% white bread, 25% wholemeal bread, 50% butter, 50% margarine
Dinner	Main choice meat/fish	Provided for 95% of population
	Main choice vegetarian	Provided for 5% of population
	Potato choice	Provided for 100% of population
	Vegetable choice	Provided for 100% of population
	Sweet	Provided for 100% of population

Appendix 15: AFFBS[78].

Food/ Food group	Standards
 Fruit and vegetables	▪ Provide at least 5 portions* of a variety of fruit and vegetables every day
	▪ Vegetables cooked in fat or oil or served in a cream/cheese sauce should not be provided more than once per meal
 Potatoes, bread, rice, pasta and other starchy carbohydrates	▪ Provide a variety of starchy foods at every meal, where at least one-third of options over a menu cycle are non-potato ▪ At least 25% of non-potato starchy options over a menu cycle should be wholegrain or higher-fibre versions ▪ At least 50% of breakfast cereal options should be high in fibre (i.e. more than 6g per 100g)
	▪ Starchy food cooked or prepared with fat or oil should not be provided more than once per day across lunch and the evening meal ▪ No more than 50% of breakfast cereal options should be high in total sugar (i.e. more than 22.5g per 100g) ▪ Main course options made with pastry should not be provided more than once per day across lunch and the evening meal
 Beans, pulses, fish, eggs, meat and other proteins	▪ Provide at least two portions of fish a week, of which one portion should be oily ▪ At least one vegetarian main course option per day should contain either: eggs, beans, peas, lentils or vegetable-based sources of protein
	▪ Processed meat products** should not be provided more than once per day across lunch and the evening meal
 Dairy and alternatives	▪ Provide a portion* of milk and/or dairy foods at every meal ▪ Offer lower fat milk, yoghurt and cheese
 Oils and spreads	▪ At least 75% of oils and spreads that are provided or used during the cooking process should be based on lower fat unsaturated fats
 Food and drinks high in fat and sugars	▪ Reduce the availability and use of food and drinks that are high in sugar and/or fat (particularly saturated fat) ▪ Savoury snacks should only be available in packet sizes of 30g or less ▪ Confectionery and packet sweet snacks should only be available in the smallest standard single portion size and not exceed 250 kcal
	▪ Meat and meat products, biscuits, cakes and pastries that are provided should be lower in saturated fat where available ▪ At least 50% of the dessert options available should be based on fruit (fresh, canned in juice, dried or frozen)
 Salt	▪ Caterers should not add salt to food after the cooking process is complete ▪ Vegetables and boiled starchy foods should be cooked without salt
	▪ Salt shall only be provided at the servery or at a central service point
 Fluids	▪ Tap water should be visible and freely available
	▪ Sugar sweetened beverages*** should not be available in a pack size of more than 330ml ▪ No more than 20% of beverages (procured by volume) may be sugar sweetened

* Refer to Ration Scales provided in JSP 456 Vol 2 Chap 3
** Processed meat products include sausages and burgers
*** Sugar sweetened beverages incorporate beverages which are not low calorie and which have added sugar

Key to symbols

- Food or food groups that must be **provided**
- Food or food groups where the frequency or amount provided should be **restricted**
- Food or food groups that are **no longer allowed**

Appendix 16: Nutritional analysis of menus by meal.

Meal	Ship	Energy (kcal) Mean (SD)	Protein (g) Mean (SD)	Carbohydrates (g) Mean (SD)	Sugar (g) Mean (SD)	Total fat (g) Mean (SD)	Saturated Fat (g) Mean (SD)	Fibre (g) Mean (SD)	Salt (g) Mean (SD)
Breakfast	HMS Bulwark	942 (119)	39 (3)	101 (16)	27 (2)	43 (7)	15 (2)	8 (1)	6 (0)
	HMS Defender	863 (149)	38 (9)	91 (19)	27 (13)	39 (7)	15 (3)	7 (2)	6 (1)
	HMS Dauntless	811 (65)	37(2)	88 (4)	27 (1)	35 (5)	13 (2)	8 (0)	5 (1)
	HMS Duncan	951 (98)	40 (5)	93 (6)	27 (3)	47 (9)	17 (4)	8 (1)	6 (1)
	HMS Illustrious	926 (119)	41 (4)	99 (16)	31 (9)	41 (7)	15 (2)	9 (1)	6 (1)
	HMS Lancaster	768 (125)	34 (6)	88 (10)	27 (2)	31 (7)	12 (3)	8 (1)	5 (1)
	HMS Ledbury	763 (52)	34 (1)	85 (5)	25 (2)	32 (4)	12 (0)	7 (1)	5 (0)
	HMS Vigilant	764 (0)	35 (0)	86 (0)	27 (0)	31 (0)	12 (0)	8 (0)	5 (0)
Lunch	HMS Bulwark	1105 (219)	46 (15)	120 (22)	26 (8)	49 (13)	17 (5)	11 (2)	5 (2)
	HMS Defender	997 (219)	39 (5)	106 (31)	20 (11)	46 (11)	16 (3)	9 (4)	5 (1)
	HMS Dauntless	1052 (103)	36 (5)	115 (13)	26 (4)	49 (7)	16 (3)	10 (1)	6 (1)
	HMS Duncan	1263 (189)	49 (11)	123 (16)	32 (14)	64 (13)	23 (7)	11 (2)	6 (1)
	HMS Illustrious	1133 (118)	41 (11)	127 (13)	28 (6)	51 (8)	17 (3)	12 (1)	6 (1)
	HMS Lancaster	1112 (245)	39 (11)	121 (20)	25 (3)	52 (15)	18 (6)	11 (1)	6 (1)
	HMS Ledbury	1002 (245)	42 (20)	104 (21)	22 (4)	46 (15)	15 (7)	13 (3)	9 (2)
	HMS Vigilant	1126 (191)	45 (10)	116 (19)	26 (4)	53 (13)	18 (5)	12 (2)	5 (1)
Dinner	HMS Bulwark	1332 (548)	56 (20)	140 (62)	43 (21)	61 (29)	21 (9)	11 (5)	5 (2)
	HMS Defender	1292 (223)	51 (13)	128 (30)	42 (16)	64 (13)	23 (7)	10 (2)	4 (1)
	HMS Dauntless	1367 (258)	58 (16)	131 (30)	43 (11)	68 (17)	22 (8)	8 (3)	5 (1)
	HMS Duncan	1281 (320)	50 (17)	133 (40)	41 (16)	61 (18)	20 (6)	10 (2)	4 (1)
	HMS Illustrious	1272 (218)	54 (7)	124 (27)	47 (16)	62 (18)	21 (6)	9 (2)	4 (1)
	HMS Lancaster	1269 (313)	62 (15)	117 (36)	36 (14)	62 (17)	20 (5)	9 (3)	5 (2)
	HMS Ledbury	1159 (270)	48 (14)	120 (32)	38 (13)	54 (15)	20 (7)	8 (2)	4 (2)
	HMS Vigilant	1453 (316)	60 (21)	151 (35)	44 (20)	68 (19)	20 (7)	12 (3)	5 (2)

Appendix 17: Food group analysis of menus.

Food Group	Analysis	HMS Bulwark	HMS Dauntless	HMS Defender	HMS Duncan	HMS Illustrious	HMS Lancaster	HMS Ledbury	HMS Vigilant	Mean
Fruit & veg.	Portions per day (n)	9.1	5.8	5.2	5.8	6.2	6.4	4.6	6.7	6.2
	Lunch/dinner vegetables cooked in fat/oil or served in a cream/cheese sauce (%)	25	28	33	28	30	24	31	36	29
Starchy foods	Lunch/dinner portions per day (n [range])	3.3 [0-3]	2.7 [1-4]	2.5 [0-3]	2.6 [0-4]	5.4 [0-5]	4.2 [0-3]	2.9 [1-3]	3.3 [0-4]	3.4 [-]
	Starchy food options: potato (%)	80	63	69	75	67	71	63	61	69
	Starchy food options: wholegrain (%)	0	0	0	0	0	0	0	0	0
	Breakfast cereals: high-sugar:fibre (%)	17:50	25:75	23:32	0:60	23:54	23:32	n/a	n/a	19:51
	Starchy foods cooked in fat/oil: lunch:dinner (%)	45:48	86:67	67:61	75:88	50:47	54:61	57:53	55:65	61:59
	Days starchy foods cooked in fat/oil served at breakfast (%)	50	14	21	21	36	0	0	0	18
	Lunch/dinner meals: pastry (%)	3	16	5	9	9	11	9	6	9
Non-dairy sources of protein	Breakfast portions per day (n)	3.0	3.1	3.2	3.6	3.2	3.0	3.0	3.0	3.1
	Lunch/dinner portions per day (range)	2-5	1-4	1-4	2-4	2-5	2-4	1-4	2-5	-
	Portions of fish (all types) per week (n)	5.5	2.5	4.5	3.5	3.5	1.5	3.5	4	3.6
	Portions of oily fish per week (n)	0	0	0.5	0.5	0	0	0	0.5	0.2
	Portions of processed meat products per day (n)	2.7	3.9	3.4	3.6	3.1	3.1	3.2	4.1	3.4
	Meals processed meat products: lunch:dinner (%)	21:7	69:19	49:4	42:9	29:2	35:15	37:25	43:24	41:13
	Meals red meat: lunch:dinner (%)	26:49	15:47	11:49	29:47	22:57	19:55	23:46	30:40	22:49
	Meals poultry: lunch:dinner (%)	26:20	15:22	11:29	29:26	22:27	19:21	23:21	30:24	22:24
	Veggie option good source of protein (%)	54	40	52	40	45	36	100	0	46
Dairy	Portions per day (n)	2.4	1.9	2.3	2.3	2.4	1.7	2.0	2.8	2.2
Foods high in fat/ sugar	Main meals deep fried/served in cheese/cream sauce (%)	15	14	10	13	12	16	7	13	13
	Lunch/dinner meals: batter/breadcrumb (%)	14	16	10	10	10	6	7	9	10
	Dessert: contained fruit (%)	29	14	29	29	29	21	14	21	23
Lunch	Days a light lunch was served (%)	86	100	64	71	93	93	0	0	63
Soup	Days soup was served (%)	86	100	64	100	93	93	0	0	67

Appendix 18: General training of health practitioners in the RN.

For context, the general training that RN Medical Officers (MO), Physical Training Instructors (PTI) and chefs have received, and specifically in the area of health and wellbeing are summarised below:

- MOs have a medical degree, have completed 15 weeks of initial military training at the Britannia Royal Naval College and 16 weeks of Naval Doctor training at the Institute of Naval Medicine (INM). Whilst at the INM, MOs attend a health and wellbeing lecture. The lecture aims to explain current health challenges in the RN, detail the activities that the organisation is taking to tackle these, their role in delivering these activities, and the resources available to help them achieve this role.
- As there is no direct entry into the Physical Training Branch, PTIs have already served in the RN in another specialisation and, as such, have undertaken 10 weeks of initial military training at HMS Raleigh followed by a period of professional training. The length of the latter varies depending on the individual's trade, followed by a period of serving in their particular trade at sea. If their transfer application is successful, personnel undertake 25 weeks of PTI training at the RN School of Physical Training. The course covers a wide variety of academic and practical subjects including: fitness, nutrition, circuit and weight training theory, anatomy and physiology, sports injuries, fitness testing and sports administration.
- Chefs undertake 10 weeks of initial military training at HMS Raleigh followed by 26 weeks of professional training at the Defence Maritime Logistics School. During training chefs attend a lecture detailing the "healthy eating" Chapter of the Defence Catering Regulations document. The Chapter details the constituents of a healthy balanced diet and what actions chefs can take to promote the health of their unit.

Appendix 19: Intervention logframe matrix.

	PROJECT DESCRIPTION	PERFORMANCE INDICATORS	MEANS OF EVALUATION	RISKS AND ASSUMPTIONS
GOAL	To increase the proportion of RN personnel who are fit to deploy	% change in proportion of RN personnel who are fit to deploy	~Navy Monthly Situation Report ~Navy Monthly Downgrades Report	
OBJECTIVE	To reduce the prevalence of obesity onboard a RN ship over a 9-month deployment	~% change in proportion of intervention ship's company who are classified at risk of obesity related ill health over 9-month deployment	~Pre- and End-deployment height, weight and waist circumference measurements of intervention ship's company	~The operational tempo of the ship allows the UHC to implement the intervention ~There is Command support for the intervention ~The UHC engage with and support the intervention ~The UHC implement the changes to the food and physical activity environment ~The ship's company engage with and support the intervention
OUTCOMES	**1** Increased proportion of personnel on the intervention ship who adopt or maintain prudent dietary behaviours over a 9-month deployment	% change in proportion of intervention ship's company who adopt or maintain prudent dietary behaviours (1)	Pre- and End-deployment questionnaire and food diary results from intervention ship's company	The ship's company engage with and support the changes to the food environment
	2 Increased proportion of personnel on the intervention ship who adopt or maintain prudent physical activity behaviours over a 9-month deployment	% change in proportion of intervention ship's company with a Physical Activity Level (PAL) ≥1.75	Pre- and End-deployment questionnaire and physical activity diary results from intervention ship's company	The ship's company engage with and support the changes to the physical activity environment
	3 Increased proportion of personnel on the intervention ship classified at no risk of obesity related ill health over a 9-month deployment	% change in proportion of intervention ship's company classified at no risk of obesity related ill health	Pre- and End-deployment height, weight and waist circumference results	Personnel who are classified at risk of obesity related ill health are ready to change, and engage with and support the intervention

Note: (1) According to prudent diet score (see subsection 7.2.4); RN, Royal Navy.

Appendix 19: Intervention logframe matrix continued.

	PROJECT DESCRIPTION	PERFORMANCE INDICATORS	MEANS OF EVALUATION	RISKS AND ASSUMPTIONS
OUTPUTS	**1.1** UHC prioritise activities to create a healthful food environment on the ship and which fit in with the ship's programme throughout the 9-month deployment	**1.1** % increase in activities onboard ship which create a healthful food environment over the 9-month deployment	**1.1** UHC monthly reports; End-deployment questionnaire and structured interviews	~The food budget holders support the intervention ~The UHC support the intervention ~The ship's company support the intervention ~There is sufficient time for me to develop the resources ~The food supplier supports the intervention
	1.2 Improved healthfulness and attractiveness of the feeding provision onboard the ship throughout the 9-month deployment	**1.2** % increase in healthfulness of the feeding provision over the 9-month deployment against the AFFBS (2)	**1.2** Monthly food menus	
	1.3 Increased number of healthy food options that are available for procurement at Pre-deployment	**1.3** Increase of an extra 10 healthy food options that are available for procurement Pre-deployment	**1.3** Food procurement list	
	1.4 UHC ensure that healthy foods can be resupplied whilst deployed throughout the 9-month deployment	**1.4** Healthy foods are resupplied throughout the 9-month deployment which enable healthy menus to be produced and delivered	**1.4** Monthly food menus; End-deployment structured interviews	
	1.5 Increased budget that is available for healthy foods throughout the 9-month deployment	**1.5** 19% increase in Daily Messing Rate (DMR)	**1.5** DMR for intervention ship	
	1.6 Improved accessibility of health education and promotion materials throughout the 9-month deployment	**1.6** % increase in health education and promotion materials that are accessible throughout the 9-month deployment	**1.6** UHC monthly reports; End-deployment questionnaire and structured interviews; Intervention resource list	
	2.1 UHC prioritise activities to create a healthful physical activity environment on the ship and which fit in with the ship's programme throughout the 9-month deployment	**2.1** % increase in activities onboard ship which create a healthful physical activity environment over the 9-month deployment	**2.1** UHC monthly reports; End-deployment questionnaire and structured interviews	~The UHC support the intervention ~The ship's company support the intervention ~There is sufficient time for me to develop the resources ~HMS Temeraire support the intervention and provide money for physical fitness equipment
	2.2 Increased provision of PTI delivered classes and sport throughout the 9-month deployment	**2.2** % increase in provision of PTI delivered classes and sport throughout the 9-month deployment	**2.2** UHC monthly reports; End-deployment questionnaire and structured interviews	
	2.3 Improved physical fitness equipment provision throughout the 9-month deployment	**2.3** % increase in physical fitness equipment provision Pre-deployment	**2.3** End-deployment structured interviews	
	2.4 Improved accessibility of health education and promotion materials throughout the 9-month deployment	**2.4** % increase in health education and promotion materials that are accessible throughout the 9-month deployment	**2.4** UHC monthly reports; End-deployment questionnaire and structured interviews; Intervention resource list	
	3.1 Continued delivery of a weight management programme (WMP) throughout the 9-month deployment	**3.1a** A WMP is delivered throughout the 9-month deployment **3.1b** At least one-fifth of the ship's company attend the WMP over the 9-month deployment and attend 75% of sessions	**3.1** UHC monthly reports; End-deployment structured interviews; WMP spreadsheet	~The ship's Command supports the delivery of the WMP ~There is sufficient time for me to develop the resources
	3.2 Improved accessibility to resources to support the existing WMP throughout the 9-month deployment	**3.2** Increase in resources to support the WMP throughout the 9-month deployment	**3.2** End-deployment structured interviews; Intervention resource list	

Note: (2) AFFBS, Armed Forces Food Based Standards (see Appendix 15); DMR, Daily Messing Rate; HMS, Her Majesty’s Ship; PTI, Physical Training Instructor; UHC, Unit Health Committee; WMP, Weight Management Programme.

Appendix 19: Intervention logframe matrix continued.

	PROJECT DESCRIPTION	PERFORMANCE INDICATORS	MEANS OF EVALUATION	RISKS AND ASSUMPTIONS
ACTIVITIES	**1.1.1** UHC identify activities which aim to create a healthful food environment on the ship and which fit in with the ship's programme throughout the 9-month deployment	**1.1.1** Needs assessment completed to identify what opportunities exist onboard ship which enable personnel to adopt or maintain prudent dietary behaviours	**1.1.1** Summary report based on data presented in chapter 5	~Chefs are given time to attend the nutrition education brief ~The food budget holders find sufficient funds to support the intervention ~Members of the UHC are given time to attend meetings ~There are rooms available on the ship for the briefs and workshops to take place ~The NAAFI supports the intervention ~The food suppliers are able to supply healthy options ~There is sufficient time for me to develop the resources ~The ship are able to print intervention resources
	1.2.1 A nutrition education brief for the chefs onboard the ship is developed and delivered Pre-deployment	**1.2.1a** A nutrition education brief is developed by a Registered Dietitian/Nutritionist for the chefs onboard the ship Pre-deployment	**1.2.1a** Intervention resource list	
		1.2.1b A nutrition education brief is delivered to the chefs onboard the ship Pre-deployment by a Registered Dietitian/Nutritionist	**1.2.1b** End-deployment structured interviews	
	1.2.2 Work with the Logistics Officer to identify what healthy snacks can be provided in the Wardroom at Pre-deployment	**1.2.2** Healthy snacks are provided daily in the Wardroom throughout the 9-month deployment	**1.2.2** End-deployment structured interviews	
	1.2.3 Comment cards are provided for the ship's company to provide feedback on menu changes throughout the 9-month deployment	**1.2.3a** Completed comment cards are reviewed by Catering Services every 3-months over the 9-month deployment **1.2.3b** Chefs amend menus based on comment card feedback	**1.2.3** UHC monthly reports; End-deployment questionnaire and structured interviews	
	1.2.4 Work with the NAAFI Manager to increase the provision of healthy options, restrict the provision of unhealthy options and improve the product placement of healthy options in the shop throughout the 9-month deployment	**1.2.4a** % increase in range of healthy options in NAAFI throughout the 9-month deployment **1.2.4b** % decrease in range of unhealthy options in NAAFI throughout the 9-month deployment **1.2.4c** Improved product placement of healthy options in NAAFI throughout the 9-month deployment	**1.2.4** NAAFI stock list; UHC monthly reports; End-deployment structured interviews	
	1.2.5 Develop and provide healthy menu plans and a guidance document for the chefs to implement whilst deployed	**1.2.5a** Healthy meal plans are developed by a Registered Dietitian/Nutritionist and provided to the Chefs at Pre-deployment **1.2.5b** A guidance document is developed by a Registered Dietitian/Nutritionist and provided to the Chefs at Pre-deployment	**1.2.5** Intervention resource list	
	1.3.1 Work with food supplier to increase the number of healthy food options available on the provision list at Pre-deployment	**1.3.1** Increase of 10 healthy food options that are available for procurement Pre-deployment	**1.3.1** End-deployment structured interviews	
	1.4.1 Work with the UHC to ensure healthy foods can be resupplied whilst deployed throughout the 9-month deployment	**1.4.1** Discussion with Logistics Officer to identify and prioritise healthy foods to be resupplied whilst deployed throughout the 9-month deployment	**1.4.1** UHC monthly reports; End-deployment structured interviews	
	1.5.1 Work with the budget holders to increase the food budget that is available for healthy foods throughout the 9-month deployment	**1.5.1** Budget increased for the intervention ship throughout the 9-month deployment	**1.5.1** DMR for intervention ship during the deployment	
	1.6.1 Develop health education resources targeted at the ships company to facilitate and motivate personnel to adopt or maintain prudent dietary behaviours throughout the 9-month deployment	**1.6.1** Health education resources (port stop briefs, joining routine briefs, factsheets and posters) are developed by a Registered Dietitian/Nutritionist for the ship's company Pre-Deployment	**1.6.1** Intervention resource list	
	1.6.2 Provide and implement point-of-choice and menu nutrition labelling for healthy options in the Galley at Pre-deployment	**1.6.2** Point-of-purchase and menu nutrition labelling are provided for healthy options in the Galley over the duration of the deployment	**1.6.2** UHC monthly reports; End-deployment questionnaire and structured interviews	
	1.6.3 MO delivers health education briefs to ship's company using intervention education resources throughout the 9-month deployment	**1.6.3a** Port stop briefs are delivered by the MO at every port stop throughout the 9-month deployment **1.6.3b** Joining routine briefs are delivered by the MO to all personnel joining the ship throughout the 9-month deployment	**1.6.3** UHC monthly reports; End-deployment questionnaire and structured interviews	

Note: DMR, Daily Messing Rate; MO, Medical Officer; NAAFI, Navy Army Air Force Institutes; UHC, Unit Health Committee.

Appendix 19: Intervention logframe matrix continued.

	PROJECT DESCRIPTION	PERFORMANCE INDICATORS	MEANS OF EVALUATION	RISKS AND ASSUMPTIONS
ACTIVITIES	**2.1.1** UHC identify activities which aim to create a healthful physical activity environment on the ship and which fit in with the ship's programme throughout the 9-month deployment	**2.1.1** Needs assessment completed to identify what opportunities exist onboard ship which enable personnel to adopt or maintain prudent physical activity behaviours	**2.1.1** Summary report based on data presented in chapter 5	~There is sufficient time for me to develop the resources ~The PTI has sufficient time to deliver the exercise classes, briefs and workshops ~Personnel attend the exercise classes, briefs and workshops ~Personnel are given time to attend the exercise classes, briefs and workshops ~There are rooms available on the ship for the briefs and workshops to take place ~HMS Temeraire find sufficient funds for the gym equipment and pedometers ~There are sufficient funds to support transportation costs for the port walks
	2.1.2 Command mandates Personnel Functional Standards (PFS) (3) throughout the 9-month deployment	**2.1.2** Discussion with the ship's Command to mandate PFS whilst deployed throughout the 9-month deployment	**2.1.2** End-deployment structured interviews	
	2.2.1 PTI to deliver departmental circuits during Defence Watches throughout the 9-month deployment	**2.2.1** Departmental circuits are delivered weekly during Defence Watches throughout the 9-month deployment	**2.2.1** UHC monthly reports; End-deployment questionnaire and structured interviews	
	2.2.2 PTI to deliver daily circuits classes for different fitness levels throughout the 9-month deployment	**2.2.2** Circuits are delivered daily for different fitness levels throughout the 9-month deployment	**2.2.2** UHC monthly reports; End-deployment questionnaire and structured interviews	
	2.2.3 PTI to organise and deliver inter-departmental games throughout the 9-month deployment	**2.2.3** Inter-departmental games are delivered monthly over the deployment	**2.2.3** UHC monthly reports; End-deployment questionnaire and structured interviews	
	2.2.4 PTI to organise and deliver weekly flight deck sports over the 9-month deployment	**2.2.4** Flight deck sports are delivered weekly throughout the 9-month deployment	**2.2.4** UHC monthly reports; End-deployment questionnaire and structured interviews	
	2.2.5 PTI to organise and deliver monthly Fleet Challenges throughout the 9-month deployment	**2.2.5** Fleet Challenges are delivered monthly throughout the 9-month deployment	**2.2.5** UHC monthly reports; End-deployment questionnaire and structured interviews	
	2.2.6 PTI to organise and deliver monthly physical activity challenges throughout the 9-month deployment	**2.2.6** Monthly physical activity challenges are delivered throughout the 9-month deployment	**2.2.6** UHC monthly reports; End-deployment questionnaire and structured interviews	
	2.2.7 PTI to deliver on ship taster sessions for different activities throughout the 9-month deployment	**2.2.7** On ship taster sessions for different fitness classes are delivered throughout the 9-month deployment	**2.2.7** UHC monthly reports; End-deployment questionnaire and structured interviews	
	2.2.8 PTI implements an onboard progression board for different physical challenges throughout the 9-month deployment	**2.2.8** Onboard progression board is installed by PTI Pre-deployment	**2.2.8** End-deployment structured interviews	
	2.3.1 PTI to work with HMS Temeraire to increase the amount and improve the quality of gym equipment on board	**2.3.1** Range/number of cardiovascular and strength training gym equipment increases on the ship Pre-deployment	**2.3.1** End-deployment structured interviews	
	2.3.2 Work with HMS Temeraire to fund pedometers to enable the PTI/MO to implement an onboard pedometer challenge	**2.3.2** Pedometers are provided to the ship during the deployment	**2.3.2** End-deployment structured interviews	
	2.4.1 Develop health education resources targeted at the ships company to facilitate and motivate personnel to adopt or maintain prudent physical activity behaviours throughout the 9-month deployment	**2.4.1** Health education resources (port stop briefs, joining routine briefs, factsheets and posters) are developed by a Registered Dietitian/Nutritionist for the ship's company Pre-Deployment	**2.4.1** Intervention resource list	
	2.4.2 Develop sport and exercise nutrition briefs/workshops for the PTI to deliver to the ship's company	**2.4.2** Sport and exercise nutrition briefs/workshops are developed by a Registered Dietitian/Nutritionist Pre-deployment	**2.4.2** Intervention resource list	
	2.4.3 PTI delivers sport and exercise nutrition briefs/workshops to the ship's company throughout the 9-month deployment	**2.4.3** Sport and exercise nutrition briefs/workshops are delivered by the PTI throughout the 9-month deployment	**2.4.3** UHC monthly reports; End-deployment questionnaire and structured interviews	
	2.4.4 MO delivers health education briefs to ship's company using intervention education resources throughout the 9-month deployment	**2.4.4a** Port stop briefs are delivered by the MO at every port stop throughout the 9-month deployment **2.4.4b** Joining routine briefs are delivered by the MO to all personnel joining the ship throughout the 9-month deployment	**2.4.4** UHC monthly reports; End-deployment questionnaire and structured interviews	

Note: (3) PFS, Personnel Functional Standards (see section 1.2); HMS, Her Majesty's Ship; MO, Medical Officer; PTI, Physical Training Instructor; UHC, Unit Health Committee.

Appendix 19: Intervention logframe matrix continued.

	PROJECT DESCRIPTION	PERFORMANCE INDICATORS	MEANS OF EVALUATION	RISKS AND ASSUMPTIONS
ACTIVITIES	**3.1.1** MO/PTI to undertake weekly weight and waist circumference measurements of personnel enrolled on the WMP throughout the 9-month deployment	**3.1.1** All personnel enrolled on the WMP are measured weekly throughout the 9-month deployment	**3.1.1** WMP data spreadsheet	~There is sufficient time for me to develop the resources ~The MO/PTI are given time as part of their job roles to deliver the WMP ~The MO is given time as part of their job role to deliver the monthly health check-ups ~Personnel attend the WMP ~Personnel are given time to attend the WMP briefs and workshops ~There are rooms available on the ship for the briefs and workshops to take place
	3.1.2 MO to offer monthly health check-ups for all personnel throughout the 9-month deployment	**3.1.2** Monthly health-checks are available for all personnel throughout the 9-month deployment	**3.1.2** UHC monthly reports; End-deployment questionnaire; End-deployment structured interviews	
	3.2.1 Provide the MO/PTI with a measurement guide for the WMP	**3.2.1** A measurement guide for the WMP is developed by a Registered Nutritionist and provided to MO/PTI Pre-deployment	**3.2.1** Intervention resources list	
	3.2.2 Develop an individual feedback form for the MO/PTI which can be completed for personnel attending the WMP	**3.2.2** An individual feedback form is developed by a Registered Nutritionist for the WMP and provided to the MO/PTI Pre-deployment	**3.2.2** Intervention resources list	
	3.2.3 Develop a weight management brief and behaviour change workshops for the MO/PTI to deliver to personnel enrolled on the WMP	**3.2.3** Briefs and workshops are developed for the WMP by a Registered Dietitian/Nutritionist Pre-deployment	**3.2.3** Intervention resources list	
	3.2.4 Develop behaviour change resources for the MO/PTI to utilise with personnel enrolled on the WMP	**3.2.4** Behaviour change resources (e.g. change plans and goal setting sheets) developed by a Registered Nutritionist for the WMP Pre-deployment	**3.2.4** Intervention resources list	
	3.2.5 Develop spreadsheet for the MO/PTI which can be used to analyse personnel's weight and waist circumference changes	**3.2.5** Spreadsheet to record physical measurements and display % changes developed by Registered Nutritionist for MO/PTI Pre-deployment	**3.2.5** Intervention resources list	
	3.2.6 Develop health education resources targeted at personnel enrolled on the WMP to facilitate and motivate personnel to adopt prudent health behaviours	**3.2.6** Health promotion resources developed by a Registered Dietitian/Nutritionist for the WMP Pre-deployment	**3.2.6** Intervention resources list	
	3.2.7 MO/PTI deliver weight management briefs and behaviour change workshops to personnel enrolled on the WMP throughout the 9-month deployment	**3.2.7** Weight management briefs and behaviour change workshops are delivered by the MO/PTI throughout the 9-month deployment	**3.2.7** UHC monthly reports; End-deployment questionnaire; End-deployment structured interviews	

Note: MO, Medical Officer; PTI, Physical Training Instructor; UHC, Unit Health Committee; WMP, weight management programme.

Appendix 20: Control ship study sample size.

		Variable	**Pre-, end-deployment n**
Ship size *n* 196	Study sample size *n* 91	Weight BMI NICE risk	68
		Waist circumference	68
		Self-reported health Food groups Sports club membership Diet social support	61
		Dietary intake	63
		Physical activity levels	64
		Energy expenditure	58
		Alcohol frequency Physical activity stage of change Physical activity self efficacy	60
		Alcohol units Physical activity social support	58
		Dietary stage of change Smoking history	59
		Binge drinking Alcohol social support	59
		Smoking stage of change	12
		Diet self efficacy	61
		Nutrition knowledge	66
		Physical activity knowledge	58
		Smoking knowledge	56
		Alcohol knowledge	59
		Barriers to physical activity	60

Appendix 21: Employee questionnaire[262].

Instructions

- Please try to complete the questionnaire as clearly as possible. There are no right or wrong answers and no question is compulsory.
- To make the evaluation a success, we need you to answer as many questions as you can.
- Please return your completed questionnaire to the PMO.

Thank you

About You

1. Name: ______________________________

2. Service Number: _____________________

3. Gender: 1☐ Male 2☐ Female

4. Date of Birth: _______________

5. Rank: _______________

6. Please state your job title: _________________________

Anthropometry

Height:	**Body Mass:**

Girths	**1**	**2**	**3**
Waist			

About Your General Health

1. How would you describe your general health?

Very poor 1☐ Poor 2☐ Fair 3☐ Good 4☐ Very good 5☐

2. How would you describe the following when you are at work?

	Very poor	Poor	Fair	Good	Very good
Energy levels	1☐	2☐	3☐	4☐	5☐
Mood	1☐	2☐	3☐	4☐	5☐
Concentration	1☐	2☐	3☐	4☐	5☐
Stress levels	1☐	2☐	3☐	4☐	5☐

Diet

A portion of vegetables equals approximately 3 serving spoons of vegetables or a dessert bowl of salad. A portion of fruit equals approximately 1 tbsp of dried fruit, 1 medium sized piece of fruit (e.g. apple), 2 small pieces of fruit (e.g. kiwi fruit) or 125 ml glass of fruit juice.

1. **Number of portions per day**

(Please tick one box in each row)	0	1	2	3	4	5+
a. How many fruit or vegetable juices do you usually drink each day?	0☐	1☐	2☐	3☐	4☐	5☐
b. How many portions of vegetables do you usually eat each day? (including fresh, frozen, canned and chilled)	0☐	1☐	2☐	3☐	4☐	5☐
c. How many portions of fruit do you usually eat each day (including fresh, dried, frozen, chilled and tinned fruit)?	0☐	1☐	2☐	3☐	4☐	5☐

2. Please tell us how often you eat/drink the following: *(please circle one answer in each row)*

Breads, other Cereals, Rice, Grains, Pasta

a. Do you have bread, toast or cereal for breakfast?	0 Never	1 Rarely	2 Sometimes	3 Everyday
b. What type of bread do you typically choose?	White	Brown	Wholemeal	Other______
c. Do you eat some of the following with all meals: bread, cereal, rice, pasta, potato etc?	0 Never	1 Rarely	2 Sometimes	3 Usually/ always
d. Do you have these foods cooked in, or with butter or oil (e.g. chips, roast potato, fried rice, butter or margarine on baked potato)?	4 Never	3 Rarely	2 Sometimes	1 Usually/ always

Meat, Fish, Alternatives

a. How often do you eat lentils, peas or beans (including baked beans)?	0 Never	1 Less than once a week	2 3 times a week	3 Everyday
b. Do you eat fish, including white or oily, fresh, frozen or tinned?	0 Never	1 Rarely	2 Once a week	3 More than twice a week
c. How often do you eat more than 90 g of red or processed meat a day (e.g. three slices of thin cut roast beef or three sausages)	4 Never	3 Rarely	2 Sometimes	1 Usually/ always

Milk and Dairy

a. Do you have a serving of dairy food (e.g. 1/3 pint milk, 25 g of cheese, a yoghurt)?	0 Never	1 A few times a week or not at all	2 Once a day	3 2-3 times a day

Foods with Fat or Sugar

a. Do you eat foods high in fat and sugar such as crisps, chocolate, cakes, ice cream, biscuits, puddings and pastries?	4 Never	3 A few times a week or not at all	2 Once a day	1 2-3 times a day
b. Do you eat sugary foods such as sweets and drink sugary soft drinks (e.g. cola, squashes, canned drinks)?	4 Never	3 Rarely or I drink sugar-free varieties	2 Sometimes	1 Often

Water

a. How often do you drink 8 glasses a day?	0 Never	1 Rarely	2 Sometimes	3 Everyday

3. (*Please tick one box only*)	No, definitely not	No, probably not	Possibly	Yes, probably	Yes, definitely	Don't know
Do you think you will increase the amount of fruit and vegetables you eat over the next 6-months?	1☐	2☐	3☐	4☐	5☐	99☐

4. Which of the following best describes you? *(Please tick one box only)*

1☐ I am not interested in pursuing a healthy diet
2☐ I have recently been thinking about changing my diet
3☐ I am intending to change my diet within the next six months
4☐ I have recently been following a healthy eating plan
5☐ I have been following a healthy eating plan for at least six months
99☐ I have special dietary needs that prevent me from changing my diet

5. Please indicate how confident you are that you could eat a healthy balanced meal in each of the following situations:

(Please tick one box in each row)	Not at all confident	Moderately confident	Very confident
a. When you are tired	1☐	2☐	3☐
b. When you are in a bad mood /stressed	1☐	2☐	3☐
c. When you feel busy or that you don't have the time	1☐	2☐	3☐
d. When you are on holiday	1☐	2☐	3☐
e. When the weather is not very good (winter, raining, cold or hot)	1☐	2☐	3☐
f. When eating out/ socialising	1☐	2☐	3☐
g. When you have consumed alcohol	1☐	2☐	3☐

6. Please tell us how often you miss any meals in a usual week:

(Please tick one box in each row)	Rarely	Occasionally	Quite often	Most days
a. I miss or skip breakfast	4☐	3☐	2☐	1☐
b. I miss or skip lunch	4☐	3☐	2☐	1☐
c. I miss or skip dinner	4☐	3☐	2☐	1☐

7. During the past month my work colleagues, friends and family:

(Please tick one box in each row)		Never	Rarely (less than once month)	Sometimes (at least once/month)	Often (once or twice/week)	Very Often (3 or more/week)
Gave me encouragement to make healthy food choices	Family	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
	Colleagues	1☐	2☐	3☐	4☐	5☐

Physical Activity

These questions ask you about the time you spend being physically active onboard ship. Please answer each question.

Job-related Physical Activity

1. Thinking about your job, in general would you say that in your job you are?

4☐ Very physically active
3☐ Fairly physically active
2☐ Not very physically active
1☐ Not at all physically active

Recreation and Sport Activities

This section asks about the sports, recreational and other physical activities that you **did during the last week** in your leisure time (before and after work, at lunch time and the weekends). For each activity, please indicate the number of days you did the activity **during the last week,** the usual time spent per session and the intensity of the activity**.** Please do not include any work activity.

2. Activity	**Number of days**	**Usual time spent per day**		**Did this activity make you breathe much harder than usual?**	
		Hours	**Minutes**	**Yes**	**No**
Walking purely for recreation/health/fitness				1☐	2☐
Jogging/running (including treadmill)				1☐	2☐
Aerobics classes (including step, high impact, keep fit, circuit training etc.)				1☐	2☐
Exercise with weights				1☐	2☐
Dancing (all types)				1☐	2☐
Sit ups, press-ups				1☐	2☐
Conditioning Exercises (e.g. exercise bike, rowing machine, stepping machine)				1☐	2☐
Yoga / Pilates				1☐	2☐
Martial arts				1☐	2☐
Other (please specify):				1☐	2☐

3. Are you a member of a sport or exercise group or club onboard ship? *(Please specify)*

1☐ ____________________

Other Activities

4. Think about ALL the physical activity you did last week. Do you participate in physical activity on **MOST** days of the week (at least **5** days) for 30 minutes or more each time?

(Please tick the one answer that best applies to you)

5☐ YES, and I have been for MORE than 6 months
4☐ YES, and I have been but for LESS than 6 months
3☐ NO, but I intend to in the next 30 days
2☐ NO, but I intend to in the next 6 months
1☐ NO, and I do NOT intend to in the next 6 months

5. Please indicate how confident you are that you could take part in exercise or physical activity in each of the following situations:

(Please tick one box in each row)	Not at all confident	Moderately confident	Very confident
a. When you are tired	1☐	2☐	3☐
b. When you are in a bad mood /stressed	1☐	2☐	3☐
c. When you feel busy or that you don't have the time	1☐	2☐	3☐
d. When you are on holiday	1☐	2☐	3☐
e. When the weather is not very good (winter, raining, cold or hot)	1☐	2☐	3☐

6. What reasons would you give for not being more physically active?

(Please tick all that apply)

1☐ I don't have time
1☐ There is no-one to do it with
1☐ I can't afford it
1☐ There are no suitable facilities
1☐ I need to rest and relax in my spare time
1☐ Can't be bothered
1☐ I don't put priority on physical activity
1☐ I might get injured or damage my health
1☐ I don't enjoy physical activity
1☐ Other [please specify] _______________
1☐ My health is not good enough
1☐ I'm active enough
1☐ I'm too old
1☐ Traffic is too heavy
1☐ No motivation
1☐ Too fat/overweight
1☐ I've got young children to look after
1☐ I'm not the sporty type

7. To what extent do you agree or disagree with the following statements about physical activity and health?

(Please tick one box in each row)	Strongly disagree	Disagree	Neither	Agree	Strongly agree
a. Taking the stairs at work or generally being more active for at least 30 minutes each day is enough to improve your health	1☐	2☐	3☐	4☐	5☐
b. Half an hour of brisk walking on most days is enough to improve your health	1☐	2☐	3☐	4☐	5☐
c. To improve your health it is essential for you to do vigorous exercise for at least 20 minutes each time, 3 times a week	1☐	2☐	3☐	4☐	5☐
d. To improve your health exercise doesn't have to be done all at one time, you can build up to 30 minutes by doing blocks of 10 minutes	1☐	2☐	3☐	4☐	5☐
e. Moderate exercise that increases your heart rate slightly can improve your health	1☐	2☐	3☐	4☐	5☐

8. During the past month my work colleagues, friends and family:

(Please tick one box in each row)		Never	Rarely (less than once month)	Sometimes (at least once/month)	Often (once or twice/week)	Very Often (3 or more/week)
Gave me encouragement to be physically active	Family	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
	Colleagues	1☐	2☐	3☐	4☐	5☐

Smoking

1. Have you ever smoked a cigarette, cigar or pipe?
1☐ Yes
2☐ No – go to question 6

2. Do you smoke cigarettes, cigar or pipe nowadays?
1☐ Yes – go to question 2a
2☐ No – go to question 2b

2a. If yes, approximately what age did you start? _____ years old

2b. If no, how long ago did you stop smoking?
1☐ Less than one month
2☐ One to six months
3☐ Seven months to one year
4☐ Over a year

3. If you are presently a smoker, approximately how many cigarettes do you smoke each day?

1☐ 1 – 5
2☐ 6 – 10
3☐ 11 – 20
4☐ 21+

4. If you smoke cigarettes, how soon after waking do you smoke your first cigarette?
1☐ Less than five minutes
2☐ 5-14 minutes
3☐ 15-29 minutes
4☐ 30 minutes or longer

5. Which of the following statements best describes you? *(Please tick one)*
5☐ I intend to give up smoking within the next month
4☐ I intend to give up smoking within the next 6 months
3☐ I intend to give up smoking within the next year
2☐ I intend to give up smoking, but not in the next year
1☐ I have no intention of giving up smoking

6. Do you think that breathing someone else's smoke is dangerous to health?
1☐ Yes
2☐ No

Alcohol

One standard drink means one unit of alcohol. There is one unit of alcohol in each of these drinks:

- A half pint of normal strength beer; *A pint of beer would therefore count as 2 standard drinks.*
- A half a standard (175 ml) glass of wine; *A large 250 ml pub glass of wine about 3 standard drinks.*
- A small single measure of spirits;
- A 50 ml pub measure of fortified wine (such as sherry or port).

1a.

	Never	Monthly or less	2-4 times a month	2-3 times a week	4 or more times a week
How often do you have a standard drink containing alcohol?	1☐	2☐	3☐	4☐	5☐

1b.

	1	2	3	4	5 or more
How many standard drinks containing alcohol do you have on a typical day when you are drinking?	1☐	2☐	3☐	4☐	5☐

2. In the past month, have you consumed?

(Please tick YES or NO for one of the following questions)

For Males:	More than 8 standard drinks in one session	1☐ Yes	2☐ No
For Females:	More than 6 standard drinks in one session	1☐ Yes	2☐ No

3. What do you think is the maximum recommended number of units of alcohol **per day** for men **and** women? (*Please tick one box per row*)

	1-2 units	2-3 units	3-4 units	4-5 units	5-6 units	6-7 units	7-8 units	>8 units
For Men	1☐	2☐	3☐	4☐	5☐	6☐	7☐	8☐
For Women	1☐	2☐	3☐	4☐	5☐	6☐	7☐	8☐

4. During the past month my work colleagues, friends and family:

(Please tick one box in each row)		Never	Rarely (less than once month)	Sometimes (at least once/month)	Often (once or twice/week)	Very Often (3 or more/week)
Gave me encouragement to make healthy drinking (alcohol) choices	Family	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
	Colleagues	1☐	2☐	3☐	4☐	5☐

Thank you for completing the questionnaire!

Appendix 22: GNKQ[263].

Adapted from General nutrition knowledge questionnaire for adults
K Parmenter and J Wardle

THE FIRST FEW ITEMS ARE ABOUT WHAT ADVICE YOU THINK EXPERTS ARE GIVING US

1 Do you think health experts recommend that people should be eating more, the same amount, or less of these foods? *(tick one box per food)*

	More	Same	Less	Not sure
Vegetables	☐	☐	☐	☐
Sugary foods	☐	☐	☐	☐
Meat	☐	☐	☐	☐
Starchy foods	☐	☐	☐	☐
Fatty foods	☐	☐	☐	☐
High fibre foods	☐	☐	☐	☐
Fruit	☐	☐	☐	☐
Salty foods	☐	☐	☐	☐

---

2 How many servings of fruit and vegetables a day do you think experts are advising people to eat?
(One serving could be, for example, an apple or a handful of chopped carrots)

. . . .

---

3 Which fat do experts say is most important for people cut down on*(tick one)*

(a) monounsaturated fat ☐

(b) polyunsaturated fat ☐

(c) saturated fat ☐

(d) not sure ☐

---

4 What version of dairy foods do experts say people should eat?
(tick one)

(a) full fat ☐

(b) lower fat ☐

(c) mixture of full fat and lower fat ☐

(d) neither, dairy foods should be cut out ☐

(e) not sure ☐

EXPERTS CLASSIFY FOODS INTO GROUPS. WE ARE INTERESTED TO SEE WHETHER PEOPLE ARE AWARE OF WHAT FOODS ARE IN THESE GROUPS

5 Do you think these are high or low in added sugar?
(tick one box per food)

	High	Low	Not sure
Bananas	☐	☐	☐
Unflavoured yoghurt	☐	☐	☐
Ice-cream	☐	☐	☐
Orange squash	☐	☐	☐
Tomato ketchup	☐	☐	☐
Tinned fruit in natural juice	☐	☐	☐

6 Do you think these are high or low in fat?
(tick one box per food)

	High	Low	Not sure
Pasta (without sauce)	☐	☐	☐
Low fat spread	☐	☐	☐
Baked beans	☐	☐	☐
Luncheon meat	☐	☐	☐
Honey	☐	☐	☐
Scotch egg	☐	☐	☐
Nuts	☐	☐	☐
Bread	☐	☐	☐
Cottage cheese	☐	☐	☐
Polyunsaturated margarine	☐	☐	☐

7 Do you think experts put these in the starchy foods group?
(tick one box per food)

	Yes	No	Not sure
Cheese	☐	☐	☐
Pasta	☐	☐	☐
Butter	☐	☐	☐
Nuts	☐	☐	☐
Rice	☐	☐	☐
Porridge	☐	☐	☐

8 Do you think these are high or low in salt?
(tick one box per food)

	High	Low	Not sure
Sausages	☐	☐	☐
Pasta	☐	☐	☐
Kippers	☐	☐	☐
Red meat	☐	☐	☐
Frozen vegetables	☐	☐	☐
Cheese	☐	☐	☐

9 Do you think these are high or low in protein?
(tick one box per food)

	High	Low	Not sure
Chicken	☐	☐	☐
Cheese	☐	☐	☐
Fruit	☐	☐	☐
Baked beans	☐	☐	☐
Butter	☐	☐	☐
Cream	☐	☐	☐

10 Do you think these are high or low in fibre/roughage?
(tick one box per food)

	High	Low	Not sure
Cornflakes	☐	☐	☐
Bananas	☐	☐	☐
Eggs	☐	☐	☐
Red Meat	☐	☐	☐
Broccoli	☐	☐	☐
Nuts	☐	☐	☐
Fish	☐	☐	☐
Baked potatoes with skins	☐	☐	☐
	High	Low	Not sure
Chicken	☐	☐	☐
Baked beans	☐	☐	☐

11 Do you think these fatty foods are high or low in saturated fat?
(tick one box per food)

	High	Low	Not sure
Mackerel	☐	☐	☐
Whole milk	☐	☐	☐
Olive oil	☐	☐	☐
Red meat	☐	☐	☐
Sunflower margarine	☐	☐	☐
Chocolate	☐	☐	☐

12 Some foods contain a lot of fat but no cholesterol

(a) agree ☐
(b) disagree ☐
(c) not sure ☐

13 Do you think experts call these a healthy alternative to red meat?
(tick one box per food)

	Yes	No	Not sure
Liver pate	☐	☐	☐
Luncheon meat	☐	☐	☐
Baked beans	☐	☐	☐
Nuts	☐	☐	☐
Low fat cheese	☐	☐	☐
Quiche	☐	☐	☐

14 A glass of unsweetened fruit juice counts as a helping of fruit

(a) agree ☐
(b) disagree ☐
(c) not sure ☐

15 Saturated fats are mainly found in:
(tick one)

(a) vegetable oils ☐
(b) dairy products ☐
(c) both (a) and (b) ☐
(d) not sure ☐

16 Brown sugar is a healthy alternative to white sugar

(a) agree ☐

(b) disagree ☐

(c) not sure ☐

---

17 There is more protein in a glass of whole milk than in a glass of skimmed milk

(a) agree ☐

(b) disagree ☐

(c) not sure ☐

---

18 Polyunsaturated margarine contains less fat than butter

(a) agree ☐

(b) disagree ☐

(c) not sure ☐

---

19 Which of these breads contain the most vitamins and minerals?
(tick one)

(a) white ☐

(b) brown ☐

(c) wholegrain ☐

(d) not sure ☐

---

20 Which do you think is higher in calories: butter or regular margarine?
(tick one)

(a) butter ☐

(b) regular margarine ☐

(c) both the same ☐

(d) not sure ☐

---

21 A type of oil which contains mostly monounsaturated fat is:
(tick one)

(a) coconut oil ☐

(b) sunflower oil ☐

(c) olive oil ☐

(d) palm oil ☐

(e) not sure ☐

---

22 There is more calcium in a glass of whole milk than a glass of skimmed milk

(a) agree ☐

(b) disagree ☐

(c) not sure ☐

---

23 Which one of the following has the most calories for the same weight?
(tick one)

(a) sugar ☐

(b) starchy foods ☐

(c) fibre/roughage ☐

(d) fat ☐

(e) not sure ☐

---

24 Harder fats contain more:
(tick one)

(a) monounsaturates ☐

(b) polyunsaturates ☐

(c) saturates ☐

(d) not sure ☐

---

25 Polyunsaturated fats are mainly found in:
(tick one)

(a) vegetable oils ☐

(b) dairy products ☐

(c) both (a) and (b) ☐

(d) not sure ☐

THE NEXT FEW ITEMS ARE ABOUT CHOOSING FOODS
Please answer what is being asked and not whether you like or dislike the food!
For example, suppose you were asked . . . .
`If a person wanted to cut down on fat, which cheese would be best to eat?'

(a) cheddar cheese

(b) camembert

(c) cream cheese

(d) cottage cheese

If you didn't like cottage cheese, but knew it was the right answer, you would still tick cottage cheese.

---

26 Which would be the best choice for a low fat, high fibre snack?
(tick one)

(a) diet strawberry yoghurt ☐

(b) raisins ☐

(c) muesli bar ☐

(d) wholemeal crackers and cheddar cheese ☐

---

27 Which would be the best choice for a low fat, high fibre light meal?
(tick one)

(a) grilled chicken ☐

(b) cheese on wholemeal toast ☐

(c) beans on wholemeal toast ☐

(d) quiche ☐

---

28 Which kind of sandwich do you think is healthier?
(tick one)

(a) two *thick* slices of bread with a *thin* slice of cheddar cheese filling ☐

(b) two *thin* slices of bread with a *thick* slice of cheddar cheese filling ☐

---

29 Many people eat spaghetti bolognese (pasta with a tomato and meat sauce). Which do you think is healthier?
(tick one)

(a) a *large* amount of pasta with a *little* sauce on top ☐

(b) a *small* amount of pasta with a *lot* of sauce on top ☐

---

30 If a person wanted to reduce the amount of fat in their diet, which would be the best choice?
(tick one)

(a) steak, grilled ☐

(b) sausages, grilled ☐

(c) turkey, grilled ☐

(d) pork chop, grilled ☐

---

31 If a person wanted to reduce the amount of fat in their diet, but didn't want to give up chips, which one would be the best choice?
(tick one)

(a) thick cut chips ☐

(b) thin cut chips ☐

(c) crinkle cut chips ☐

---

32 If a person felt like something sweet, but was trying to cut down on sugar, which would be the best choice?
(tick one)

(a) honey on toast ☐

(b) a cereal snack bar ☐

(c) plain Digestive biscuit ☐

(d) banana with plain yoghurt ☐

---

33 Which of these would be the healthiest pudding?
(tick one)

(a) baked apple ☐

(b) strawberry yoghurt ☐

(c) wholemeal crackers and cheddar cheese ☐

(d) carrot cake with cream cheese topping ☐

---

34 Which cheese would be the best choice as a lower fat option?
(tick one)

(a) plain cream cheese ☐

(b) Edam ☐

(c) cheddar ☐

(d) Stilton ☐

35 If a person wanted to reduce the amount of salt in their diet, which would be the best choice?
(tick one)

(a) ready made frozen shepherd's pie ☐

(b) gammon with pineapple ☐

(c) mushroom omelette ☐

(d) stir fry vegetables with soy sauce ☐

THIS SECTION IS ABOUT HEALTH PROBLEMS OR DISEASES

36 Are you aware of any major health problems or diseases that are related to a *low intake of fruit and vegetables*?

(a) yes ☐

(b) no ☐

(c) not sure ☐

If yes, what diseases or health problems do you think are related to a low intake of fruit and vegetables?

. . . .
. . . .

---

37 Are you aware of any major health problems or diseases that are related to a *low intake of fibre*?

(a) yes	☐
(b) no	☐
(c) not sure	☐

If yes, what diseases or health problems do you think are related to a low intake of fibre?

. . . .

. . . .

38 Are you aware of any major health problems or diseases that are related to *how much sugar* people eat?

(a) yes	☐
(b) no	☐
(c) not sure	☐

If yes, what diseases or health problems do you think are related to sugar?

. . . .
. . . .

39 Are you aware of any major health problems or diseases that are related to *how much salt* or sodium people eat?

(a) yes	☐
(b) no	☐
(c) not sure	☐

If yes, what diseases or health problems do you think are related to salt?

. . . .
. . . .

40 Are you aware of any major health problems or diseases that are related to the *amount of fat* people eat?

(a) yes	☐
(b) no	☐
(c) not sure	☐

If yes, what diseases or health problems do you think are related to fat?

. . . .
. . . .

41 Do you think these help to reduce the chances of getting certain kinds of cancer?
(answer each one)

	Yes	No	Not sure
eating more fibre	☐	☐	☐
eating less sugar	☐	☐	☐
eating less fruit	☐	☐	☐
eating less salt	☐	☐	☐
eating more fruit and vegetables	☐	☐	☐
eating less preservatives/additives	☐	☐	☐

42 Do you think these help prevent heart disease?
(answer each one)

	Yes	No	Not sure
eating more fibre	☐	☐	☐
eating less saturated fat	☐	☐	☐
eating less salt	☐	☐	☐
eating more fruit and vegetables	☐	☐	☐
eating less preservatives/additives	☐	☐	☐

43 Which one of these is more likely to raise people's blood cholesterol level?
(tick one)

(a) antioxidants	☐	☐	☐
(b) polyunsaturated fats	☐	☐	☐
(c) saturated fats	☐	☐	☐
(d) cholesterol in the diet	☐	☐	☐
(e) not sure	☐	☐	☐

44 Have you heard of antioxidant vitamins?

(a) yes ☐

(b) no ☐

45 If YES to question 44, do you think these are antioxidant vitamins?
(answer each one)

	Yes	No	Not sure
Vitamin A	☐	☐	☐
B Complex Vitamins	☐	☐	☐
Vitamin C	☐	☐	☐
Vitamin D	☐	☐	☐
Vitamin E	☐	☐	☐
Vitamin K	☐	☐	☐

FINALLY, WE WOULD LIKE TO ASK YOU A FEW QUESTIONS ABOUT YOURSELF

46 Are you:

(a) single ☐

(b) married ☐

(c) living as married ☐

(d) separated ☐

(e) divorced ☐

(f) widowed ☐

47 What is your ethnic origin?

(a) White ☐

(b) Black Caribbean ☐

(c) Black African ☐

(d) Black other ☐

(e) Indian ☐

(f) Pakistani ☐

(g) Bangladeshi ☐

(h) Chinese ☐

(i) Asian ± other ☐
Please specify:
. . . .

j) Any other ethnic group ☐
Please specify:
. . . .

---

48 Do you have any children?

(a) No ☐

(b) 1 ☐

(c) 2 ☐

(d) 3 ☐

(e) 4 ☐

(f) more than 4 ☐

---

49 What is the highest level of education you have completed?

(a) primary school ☐

(b) secondary school ☐

(c) O levels/GCSEs ☐

(d) A levels ☐

(e) Technical or trade certificate ☐

(f) Diploma ☐

(g) Degree ☐

(g) Post-graduate degree ☐

---

50 Do you have any health or nutrition related qualifications?

(a) Yes ☐
Please specify:
. . . .

(b) No ☐

---

51 Are you on a special diet?

(a) Yes ☐
Please specify:
. . . .

(b) No ☐

Appendix 23: Food diary[264].

INM Study Food Record Card Breakfast

Service No. ________________ Surname, Initials _______ Date_____

	Quantity	Leftovers		How many	Leftovers
Rice krispies & milk	bowls		White Bread/Toast	slices	slices
Cornflakes & milk	bowls		Brown Bread/Toast	slices	slices
Weetabix & milk	bowls		Tomato sauce		
Branflakes & milk	bowls		Brown sauce		
Cocopops & milk	bowls		Salt		
Porridge	bowls		Flora		
Sugar on cereal	spoons		Jam/marmalade		
			Apple/pear		
Sausage			Orange		
Bacon			Banana		
Fried egg			Squash*	ml	
Poached egg			Tea/coffee – black*	ml	
Fried Bread	pieces	pieces	Tea/coffee – white*	ml	
Scrambled egg	spoons	spoons	Sugar in tea/coffee	spoons	
Cooked tomatoes	spoons	spoons	**Other items:**	**How much**	**Leftovers**
Baked beans	spoons	spoons			
Croissant					

* Cup = 200ml, Mug = 300ml, Sports bottle = 500ml or 750ml, black RM bottle = 1L

And Now…..

Foods and Drinks Consumed Since Your Last Meal in the Dining Room

Please list **all** confectionary, food and drink that you have consumed since you last filled out a form: ***(This means any foods/drinks/snacks you ate last night as well)***

Description of Food or Drink	Quantity

INM Study Food Record Card Lunch

Service No. ________________ **Surname, Initials** _______ **Date**_____

	Quantity	Leftovers		How many	Leftovers
Main course: _	spoons/ portions	spoons/ portions	White Bread	slices	slices
			Brown Bread	slices	slices
			Tomato sauce		
Pizza: Topping _ _ _ _ _ _ _ _ _ _ _ _ _ _	slices	slices	Brown sauce		
			Salt		
Baguette:			Salad cream		
Egg	_ _ _ _ _ _	_ _ _ _ _ _	Flora		
Tuna	_ _ _ _ _ _	_ _ _ _ _ _	Apple/pear		
Cheese	_ _ _ _ _ _	_ _ _ _ _ _	Orange		
Meat	_ _ _ _ _ _	_ _ _ _ _ _			
Chips	scoops	scoops	Banana		
Baked half potato			Squash*		
Pasta	spoons	spoons			
Plain Rice	spoons	spoons			
Fried Rice	spoons	spoons	**Other items**	**How much**	**Leftovers**
Vegetables:					
Sweetcorn	_ _ _ _ spoons	_ _ _ _ spoons			
Peas	_ _ _ _ spoons	_ _ _ _ spoons			
Other: _ _ _ _ _ _	_ _ _ _ spoons	_ _ _ _ spoons			
Baked beans	spoons	spoons			
Gravy	ladles	ladles			
Coleslaw	spoons	spoons			
Pasta salad	spoons	spoons			
Green salad	spoons	spoons			

* Cup = 200 ml, Mug = 300ml, Sports bottle = 500ml or 750ml, black RM bottle = 1L

And Now…..

Foods and Drinks Consumed Since Your Last Meal in the Dining Room

Please list **all** confectionary, food and drink that you have consumed since you last filled out a form:

Description of Food or Drink	**Quantity**

INM Study Food Record Card Dinner

Service No. ________________ **Surname, Initials** _______ **Date**________

	Quantity	**Leftovers**		**How many**	**Leftovers**
Main course: __________ ________ __________ ________	spoons/ portions	spoons/ portions	White Bread	slices	slices
			Brown Bread	slices	slices
			Tomato sauce		
Roast Potato	scoops	scoops	Brown sauce		
Boiled Potato	spoons	spoons	Salt		
Plain Rice	spoons	spoons	Salad cream		
Fried Rice	spoons	spoons	Flora		
Vegetables: __________ ________ __________ ________ __________ _______	___ spoons ___ spoons ___ spoons	___ spoons ___ spoons ___ spoons	Apple/pear		
			Orange		
			Banana		
			Squash*	ml	
Gravy	ladles	ladles	**Other items**	**How much**	**Leftovers**
Pudding: __________	spoons/ portions	spoons/ portions			
Custard	ladles	ladles			

* Cup = 200 ml Mug = 300ml, Sports bottle = 500ml or 750ml, black RM bottle = 1L

And Now…..

Foods and Drinks Consumed Since Your Last Meal in the Dining Room

Please list **all** confectionary, food and drink that you have consumed since you last filled out a form:

Description of Food or Drink	**Quantity**

Appendix 24: Physical activity diary.

Please record the activity you do on 4 days.

The 24-hour period has been broken down to 15-minute slots below. Please complete each of these slots.

What you need to do: - Record the **date**, your **Surname**, **Initials** and **Service No** in the box at the top of this page.

- As you go through the day **record the time and types of activities per hour and in 15-minute slots**.

- **Code the activity** with a number from 1 – 7 (see Activity Codes) and **fill in each 15-minute slot** with that number.

	Midnight-01:00				01:00 – 02:00				02:00 – 03:00				03:00 – 04:00				04:00 – 05:00				05:00 – 06:00				06:00 – 07:00				07:00 – 08:00			
Activity Code																																
	08:00 – 09:00				09:00 – 10:00				10:00 – 11:00				11:00 – 12:00				12:00 – 13:00				13:00 – 14:00				14:00 – 15:00				15:00 – 16:00			
Activity Code																																
	16:00 – 17:00				17:00 – 18:00				18:00 – 19:00				19:00 – 20:00				20:00 – 21:00				21:00 – 22:00				22:00 – 23:00				23:00 - Midnight			
Activity Code																																

Activity Codes:

1 = Sleeping

2 = Sitting (eating at table, reading, desk duties/ computer based work)

3 = Relaxing (watching TV, watching a film or playing on computer)

4 = Standing (personal admin, watch duty)

5 = Light activity (general ship duties, unloaded transit around ship, climbing up/down ladders)

6 = Moderate activity (manual handling tasks, loaded transit around ship, moving equipment)

7 = Intense activity (maximum effort, fire fighting, shoring, emergency drills, physical training)

Appendix 25: Summary table of results.

Variable (units)			Statistic	HMS Defender 'control ship'		HMS Duncan 'intervention ship'	
				Pre-deployment	End-deployment	Pre-deployment	End-deployment
1	Weight (kg)		Mean (SD)	84.7 (13.2)	84.2 (12.5)	87.1 (14.3)	84.7 (12.8)
2	Waist circumference (cm)		Mean (SD)	89.2 (11.7)	88.1 (10.0)	88.2 (11.8)	86.1 (9.7)
3	BMI ($kg.m^{-2}$)		Mean (SD)	27.2 (3.6)	27.0 (3.3)	27.1 (3.8)	26.3 (3.3)
4	NICE risk classification at 'any risk'		%	34	28	26	23
5	General health 'good or very good'		%	59	74	54	69
6-14	Dietary intake	Energy intake (kcal)	Mean (SD)	2436 (660)	2263 (486)	2328 (597)	2021 (569)
		Energy from protein (%)	Mean (SD) / Median (IQR)	20 (3)	20 (4)	19 (16-22)	21 (18-23)
		EI from carbohydrate (%)	Mean (SD)	37 (7)	36 (5)	37 (6)	34 (7)
		EI from total fat (%)	Mean (SD)	42 (5)	41 (5)	41 (5)	42 (6)
		EI from saturated fat (%)	Mean (SD)	15 (3)	13 (3)	11 (2)	13 (2)
		Sugar (g)	Median (IQR)	65.3 (48.7-104.6)	58.0 (38.8-83.1)	86.5 (38.6)	65.0 (33.3)
		Dietary fibre (g)	Mean (SD)	21.0 (8.1)	20.7 (7.0)	20.1 (6.9)	17.7 (6.1)
		Salt (g)	Median (IQR) / Mean (SD)	6.8 (5.1-8.6)	9.4 (6.9-11.7)	7.3 (2.2)	7.8 (2.4)
		Protein supplement usage	%	18	22	28	35
15-26	Proportion meeting dietary recommendations	Percentage EI from carbohydrate >50%	%	0	5	1	1
		Percentage EI from total fat <35%	%	10	10	7	12
		Percentage EI from saturated fat <11%	%	6	24	48	21
		Sugar <90 g	%	68	78	44	81
		Dietary fibre >23 g	%	35	32	28	16
		Salt <6 g	%	38	14	32	21
		Fruit and vegetables: ≥5 portions a day	%	49	49	47	54
		Starchy foods consumed at every meal	%	59	56	57	42
		Fish: 2 portions a week	%	28	25	12	17
		Red and processed meat: <90 g per day	%	2	3	1	3
		Dairy: 2-3 portions a day	%	6	5	17	8
		Fluid: 8 glasses a day	%	21	33	21	39

Variable (units)			Statistic	HMS Defender 'control ship'		HMS Duncan 'intervention ship'	
				Pre-deployment	End-deployment	Pre-deployment	End-deployment
27	PAL		Median (IQR)	1.9 (1.6-2.2)	1.8 (1.5-2.0)	1.8 (1.6-2.0)	1.8 (1.6-2.0)
28	EE (kcal)		Mean (SD)	3433 (696)	3265 (765)	3461 (870)	3354 (836)
29	Membership of sport and exercise groups/clubs		%	20	31	26	50
30	Current smokers		%	31	27	14	13
31	Frequency of alcohol consumption: '2+ times a week'		%	40	20	39	22
32	Binge drinking		%	71	78	72	57
33-34	Stage of change 'action and maintenance'	Diet	%	38	62	22	67
		Physical activity	%	58	72	40	74
35-36	Self-efficacy	Diet	Mean (SD)	1.9 (0.5)	1.9 (0.5)	2.0 (0.5)	2.0 (0.6)
		Physical activity	Mean (SD)	2.0 (0.5)	2.0 (0.6)	2.1 (0.7)	2.1 (0.6)
37-39	Social support	Diet	Mean (SD)	2.4 (1.1)	2.1 (1.1)	2.5 (0.9)	2.3 (1.2)
		Physical activity	Mean (SD)	2.6 (1.2)	2.5 (1.3)	2.6 (1.1)	2.7 (1.2)
		Alcohol	Median (IQR)	1.7 (1.0-2.3)	1.0 (1.0-2.0)	2.0 (1.0-2.0)	1.0 (1.0-2.0)
40-43	Knowledge	Nutrition	Mean (SD)	55 (10)	57 (10)	55 (10)	57 (10)
		Physical activity	Median (IQR)	72 (64-80)	76 (72-84)	76 (68-80)	76 (69-80)
		Smoking	%	98	96	97 (82)	99 (84)
		Alcohol	%	44	42	42 (39)	33 (31)

Note: orange, no significant change; green, (decreasing/increasing) getting better; red, (decreasing/increasing) getting worse.

Appendix 26: Intervention ship study sample size.

		Variable	**Pre-, end-deployment n**
Ship size *n* 241	Study sample size *n* 115	NICE risk	103
		Alcohol frequency Binge drinking Alcohol knowledge	94
		Smoking history Dietary stage of change Alcohol social support	93
		Alcohol units Sports club membership Diet social support Physical activity knowledge Barriers to physical activity	92
		Food groups Diet self efficacy Physical activity self efficacy Physical activity social support	91
		Physical activity stage of change	90
		Nutrition knowledge	88
		Physical activity levels Energy expenditure Smoking knowledge	85
		Dietary intake	75
		Smoking stage of change	5

Appendix 27: Additional end-deployment questions[262].

1. Have any of the following been provided onboard your ship during your deployment?

		Yes	No
a.	Healthy lifestyle information e.g. leaflets/ posters on healthy eating	1☐	2☐
b.	Taster events e.g. sports	1☐	2☐
c.	Seminars, presentations, demonstrations e.g. healthy eating brief	1☐	2☐
d.	Activity classes e.g. circuits, spinning	1☐	2☐
e.	Activity clubs/ challenges e.g. row the Suez	1☐	2☐
f.	Diet and nutrition initiatives	1☐	2☐
g.	Weight management programme e.g. Biggest Loser	1☐	2☐
h.	Alcohol and drug initiatives	1☐	2☐
i.	Stop smoking initiatives	1☐	2☐
j.	Health screening initiative e.g. regular measurements of waist or weight	1☐	2☐
k.	Healthy eating facilities e.g. improvements in NAAFI or Galley provision	1☐	2☐
l.	Other initiatives Please detail: ________________________________	1☐	2☐

2. Please list and provide details for all the activities (see list above for a reminder) you have participated in onboard your ship during your deployment.

What did you think?

1. Did the activities that you participated in during your deployment...
(Please tick one box in each row)

	Strongly agree 1	Agree 2	Neither agree or disagree 3	Disagree 4	Strongly disagree 5	Not applicable 0
a. help you to…						
improve your health	☐	☐	☐	☐	☐	☐
be more physically active	☐	☐	☐	☐	☐	☐
quit smoking	☐	☐	☐	☐	☐	☐
eat more healthily	☐	☐	☐	☐	☐	☐
drink less alcohol	☐	☐	☐	☐	☐	☐
lose weight	☐	☐	☐	☐	☐	☐
reduce stress	☐	☐	☐	☐	☐	☐
improve your performance at work	☐	☐	☐	☐	☐	☐
b. give you more opportunity to…						
be physically active	☐	☐	☐	☐	☐	☐
eat more healthily	☐	☐	☐	☐	☐	☐
c. make you more motivated to…						
be more physically active	☐	☐	☐	☐	☐	☐
quit smoking	☐	☐	☐	☐	☐	☐
eat more healthily	☐	☐	☐	☐	☐	☐
drink less alcohol	☐	☐	☐	☐	☐	☐
d. make it more affordable to…						
be physically active	☐	☐	☐	☐	☐	☐
eat more healthily	☐	☐	☐	☐	☐	☐
e. change the way you feel about…						
your health	☐	☐	☐	☐	☐	☐
being physically active	☐	☐	☐	☐	☐	☐
quitting smoking	☐	☐	☐	☐	☐	☐
eating more healthily	☐	☐	☐	☐	☐	☐
drinking alcohol	☐	☐	☐	☐	☐	☐
your job	☐	☐	☐	☐	☐	☐

2. Please add any recommendations that you have for future changes onboard RN ships with regards to a healthy lifestyle intervention.

Thank you for completing the questionnaire!

Appendix 28: Intervention resource list.

Section	Logframe performance indicator	Activity	Lead	Delivered as intended?
Command	2.1.2	Discussion with ship's Command to mandate PFS throughout the deployment	INM/XO	Yes
Fleet Catering	1.5.1	Increase in DMR for ship over the deployment	Fleet Catering WO	Yes
Catering Services and NAAFI	1.2.1a	Nutrition education brief developed for chefs	INM	Yes
	1.2.5a	Healthy menu plans developed for chefs	INM/Fleet Catering WO/LO/head chef	Yes
	1.2.5b	Healthy menu guidance document and recipe document developed for chefs	INM	Yes
	1.3.1	Meeting with food supplier to identify healthy food options for procurement	INM/Fleet Catering WO	Yes
	1.4.1	Discussion with LO to identify and prioritise healthy foods to be resupplied during the deployment	INM/LO	Yes
	1.2.4	Meeting with NAAFI manager to identify options for procurement	INM/NAAFI manager	Yes
Sickbay & Physical training	1.6.1, 2.4.1	Port stop briefs, joining routine briefs, nutrition factsheets and posters and healthy lifestyle quiz developed for ship	INM	Yes
	2.3.1	PTI sourced extra cardiovascular and strength training exercise equipment	PTI/HMS Temeraire	Yes
	2.4.2	Sport and exercise nutrition briefs developed for PTI	INM	Yes
	3.2.1	Measurement guide for WMP developed for MO/PTI	INM	Yes
	3.2.2	Individual feedback form developed for WMP	INM	Yes
	3.2.3	Briefs and workshops developed for WMP	INM	Yes
	3.2.4	Behaviour change resources developed for WMP	INM	Yes
	3.2.5	Spread sheet to record physical measurements and display % changes developed for WMP	INM	Yes
	3.2.6	Health promotion resources developed for WMP	INM	Yes

References

1. Royal Navy. *What we do*. Available from: http://www.royalnavy.mod.uk (accessed 30 Aug 2016).

2. Royal Navy. *The equipment*. Available from: http://www.royalnavy.mod.uk (accessed 20 Aug 2016).

3. Ministry of Defence. *Royal Navy and Royal Marines Monthly Personnel Situation Report for 1 October 2017*. Ministry of Defence. 2017.

4. Ministry of Defence. *UK Armed Forces Biannual Diversity Statistics 1 October 2017*. Ministry of Defence. 2017.

5. Ministry of Defence. *Freedom of Information Request 2017-04461*. Ministry of Defence. 2017.

6. ArmedForces.co.uk. *Royal Navy Pay Scales*. Available from: http://www.armedforces.co.uk/royalnavypayscales (accessed 7 Jan 2019).

7. Royal Navy. *BRd 51*. Royal Navy. 2015.

8. National Institute for Health and Care Excellence (NICE). *Obesity: identification, assessment and management: NICE Guideline [CG189]*. 2014.

9. Ministry of Defence. *Joint Services Publication 950. Medical Policy.* Ministry of Defence. 2017.

10. Royal Navy. *BRd 3*. Royal Navy. 2011.

11. Ministry of Defence. *Armed Forces Weight Management Policy*. Ministry of Defence. 2017.

12. Maio G, Manstead A, Verplanken B, et al. Tackling Obesities: Future Choices - Lifestyle Change - Evidence Review. Government Office for Science. 2007.

13. Buttriss J, Stanner S, McKevith B, et al. Successful ways to modify food choice: lessons from the literature. *Nutrition Bulletin.* 2004;29(4):333-343.

14. Booth SL, Sallis JF, Ritenbaugh C, et al. Environmental and societal factors affect food choice and physical activity: rationale, influences, and leverage points. *Nutrition Reviews.* 2001;59(3):S21-S36.

15. Wardle J. Eating behaviour and obesity. *Obesity Reviews.* 2007;8(s1):73-75.

16. Scholes S, Mindell J. *Health Survey for England 2012. Physical activity in adults.* London, UK, 2013.

17. Bates B, Cox L, Nicholson S, et al. National Diet and Nutrition Survey: Results from Years 5 and 6 (Combined) of the Rolling Programme (2012/2013–2013/2014). London: Public Health England; 2016.

18. Fallowfield J, Delves S, Brown P, et al. *Surgeon General’s Armed Forces Feeding Project: Operational Feeding Onboard Ship (HMS Dauntless)*. Institute of Naval Medicine. Report number: 2012.009, 2012.

19. Fallowfield J, Delves S, Shaw A, et al. *Surgeon General’s Armed Forces Feeding Project: Operational Feeding Onboard Ship (HMS Daring)*. Institute of Naval Medicine. Report number: 2013.028, 2013.

References

20. McArthur AJ. *Evaluation of fruit and vegetable intakes and dietary quality in Royal Naval personnel deployed at sea: effects on energy intake, body composition and acid-base balance.* Nutrition Society Conference; 2013; London, UK

21. Oakley L. *An investigation into dairy product consumption in Royal Naval Personnel during Deployment: Effects on Health Outcomes*. BSc Thesis. University of Surrey; 2013.

22. Martinez JA. Body-weight regulation: causes of obesity. *Proceedings of the Nutrition Society.* 2000;59(3):337-345.

23. Prentice AM, Jebb SA. Obesity in Britain: gluttony or sloth? *British Medical Journal*. 1995;311(7002):437-439.

24. Conolly A, Davies B. *Health Survey for England 2017. Adult and child overweight and obesity*. London, UK, 2018.

25. Public Health England. *Making the Case for Tackling Obesity – Why Invest?* [Presentation]. 2015.

26. Calle EE, Rodriguez C, Walker-Thurmond K, et al. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of US adults. *New England Journal of Medicine.* 2003;348(17):1625-1638.

27. Bray GA. Medical consequences of obesity. *The Journal of Clinical Endocrinology and Metabolism*. 2004;89(6):2583-2589.

28. World Health Organization. *Obesity and Overweight, Factsheet No 311*. Geneva: World Health Organization; 2012.

29. Kopelman P. Health risks associated with overweight and obesity. *Obesity Reviews*. 2007;8(s1):13-17.

30. Allsopp AJ, Scarpello EG, Andrews S, et al. Survival of the fittest? The scientific basis for the Royal Navy pre-joining fitness test. *Journal of the Royal Naval Medical Service.* 2003;89(1):11-18.

31. Bennett A, Brasher K, Bridger R. Body Mass Index and Changes in Body Mass in Royal Navy Personnel 2007-2011. Institute of Naval Medicine. Report number: 2011.044, 2011.

32. Dziubak A, House C, Taylor R, et al. *Surgeon General's Armed Forces Feeding Project:An evaluation of physical training progression, dietary intake and bone health in Royal Navy Phase-1 Recruits at HMS Raleigh*. Institute of Naval Medicine. Report number: 2011.042, 2011.

33. Fallowfield J, Cobley R, Delves S, et al. *Surgeon General's Armed Forces Feeding Project: An evaluation of physical training progression and dietary intake during Royal Navy Initial Officer Training*. Institute of Naval Medicine. Report number: 2010.038, 2010.

34. Kilminster S, Roiz de Sa D, Bridger R. *Obesity in the Royal Naval Service*. Institute of Naval Medicine. Report number: 2008.019, 2008.

35. Sundin J, Fear NT, Wessely S, et al. Obesity in the UK Armed Forces: risk factors. *Military Medicine*. 2011;176(5):507-512.

36. Wood P. *The prevalence of UK service personnel at risk of obesity related ill health*. Dstl. Report number: DSTL/TR27252, 2007.

37. Ministry of Defence. *Freedom of Information Request FOI2016/08149*. Ministry of Defence. 2016.

38. Spencer EA, Appleby PN, Davey GK, et al. Validity of self-reported height and weight in 4808 EPIC–Oxford participants. *Public Health Nutrition*. 2002;5(4):561-565.

39. World Health Organization. *Obesity: preventing and managing the global epidemic*. Geneva: World Health Organization; 2000.

40. Craig R, Mindell J (eds.). *Health Survey for England 2010*. London, UK, 2011.

41. Bridger R, Munnoch K, Dew A, et al. Smoking, BMI and psychological strain and fitness in the Naval Service. *Occupational Medicine.* 2009;59(3):195-196.

42. Lloyd J. *Obesity and Deployability: Empirical Evidence from the UK Armed Forces (Royal Navy Case Study): DFNWM WG Briefing Note*. Ministry of Defence. 2017.

43. Bridger RS, Brasher K, Bennett A. Sustaining person-environment fit with a changing workforce. *Ergonomics*. 2013;56(3):565-577.

44. Kress AM, Peterson MR, Hartzell MC. Association between obesity and depressive symptoms among US Military active duty service personnel, 2002. *Journal of Psychosomatic Research*. 2006;60(3):263-271.

45. Kyröläinen H, Häkkinen K, Kautiainen H, et al. Physical fitness, BMI and sickness absence in male military personnel. *Occupational Medicine*. 2008;58(4):251-256.

46. Lloyd J. *Obesity and Deployabilty: Does Size Matter?* Tri-Service Occupational Health Symposium; 2017; Sandhurst, UK.

47. McLaughlin R, Wittert G. The obesity epidemic: implications for recruitment and retention of defence force personnel. *Obesity Reviews*. 2009;10(6):693-699.

48. Dall TM, Zhang Y, Chen YJ, et al. Cost Associated with Being Overweight and with Obesity, High Alcohol Consumption, and Tobacco Use within the Military Health System's TRICARE Prime—Enrolled Population. *American Journal of Health Promotion*. 2007;22(2):120-139.

49. Ministry of Defence. *UK Armed Forces Quarterly Personnel Report 1 April 2012*. Ministry of Defence. 2012.

50. Ministry of Defence. *Strategic Defence and Security Review*. Ministry of Defence. 2010.

51. Ministry of Defence. *UK Armed Forces Monthly Service Personnel Statistics 1 October 2017.* Ministry of Defence. 2017.

52. Ministry of Defence. *Annual Medical Discharges in the UK Regular Armed Forces. 1 April 2013 to 31 March 2018*. Ministry of Defence. 2018.

53. Bray GA. Obesity-A Disease of Nutrient or Energy Balance? *Nutrition Reviews*. 1987;45(4):33-43.

54. Butland B, Jebb S, Kopelman P, et al. *Foresight. Tackling obesities: future choices. Project report. Foresight. Tackling obesities: future choices. Project report*. London: Government Office for Science; 2007.

55. Vandenbroeck P, Goossens J, Clemens M. *Foresight: Tackling Obesities: Future Choices. Obesity System Atlas*. London: Government Office for Science; 2007.

56. Jones A, Bentham G, Foster C, et al. *Obesogenic environments: evidence review. Foresight tackling obesities: future choices project*. London: Government Office for Science; 2007.

57. Sharpe B, Parry V, Dubhthaigh R, et al. *Tackling Obesities: Future Choices - Future trends in technology and their impact on Obesity. Report for Foresight*. London: Government Office for Science; 2007.

58. Department of Health. *Healthy Weight, Healthy lives: A Cross-Government Strategy for England*. London: Department of Health; 2008.

59. Hawkes C, Ahern AL, Jebb SA. A stakeholder analysis of the perceived outcomes of developing and implementing England's obesity strategy 2008–2011. *BMC public health* 2014;14(1):441.

60. Department of Health. *Healthy Lives, Healthy People: A call to action on obesity in England*. London: Department of Health; 2011.

61. British Nutrition Foundation. *White paper consultation - Healthy lives, healthy people: our strategy for public health in England*. London: British Nutrition Foundation; 2011.

62. Nuffield Council on Bioethics. The intervention ladder. From Chapter 3: Policy process and practice. In *Public Health Ethical Issues*. London: Nuffield Council on Bioethics; 20077.

63. Jebb SA, Aveyard P, Hawkes C. The evolution of policy and actions to tackle obesity in E ngland. *Obesity Reviews.* 2013;14:42-59.

64. House of Lords Science and Technology Select Committee. *Behaviour Change: 2nd Report of Session 2010-12.* London: The Stationary Office Limited; 2011.

65. National Obesity Forum. *Obesity in the UK: Analysis and Expectations*. 2014. Available from: http://www.nationalobesityforum.org.uk (accessed 7 Jan 2019).

66. National Institute for Health and Care Excellence (NICE). *Obesity: working with local communities: NICE Guideline [PH42]*. 2012.

67. Local Government Association. *Health in All Policies: a manual for local government*. London: LGA; 2016.

68. Garside R, Pearson M, Hunt H, et al. *Identifying the key elements and interactions of a whole system approach to obesity prevention*. Exeter: Peninsula Technology Assessment Group (PenTAG), University of Exeter (for NICE); 2010.

69. OECD. *Systems Approaches to Public Sector Challenges: Working with Change*. 2017. Available from: https://www.oecd.org/publications/systems-approaches-to-public-sector-challenges-9789264279865-en.htm (accessed 8 Aug 2019).

70. Lee BY, Bartsch SM, Mui Y, et al. A systems approach to obesity. *Nutrition Reviews*. 2017;75(suppl_1):94-106.

71. Hunt H, Anderson R, Coelho H, et al. The effectiveness of Whole System Approaches to prevent obesity. 2011. Available from: https://www.nice.org.uk (accessed 4 Aug 2018).

72. Pearson M, Garside R, Fry- Smith A, et al. *Preventing obesity using a "whole system" approach at local and community level. Barriers and facilitators to effective whole system approaches*. 2011. Available from: https://www.nice.org.uk (accessed 4 Aug 2018).

73. Bagnall A, Radley D, Jones R, et al. Whole systems approaches to obesity and other complex public health challenges: a systematic review. *BMC Public Health*. 2019;19(1):8.

74. Royal Society for Public Health. Whole Systems Obesity Programme. Perspectives in *Public Health*. 2017;137(3):146-147.

75. Local Government Association. *Making obesity everybody's business. A whole systems approach to obesity. A briefing for elected members.* London: LGA; 2017.

76. Tedstone A. *Implementing the Whole Systems Approach to obesity*. Available from: https://publichealthmatters.blog.gov.uk/2018/07/11/implementing-the-whole-systems-approach-to-obesity (accessed 14 Jan 2019).

77. McLeroy KR, Bibeau D, Steckler A, et al. An ecological perspective on health promotion programs. *Health Education Quarterly*. 1988;15(4):351-377.

78. Ministry of Defence. *Joint Services Publication 456: Defence Catering Manual*. Ministry of Defence. 2014.

79. Scientific Advisory Committee on Nutrition. *SACN Statement on Military Dietary Reference Values for Energy*. London: Public Health England; 2016.

80. Public Health England. *Eatwell Guide*. London: Public Health England; 2016.

81. Frieden TR. A framework for public health action: the health impact pyramid. *American Journal of Public Health*. 2010;100(4):590-595.

82. O'Grady MC. *Request for Scientific Support from the INM*. Ministry of Defence. 2013.

83. Quintiliani L, Sattelmair J, Sorensen G. *The workplace as a setting for interventions to improve diet and promote physical activity*. Geneva: World Health Organization; 2007.

84. World Health Organization. *The Ottawa Charter for Health Promotion: First International Conference on Health Promotion, Ottawa, 21 November 1986*. Geneva: World Health Organization; 1986.

85. World Health Organization. *Global Strategy on Diet Physical Activity and Health*. Geneva: World Health Organization; 2004.

86. Task Force on Community Preventive Services. A recommendation to improve employee weight status through worksite health promotion programs targeting nutrition, physical activity, or both. *American Journal of Preventive Medicine*. 2009;37(4):358-359.

87. Hollands GJ, Shemilt I, Marteau TM, et al. Altering micro-environments to change population health behaviour: towards an evidence base for choice architecture interventions. *BMC Public Health*. 2013;13(1):1218.

88. Mhurchu CN, Aston LM, Jebb SA. Effects of worksite health promotion interventions on employee diets: a systematic review. *BMC Public Health*. 2010;10(1):62.

89. Glanz K, Sorensen G, Farmer A. The health impact of worksite nutrition and cholesterol intervention programs. *American Journal of Health Promotion*. 1996;10(6):453-470.

90. Holdsworth M, Haslam C. A review of point-of-choice nutrition labelling schemes in the workplace, public eating places and universities. *Journal of Human Nutrition and Dietetics*. 1998;11(5):423-445.

91. Seymour JD, Yaroch AL, Serdula M, et al. Impact of nutrition environmental interventions on point-of-purchase behavior in adults: a review. *Preventive Medicine*. 2004;39:108-136.

92. Maes L, Van Cauwenberghe E, Van Lippevelde W, et al. Effectiveness of workplace interventions in Europe promoting healthy eating: a systematic review. *The European Journal of Public Health.* 2012;22(5):677-683.

93. Schröer S, Haupt J, Pieper C. Evidence-based lifestyle interventions in the workplace—an overview. *Occupational Medicine*. 2013;64(1):8-12.

94. Matson-Koffman DM, Brownstein JN, Neiner JA, et al. A site-specific literature review of policy and environmental interventions that promote physical activity and nutrition for cardiovascular health: what works? *American Journal of Health Promotion*. 2005;19(3):167-193.

95. Grech A, Allman-Farinelli M. A systematic literature review of nutrition interventions in vending machines that encourage consumers to make healthier choices. *Obesity Reviews*. 2015;16(12):1030-1041.

96. Abraham C, Graham-Rowe E. Are worksite interventions effective in increasing physical activity? A systematic review and meta-analysis. *Health Psychology Review*. 2009;3(1):108-144.

97. Dugdill L, Brettle A, Hulme C, et al. Workplace physical activity interventions: a systematic review. *International Journal of Workplace Health Management*. 2008;1(1):20-40.

98. Conn VS, Hafdahl AR, Cooper PS, et al. Meta-analysis of workplace physical activity interventions. *American Journal of Preventive Medicine*. 2009;37(4):330-339.

99. To QG, Chen TT, Magnussen CG, et al. Workplace physical activity interventions: a systematic review. *American Journal of Health Promotion*. 2013;27(6):e113-e123.

100. Mozaffarian D, Afshin A, Benowitz NL, et al. Population approaches to improve diet, physical activity, and smoking habits. *Circulation*. 2012;126(12):1514-1563.

101. Kahn-Marshall JL, Gallant MP. Making Healthy Behaviors the Easy Choice for Employees A Review of the Literature on Environmental and Policy Changes in Worksite Health Promotion. *Health Education and Behavior*. 2012;39(6):752-776.

102. Engbers LH, van Poppel MN, Paw MJCA, et al. Worksite health promotion programs with environmental changes: a systematic review. *American Journal of Preventive Medicine.* 2005;29(1):61-70.

103. Anderson LM, Quinn TA, Glanz K, et al. The effectiveness of worksite nutrition and physical activity interventions for controlling employee overweight and obesity: a systematic review. *American Journal of Preventive Medicine*. 2009;37(4):340-357.

104. Verweij L, Coffeng J, van Mechelen W, et al. Meta-analyses of workplace physical activity and dietary behaviour interventions on weight outcomes. *Obesity Reviews*. 2011;12(6):406-429.

105. Gudzune K, Hutfless S, Maruthur N, et al. Strategies to prevent weight gain in workplace and college settings: a systematic review. *Preventive Medicine*. 2013;57(4):268-277.

106. Geaney F, Kelly C, Greiner B, et al. The effectiveness of workplace dietary modification interventions: a systematic review. *Preventive Medicine*. 2013;57(5):438-447.

107. Dishman RK, Oldenburg B, O'Neal H, et al. Worksite physical activity interventions. *American Journal of Preventive Medicine.* 1998;15(4):344-361.

108. Malik SH, Blake H, Suggs LS. A systematic review of workplace health promotion interventions for increasing physical activity. *British Journal of Health Psychology*. 2014;19(1):149-180.

109. Marshall A. Challenges and opportunities for promoting physical activity in the workplace. *Journal of Science and Medicine in Sport.* 2004;7(1):60-66.

110. Eves FF, Webb OJ. Worksite interventions to increase stair climbing; reasons for caution. *Preventive Medicine*. 2006;43(1):4-7.

111. Chau JY, van der Ploeg HP, Van Uffelen JG, et al. Are workplace interventions to reduce sitting effective? A systematic review. *Preventive Medicine*. 2010;51(5):352-356.

112. Allan J, Querstret D, Banas K, et al. Environmental interventions for altering eating behaviours of employees in the workplace: a systematic review. *Obesity Reviews*. 2017;18(2):214-226.

113. Hutchinson AD, Wilson C. Improving nutrition and physical activity in the workplace: a meta-analysis of intervention studies. *Health Promotion International*. 2012;27(2):238-249.

114. Sorensen G, Linnan L, Hunt MK. Worksite-based research and initiatives to increase fruit and vegetable consumption. *Preventive Medicine*. 2004;39:94-100.

115. Glanz K, Rimer BK, Viswanath K (eds.). *Health behavior and health education: theory, research, and practice* (4th ed.). New York, US: John Wiley & Sons; 2008. p465-482.

116. Green LW, Richard L, Potvin L. Ecological foundations of health promotion. *American Journal of Health Promotion*. 1996;10(4):270-281.

117. Sallis JF, Cervero RB, Ascher W, et al. An ecological approach to creating active living communities. *Annual Review of Public Health*. 2006;27:297-322.

118. Moher D, Liberati A, Tetzlaff J, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *Annals of Internal Medicine*. 2009;151(4):264-269.

119. The World Bank Group. *World Bank Country and Lending Groups*. Available from: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups. (accessed 1 Sep 2017).

120. National Institute for Health and Care Excellence (NICE). *Methods for the development of NICE public health guidance: NICE Guideline [PMG4]*. 2012.

121. Higgins JP, Altman DG, Gøtzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *British Medical Journal*. 2011;343:d5928.

122. Sterne JA, Hernan MA, Reeves BC, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *British Medical Journal.* 2016;355:i4919.

123. Hoffmann TC, Glasziou PP, Boutron I, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *British Medical Journal.* 2014;348:g1687.

124. Michie S, Richardson M, Johnston M, et al. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine*. 2013;46(1):81-95.

125. Wilson D. *Practical Meta-Analysis Effect Size Calculator.* Available from: https://www.campbellcollaboration.org/escalc/html/EffectSizeCalculator-Home.php. (accessed 5 Nov 2017).

126. Belanger BA, Kwon J. Effectiveness of Healthy Menu Changes in a Nontrainee Military Dining Facility. *Military Medicine*. 2016;181(1):82-89.

127. Bingham CML, Lahti-Koski M, Puukka P, et al. Effects of a healthy food supply intervention in a military setting: positive changes in cereal, fat and sugar containing foods. *International Journal of Behavioral Nutrition and Physical Activity*. 2012;9:91.

128. Crombie AP, Funderburk L, Smith TJ, et al. Effects of Modified Foodservice Practices in Military Dining Facilities on Ad Libitum Nutritional Intake of US Army Soldiers. *Journal of the Academy of Nutrition and Dietetics*. 2013;113(7):920-927.

129. Friedl KE, Klicka MV, King N, et al. Effects of reduced fat intake on serum lipids in healthy young men and women at the U.S. Military Academy. *Military Medicine*. 1995;160(10):527-533.

130. Hjarnoe L, Leppin A. Health promotion in the Danish maritime setting: Challenges and possibilities for changing lifestyle behavior and health among seafarers. *BMC Public Health*. 2013;13(1):1165.

131. Lassen A, Thorsen AV, Trolle E, et al. Successful strategies to increase the consumption of fruits and vegetables: Results from the Danish '6 a day' Work-site Canteen Model Study. *Public Health Nutrition*. 2004;7(2):263-270.

132. Sproul AD, Canter DD, Schmidt JB, et al. Does point-of-purchase nutrition labeling influence meal selections? A test in an Army cafeteria. *Military Medicine*. 2003;168(7):556-560

133. Thorsen AV, Lassen AD, Tetens I, et al. Long-term sustainability of a worksite canteen intervention of serving more fruit and vegetables. *Public Health Nutrition*. 2010;13(10):1647-1652.

134. Uglem S, Kjollesdal MKR, Frolich W, et al. Effect of a Nutrition Intervention on Intake of Vegetables, Fruits, and Semi Whole Grain Bread Among Low and High Consumers in the Norwegian National Guard. *Military Medicine*. 2014;179(9):1013-1020.

135. Uglem S, Stea TH, Kjollesdal MKR, et al. A nutrition intervention with a main focus on vegetables and bread consumption among young men in the Norwegian National Guard. *Food and Nutrition Research.* 2013;57: doi: 10.3402/fnr.v57i0.21036.

136. Fiedler ER, Cortner DM, Ktenidis H, et al. Healthy eating in practice: The US Air Force demonstration at basic military training. *Applied and Preventive Psychology*. 1999;8(3):155-163.

137. Harden A, Peersman G, Oliver S, et al. A systematic review of the effectiveness of health promotion interventions in the workplace. *Occupational Medicine*. 1999;49:540-548.

138. Nittari G, Tomassoni D, Di Canio M, et al. Overweight among seafarers working on board merchant ships. *BMC Public Health*. 2019;19(1):45.

139. Hjarnoe L, Leppin A, Hjarnoe L, et al. A risky occupation? (Un)healthy lifestyle behaviors among Danish seafarers. *Health Promotion International*. 2014;29(4):720-729.

140. Gregg MA, Jankosky CJ. Physical readiness and obesity among male US Navy personnel with limited exercise availability while at sea. *Military Medicine*. 2012;177(11):1302-1307.

141. Sedek R, Koon PB, Noor IM. Body mass index and body composition among Royal Malaysian Navy (RMN) Personnel. *Journal of Defence Security*. 2010;1(1):1-18.

142. Sanderson PW, Clemes SA, Biddle SJ. Prevalence and socio-demographic correlates of obesity in the British Army. *Annals of human biology* 2014;41(3):193-200.

143. Heinrich KM, Jitnarin N, Suminski RR, et al. Obesity classification in military personnel: a comparison of body fat, waist circumference, and body mass index measurements. *Military Medicine*. 2008;173(1):67-73.

144. Prentice AM, Jebb SA. Beyond body mass index. Obesity Reviews. 2001;2(3):141-147.

145. National Institute for Health and Care Excellence (NICE). *Obesity guidance on the prevention, identification, assessment and management of overweight and obesity in adults and children: NICE Guideline [CG43]*. 2006.

146. Jebb S. Dietary determinants of obesity. *Obesity Reviews*. 2007;8(s1):93-97.

147. Nestle M, Wing R, Birch L, et al. Behavioral and social influences on food choice. *Nutrition Reviews*. 1998;56(5):50-64.

148. Shepherd R. Social determinants of food choice. *Proceedings of the Nutrition Society*. 1999;58(4):807-812.

149. Research and Technology Organisation. *Nutrition Science and Food Standards for Military Operations*. Research and Technology Organisation. 2010.

150. Fallowfield J, Wood P. *Nutrition for UK Armed Forces In-Unit and Operational Feeding: Towards Evidence-Based Policy and Operational Best Practice. A Research Proposal Endorsed by Surgeon General's Research Strategy Group*. Ministry of Defence. 2008.

151. World Medical Association. *Declaration of Helsinki 52nd WMA General Assembly*. Edinburgh, Scotland, 2000.

152. Ministry of Defence. *UK Armed Forces Annual Personnel Report - 1 April 2012.* Ministry of Defence. 2012.

153. Green SB. How many subjects does it take to do a regression analysis. *Multivariate Behavioral Research.* 1991;26(3):499-510.

154. Shaw A. *Body mass index, waist circumference and motives for food choice in a sample of land-based Royal Navy personnel*. MSc. University of Southampton; 2012.

155. Department of Health. *General Practice Physical Activity Questionnaire*. London: HMSO; 2006.

156. Hardy CJ, Palmer BP, Muir KR, et al. Smoking history, alcohol consumption, and systemic lupus erythematosus: a case-control study. *Annals of the Rheumatic Diseases*. 1998;57(8):451-455.

157. Steptoe A, Pollard TM, Wardle J. Development of a measure of the motives underlying the selection of food: the food choice questionnaire. *Appetite*. 1995;25(3):267-284.

158. Salvini S, Hunter DJ, Sampson L, et al. Food-based validation of a dietary questionnaire: the effects of week-to-week variation in food consumption. *International Journal of Epidemiology*. 1989;18(4):858-867.

159. Baker C. *Obesity Statistics. Briefing Paper (3336)*. House of Commons Library. 2019.

160. Januszewska R, Pieniak Z, Verbeke W. Food choice questionnaire revisited in four countries. Does it still measure the same? *Appetite*. 2011;57(1):94-98.

References

161. Pollard TM, Steptoe A, Wardle J. Motives underlying healthy eating: using the Food Choice Questionnaire to explain variation in dietary intake. *Journal of Biosocial Science*. 1998;30(2):165-179.

162. Prescott J, Young O, O'neill L, et al. Motives for food choice: a comparison of consumers from Japan, Taiwan, Malaysia and New Zealand. *Food Quality and Preference*. 2002;13(7):489-495.

163. Nyberg ST, Heikkila K, Fransson EI, et al. Job strain in relation to body mass index: pooled analysis of 160 000 adults from 13 cohort studies. *Journal of Internal Medicine*. 2012;272(1):65-73.

164. Fotopoulos C, Krystallis A, Vassallo M, et al. Food Choice Questionnaire (FCQ) revisited. Suggestions for the development of an enhanced general food motivation model. *Appetite*. 2009;52(1):199-208.

165. Chambers S, Lobb A, Butler LT, et al. The influence of age and gender on food choice: a focus group exploration. *International Journal of Consumer Studies*. 2008;32(4):356-365.

166. Lindeman M, Väänänen M. Measurement of ethical food choice motives. *Appetite*. 2000;34(1):55-59.

167. Renner B, Sproesser G, Strohbach S, et al. Why we eat what we eat. The Eating Motivation Survey (TEMS). *Appetite*. 2012;59(1):117-128.

168. Jackson B, Cooper ML, Mintz L, et al. Motivations to eat: Scale development and validation. *Journal of Research in Personality*. 2003;37(4):297-318.

169. Tapper K, Pothos EM. Development and validation of a Food Preoccupation Questionnaire. *Eating Behaviors*. 2010;11(1):45-53.

170. Furst T, Connors M, Bisogni CA, et al. Food choice: a conceptual model of the process. *Appetite*. 1996;26(3):247-266.

171. Ministry of Defence. *Armed Forces Pay Review Body 46th Report*. Ministry of Defence. 2017.

172. Konttinen H, Sarlio-Lähteenkorva S, Silventoinen K, et al. Socio-economic disparities in the consumption of vegetables, fruit and energy-dense foods: the role of motive priorities. *Public Health Nutrition*. 2013;16(5):873-882.

173. Steenhuis IH, Waterlander WE, De Mul A. Consumer food choices: the role of price and pricing strategies. *Public Health Nutrition*. 2011;14(12):2220-2226.

174. Steptoe A, Wardle J. Motivational factors as mediators of socioeconomic variations in dietary intake patterns. *Psychology and Health*. 1999;14(3):391-402.

175. Dressler H, Smith C. Food choice, eating behavior, and food liking differs between lean/normal and overweight/obese, low-income women. *Appetite*. 2013;65:145-152.

176. Hebden L, Chan H, Louie J, et al. You are what you choose to eat: factors influencing young adults' food selection behaviour. *Journal of Human Nutrition and Dietetics.* 2015;28(4):401-408.

177. Rouhani M, Salehi-Abargouei A, Surkan P, et al. Is there a relationship between red or processed meat intake and obesity? A systematic review and meta-analysis of observational studies. *Obesity Reviews*. 2014;15(9):740-748.

178. Ledoux T, Hingle MD, Baranowski T. Relationship of fruit and vegetable intake with adiposity: a systematic review. *Obesity Reviews*. 2011;12(5):e143-e150.

179. Flores-Mateo G, Rojas-Rueda D, Basora J, et al. Nut intake and adiposity: meta-analysis of clinical trials. *The American Journal of Clinical Nutrition*. 2013;97(6):1346-1355.

180. McCarthy S, Robson P, Livingstone M, et al. Associations between daily food intake and excess adiposity in Irish adults: towards the development of food-based dietary guidelines for reducing the prevalence of overweight and obesity. *International Journal of Obesity*. 2006;30(6):993-1002.

181. McCann SE, Marshall JR, Brasure JR, et al. Analysis of patterns of food intake in nutritional epidemiology: food classification in principal components analysis and the subsequent impact on estimates for endometrial cancer. *Public Health Nutrition*. 2001;4(5):989-997.

182. Northstone K, Ness A, Emmett P, et al. Adjusting for energy intake in dietary pattern investigations using principal components analysis. *European Journal of Clinical Nutrition*. 2008;62(7):931-938.

183. Crozier SR, Robinson SM, Borland SE, et al. Dietary patterns in the Southampton Women's Survey. *European Journal of Clinical Nutrition*. 2006;60(12):1391-1399.

184. Whichelow MJ, Prevost AT. Dietary patterns and their associations with demographic, lifestyle and health variables in a random sample of British adults. *British Journal of Nutrition*. 1996;76(1):17-30.

185. Williams DE, Prevost AT, Whichelow MJ, et al. A cross-sectional study of dietary patterns with glucose intolerance and other features of the metabolic syndrome. *British Journal of Nutrition*. 2000;83(3):257-266.

186. Hearty AP, Gibney MJ. Comparison of cluster and principal component analysis techniques to derive dietary patterns in Irish adults. *British Journal of Nutrition*. 2008;101(4):598-608.

187. Department of Health and Social Care. *UK Physical Activity Guidelines*. Department of Health and Social Care. 2011.

188. Davison H, Virk D, Bridger R. *A qualitative analysis of the views expressed by a sample of Royal Navy personnel with respect to their health, fitness and lifestyle*. Institute of Naval Medicine. 2012.

189. Scholes S, Neave A. *Health Survey for England 2016. Physical activity in adults*. London, UK, 2016.

190. Osborne B, Cooper V. *Health Survey for England 2017: Adult health related behaviours*. London, UK, 2018.

191. Office for National Statistics. *Adult smoking habits in the UK: 2018*. Office for National Statistics. 2019.

192. Livingston M, Callinan S. Underreporting in alcohol surveys: whose drinking is underestimated? *Journal of Studies on Alcohol and Drugs.* 2015;76(1):158-164.

193. Stockwell T, Donath S, Cooper-Stanbury M, et al. Under-reporting of alcohol consumption in household surveys: a comparison of quantity–frequency, graduated–frequency and recent recall. *Addiction.* 2004;99(8):1024-1033.

194. Stockwell T, Zhao J, Macdonald S. Who under-reports their alcohol consumption in telephone surveys and by how much? An application of the 'yesterday method'in a national C anadian substance use survey. *Addiction.* 2014;109(10):1657-1666.

195. Traversy G, Chaput J-P. Alcohol consumption and obesity: an update. *Current obesity reports.* 2015;4(1):122-130.

196. Buck D, Frosini F. *Clustering of unhealthy behaviours over time*. London: The Kings Fund; 2012.

197. Nelson TL, Vogler GP, Pedersen NL, et al. Genetic and environmental influences on waist-to-hip ratio and waist circumference in an older Swedish twin population. *International Journal of Obesity and Related Metabolic Disorders.* 1999;23(5):449-455.

198. Rose G. Sick individuals and sick populations. *International Journal of Epidemiology.* 2001;30(3):427-432.

199. Naghii MR. The importance of body weight and weight management for military personnel. *Military Medicine*. 2006;171(6):550-555.

200. Ministry of Defence. *Service Personnel Board. Defence Health Strategy: Annex A*. Ministry of Defence. 2007.

201. Ministry of Defence. *Defence Board 08 42 'A Service Personnel Programme for 2009 and Beyond'*. Ministry of Defence. 2008.

202. Link BG, Phelan J. Social conditions as fundamental causes of disease. *Journal of Health and Social Behaviour*. 1995;Spec No:80-94.

203. French SA, Jeffery RW, Story M, et al. A pricing strategy to promote low-fat snack choices through vending machines. *American Journal of Public Health*. 1997;87(5):849-851.

204. World Health Organization. *Global action plan for the prevention and control of noncommunicable diseases 2008-2013*. Geneva: World Health Organization; 2008.

205. Thow AM, Jan S, Leeder S, et al. The effect of fiscal policy on diet, obesity and chronic disease: a systematic review. *Bulletin of the World Health Organization.* 2010;88(8):609-614.

206. Caraher M, Cowburn G. Taxing food: implications for public health nutrition. *Public Health Nutrition*. 2005;8(8):1242-1249.

207. Craig P, Dieppe P, Macintyre S, et al. Developing and evaluating complex interventions: the new Medical Research Council guidance. *British Medical Journal.* 2008;337:a1655.

208. Thompson B, Coronado G, Snipes SA, et al. Methodologic advances and ongoing challenges in designing community-based health promotion programs. *Annual Review of Public Health*. 2003;24(1):315-340.

209. Steyn N, Parker W, Lambert E, et al. Nutrition interventions in the workplace: Evidence of best practice. *South African Journal of Clinical Nutrition.* 2009;22(3):111-117.

210. Diepeveen S, Ling T, Suhrcke M, et al. Public acceptability of government intervention to change health-related behaviours: a systematic review and narrative synthesis. *BMC Public Health.* 2013;13(1):756.

211. Teddlie C, Yu F. Mixed methods sampling: A typology with examples. *Journal of Mixed Methods Research*. 2007;1(1):77-100.

212. Attwood M, Pedler M, Pritchard S. *Leading change: A guide to whole systems working*. Bristol, UK: Policy Press; 2003.

213. O'Cathain A, Murphy E, Nicholl J. Three techniques for integrating data in mixed methods studies. *British Medical Journal*. 2010;341:c4587.

214. Morgan DL. Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods. *Journal of Mixed Methods Research.* 2007;1(1):48-76.

215. Lingard L, Albert M, Levinson W. Grounded theory, mixed methods, and action research. *British Medical Journal.* 2008;337:a567.

216. British Heart Foundation. *Health at Work Employee Survey*. British Health Foundation. 2012.

217. Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative Research in Psychology*. 2006;3(2):77-101.

218. Ministry of Defence. *Defence Food Services: food quality standard. v.12.* Ministry of Defence. 2015.

219. Richard M, Christina MF, Deborah LS, et al. Intrinsic motivation and exercise adherence. *International Journal of Sport Psychology*. 1997;28(4):335-354.

220. Prochaska JO, Velicer WF. The transtheoretical model of health behavior change. *American Journal of Health Promotion*. 1997;12(1):38-48.

221. Mastellos N, Gunn LH, Felix LM, et al. Transtheoretical model stages of change for dietary and physical exercise modification in weight loss management for overweight and obese adults. *Cochrane Database of Systematic Reviews*. 2014;2(2):CD008066.

222. Garip G. *Modifying and evaluating the feasibility of a web-based weight loss intervention for Royal Naval personnel*. PhD Thesis. University of Southampton, 2013.

223. Dennis KE, Pane KW, Adams BK, et al. The impact of a shipboard weight control program. *Obesity Research*. 1999;7(1):60-67.

224. Gittelsohn J, Rowan M, Gadhoke P. Interventions in small food stores to change the food environment, improve diet, and reduce risk of chronic disease. *Preventing Chronic Disease*. 2012;9.

225. Jones NR, Conklin AI, Suhrcke M, et al. The growing price gap between more and less healthy foods: analysis of a novel longitudinal UK dataset. *PLoS One*. 2014;9(10):e109343.

226. J Jones NRV, Tong TYN, Monsivais P. Meeting UK dietary recommendations is associated with higher estimated consumer food costs: an analysis using the National Diet and Nutrition Survey and consumer expenditure data, 2008–2012. *Public Health Nutrition*. 2018;21(5):948-956.

227. Gorton D, Carter J, Cvjetan B, et al. Healthier vending machines in workplaces: both possible and effective. *The New Zealand Medical Journal*. 2010;123(1311):43-52.

228. Carlsen B, Glenton C. What about N? A methodological study of sample-size reporting in focus group studies. *BMC Medical Research Methodology* 2011;11(1):26.

229. Gielen AC, Green LW. The impact of policy, environmental, and educational interventions: a synthesis of the evidence from two public health success stories. *Health Education and Behavior*. 2015;42(1_suppl):20S-34S.

230. Golden SD, McLeroy KR, Green LW, et al. Upending the social ecological model to guide health promotion efforts toward policy and environmental change *Health Education and Behavior*. 2015;42(1_suppl):8S-14S.

231. Sallis J, Owen N, Fisher E (eds.). *Ecological models of health behavior*. San Francisco, US: Jossey-Bass; 2008.

232. Glanz K, Sallis JF, Saelens BE, et al. Healthy nutrition environments: concepts and measures. *American Journal of Health Promotion*. 2005;19(5):330-333.

233. Carins J, Rundle-Thiele S. Fighting to eat healthfully: measurements of the military food environment. *Journal of Social Marketing*. 2014;4(3):223-239.

234. Navy and Marine Corps Public Health Center. *Military nutrition environment assessment tool (m-Neat)*. Navy and Marine Corps Public Health Center. 2013.

235. Food Standards Agency. *Food portion sizes (3rd ed)*. London: TSO; 1994.

236. Scientific Advisory Committee on Nutrition. *Salt and Health Report*. Norwich: TSO; 2003.

237. Scientific Advisory Committee on Nutrition. *Carbohydrates and Health*. Norwich: TSO; 2015.

238. Department of Health. *Dietary reference values for food energy and nutrients for the United Kingdom. (Report on Health and Social Subjects, No. 41.)*. London: HMSO; 1991.

239. Department for Environment Food and Rural Affairs (DEFRA). *Sustainable procurement: the GBS for food and catering services*. DEFRA. 2014.

240. Department of Health/ Food Standards Agency. *Guide to creating a front of pack (FoP) nutrition label for pre-packed products sold through retail outlets*. Department of Health. 2013.

241. British Nutrition Foundation. *Nutrition Requirements*. British Nutrition Foundation. 2015.

242. Elmer T. Tim Elmer:'in the armed forces we lose thousands of man hours each year to people leaving to have dental care delivered.'. *British Dental Journal*. 2014;217(1):12-14.

243. French SA, Jeffery RW, Story M, et al. Pricing and promotion effects on low-fat vending snack purchases: the CHIPS Study. *American Journal of Public Health*. 2001;91(1):112-117.

244. Ministry of Defence and Defence Equipment and Support. *Daily messing rates for military personnel*. Ministry of Defence. 2015.

245. Food Standards Agency (FSA). *Planning your menu.* FSA. 2016.

246. Foster C, Hillsdon M, Thorogood M, et al. *Interventions for promoting physical activity*. The Cochrane Library. 2005.

247. Coggon J. The Nanny State Debate: A Place Where Words Don't Do Justice. Faculty of Public Health. 2018.

248. Manning FJ. Morale and cohesion in military psychiatry. *Military Psychiatry: Preparing in peace for war*. Washington DC, US: TMM Publications; 1994. p1-18.

249. Miller-Keane (ed.). *Encyclopedia and Dictionary of Medicine, Nursing, and Allied Health (7th ed)*. 2003. Available from: https://medical-dictionary.thefreedictionary.com/conceptual+model (accessed 4 Jul 2019).

250. Zaza S, Briss PA, Harris KW. *The guide to community preventive services: what works to promote health?* Oxford University Press; 2005.

251. Hanson D, Gunning C, Rose J, et al. Working from the inside out: a case study of Mackay Safe Community. *Health Education and Behavior*. 2015;42(1_suppl):35S-45S.

252. Tempus. *Handbook: Objective oriented design and management*. Torino: European Training Foundation; 1998.

253. Renault V. *The community toolbox*. 2018. Available from: https://ctb.ku.edu/en (accessed 1 Jun 2019).

254. Duignan P. *Intervention Logic: How to build outcomes hierarchy diagrams using the OH Diagramming Approach*. Parker Duignan Ltd. 2004. Available from: http://www.parkerduignan.com/documents/124pdf.PDF (accessed 1 Jun 2019).

255. Kaplan SA, Garrett KE. The use of logic models by community-based initiatives. *Evaluation and Program Planning*. 2005;28(2):167-172.

256. Jensen G. *The logical framework approach*. Bond for International Development. 2010.

257. Department for International Development (DFID). *Tools for Development. Chapter 5*. DFID. 2004.

258. Taylor-Powell E, Henert E. *Developing a logic model: Teaching and training guide*. University of Wisconsin-Extension. 2008.

259. Örtengren K. *The Logical Framework Approach: A summary of the theory behind the LFA method*. Sida. 2004.

260. Leeman J. An evaluation framework for obesity prevention policy interventions. *Preventing Chronic Disease*. 2012;9:e120.

261. Koplan JP, Milstein R, Wetterhall S. Framework for program evaluation in public health. *MMWR: Recommendations and Reports*. 1999;48:1-40.

262. Bull F, Adams E, Hooper P. *Well@ work: promoting active and healthy workplaces final evaluation report*. British Heart Foundation. 2008.

263. Parmenter K, Wardle J. Development of a general nutrition knowledge questionnaire for adults. *European Journal of Clinical Nutrition*. 1999;53(4):298-308.

264. Davey T, Delves S, Allsopp A, et al. Validation of a bespoke food record card as a method of recording dietary intake in Royal Marine recruits. *Proceedings of the Nutrition Society*. 2010;69(OCE1).

265. Scientific Advisory Committee on Nutrition. *The Nutrition Wellbeing of the British Population*. London: TSO; 2008.

266. Henry C. Basal metabolic rate studies in humans: measurement and development of new equations. *Public Health Nutrition*. 2005;8(7a):1133-1152.

267. Goldberg G, Black A, Jebb S, et al. Critical evaluation of energy intake data using fundamental principles of energy physiology: 1. Derivation of cut-off limits to identify under-recording. *European Journal of Clinical Nutrition*. 1991;45(12):569-581.

268. Livingstone MBE, Black AE. Markers of the validity of reported energy intake. *The Journal of Nutrition*. 2003;133(3):895S-920S.

269. Fallowfield JL, Delves SK, Hill NE, et al. Energy expenditure, nutritional status, body composition and physical fitness of Royal Marines during a 6-month operational deployment in Afghanistan. *British Journal of Nutrition*. 2014;112(5):821-829.

270. Vaz M, Karaolis N, Draper A, et al. A compilation of energy costs of physical activities. *Public Health Nutrition*. 2005;8(7a):1153-1183.

271. Food and Agriculture Organization. *Human energy requirements*. Report of a Joint FAO/WHO/UNU Expert Consultation, Rome, 17-24 October 2001, 2004.

272. Fear NT, Iversen A, Meltzer H, et al. Patterns of drinking in the UK Armed Forces. *Addiction*. 2007;102(11):1749-1759.

273. Williamson DA, Bray GA, Ryan DH. Is 5% weight loss a satisfactory criterion to define clinically significant weight loss? *Obesity*. 2015;23(12):2319-2320.

274. Casey A, Hughes J, Izard RM, et al. Supplement use by UK-based British Army soldiers in training. *British Journal of Nutrition*. 2014;112(7):1175-1184.

275. Ministry of Defence. *Joint Services Publication 835: Alcohol and Substance Misuse and Testing. Ministry of Defence*. 2013.

276. Knapik JJ, Sharp MA, Canham-Chervak M, et al. Risk factors for training-related injuries among men and women in basic combat training. *Medicine and Science in Sports and Exercise.* 2001;33(6):946-954.

277. Munnoch K, Bridger RS. Smoking and injury in Royal Marines' training. *Occupational Medicine.* 2007;57(3):214-216.

278. Hoad N, Clay D. Smoking impairs the response to a physical training regime: a study of officer cadets. *Journal of the Royal Army Medical Corps.* 1992;138(3):115-117.

279. Henderson A, Langston V, Greenberg N. Alcohol misuse in the Royal Navy. *Occupational Medicine*. 2008;59(1):25-31.

280. HSCIC. *Health Survey for England: General Health*. Available from: http://healthsurvey.hscic.gov.uk/data-visualisation/data-visualisation/explore-the-trends/general-health.aspx?type=adult (accessed 22 Apr 2019).

281. Steel DV. *Personnel Communication to all Commanding Officers and Logistics Officers of RN/RM/RFA Ships, Establishments and Units*. Ministry of Defence. 2014.

282. Shaw A, Morrow L, Abrams C, et al. *Second Sea Lord's Feeding the Fleet Initiative: Evaluation of a Weight Management Programme Aboard a Royal Navy Ship During a 9-month Deployment.* Institute of Naval Medicine. Report number: 2018.013, 2018.

283. Department of Health. *Developing a specification for lifestyle weight management services–best practice guidance for tier 2 services*. Department of Health. 2013.

284. Smith B, Ryan MA, Wingard DL, et al. Cigarette smoking and military deployment: a prospective evaluation. *American Journal of Preventive Medicine.* 2008;35(6):539-546.

285. Bucher T, Collins C, Rollo ME, et al. Nudging consumers towards healthier choices: a systematic review of positional influences on food choice. *British Journal of Nutrition*. 2016;115(12):2252-2263.

286. Schwarte L, Samuels SE, Capitman J, et al. The Central California Regional Obesity Prevention Program: changing nutrition and physical activity environments in California's heartland. *American Journal of Public Health*. 2010;100(11):2124-2128.

287. Copeland R, Mouillin M, Reece L, et al. *Sheffield's Let's Change4Life: a whole systems approach to tackling overweight and obesity in children, young people and families. A local evaluation report*. Sheffield: Sheffield Hallam University; 2011.

288. London Borough of Hackney. *Health Heroes: a whole school approach to healthy weight. Final Evaluation report*. 2014.

289. Kegler MC, Norton BL, Aronson R. Achieving organizational change: findings from case studies of 20 California healthy cities and communities coalitions. *Health Promotion International*. 2008;23(2):109-118.

290. de Leeuw E, Tsouros AD, Dyakova M, et al. *Healthy cities, promoting health and equity-evidence for local policy and practice.* WHO Regional Office for Europe; 2014.

291. Kegler MC, Painter JE, Twiss JM, et al. Evaluation findings on community participation in the California Healthy Cities and Communities program. *Health Promotion International*. 2009;24(4):300-310.

292. Public Health England. *Paths to public health and wellbeing: examples of local authority action in the South-West*. London: Public Health England; 2014.

293. Serpas S, Brandstein K, McKennett M, et al. San Diego Healthy Weight Collaborative: a systems approach to address childhood obesity. *Journal of Health Care for the Poor and Underserved*. 2013;24(2):80-96.

294. Simos J, Spanswick L, Palmer N, et al. The role of health impact assessment in Phase V of the Healthy Cities European Network. *Health Promotion International*. 2015;30(suppl_1):i71-i85.

295. Goumans M, Springett J. From projects to policy:'Healthy Cities' as a mechanism for policy change for health? *Health promotion international*. 1997;12(4):311-322.

296. Plümer KD, Kennedy L, Trojan A. Evaluating the implementation of the WHO Healthy Cities Programme across Germany (1999–2002). *Health Promotion International*. 2010;25(3):342-354.

297. Public Health England. *Whole systems approach to obesity programme. Learning from co-producing and testing the guide and resources*. London: Public Health England; 2019.

298. Public Health England. *Whole systems approach to obesity. A guide to support local approaches to promoting a healthy weight*. London: Public Health England; 2019.

299. Department of Health and Social Care. *Tackling obesity: empowering adults and children to live healthier lives*; 2020.

300. Scarborough P, Kaur A, Cobiac L, et al. Eatwell Guide: modelling the dietary and cost implications of incorporating new sugar and fibre guidelines. *BMJ Open.* 2016;6(12):e013182.

301. Gadsby EW, Hotham S, Eida T, et al. Impact of a community-based pilot intervention to tackle childhood obesity: a 'whole-system approach'case study. *BMC Public Health.* 2020;20(1):1-12.

302. Bolton K, Kremer P, Gibbs L, et al. The outcomes of health-promoting communities: being active eating well initiative—a community-based obesity prevention intervention in Victoria, Australia. *International Journal of Obesity.* 2017;41(7):1080-1090.

303. Fallowfield J, Shaw A, Davey T, et al*. The Defence Occupational Fitness Programme: A Process, outcome and impact evaluation of a 12-month weight management intervention for British military personnel (the "DOfit") - Final report*. Institute of Naval Medicine. Report number: 2019.012, 2019.