University of Southampton

Faculty of Environmental and Life Sciences

Geography and Environmental Science

Longitudinal geographies of alcohol consumption: understanding middle-aged adult drinking in the UK.

by

Lauren Elena Wilson

Thesis for the degree of Doctor of Philosophy (PhD)

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Abstract

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Drinking alcohol to excess is one of the largest modifiable causes of morbidity in middle-aged adults with a third of drinkers aged 45-64 years drinking above the UK low-risk guidelines (14+ units per week). Social-ecological frameworks suggest that alcohol behaviour is driven by both individual factors and wider level contexts. Evidence gaps for understanding risk alcohol use in this age group were identified for trends in intake, individual, transitional and regional associations and an age-relevant understanding of income and alcohol expenditure. The current middle-aged literature was found to be limited by inconsistent risk alcohol intake thresholds, a lack of late middle-aged adults in birth cohorts, and lack of adjustment for the wider determinants of health. This thesis addressed these research gaps using three independent but linked studies.

The first study used cross-sectional data from the Health Survey for England (HSE) from 1998 (20,871 n pooled) to consider trends and demographic, socioeconomic and co-risk factors associated with exceeding the former UK guidelines (21/14+ units per week) and binge drinking (8/6+ units on heaviest day). The second study used two waves from Understanding Society (USoc), a UK panel study (12,737 n), to determine if transitions in socioeconomic or social status between waves were associated with binge drinking patterns. The final study used USoc longitudinally over 7 waves (17,407 households) to assess the relationship with income and household composition factors associated with expenditure on alcohol. Each study used multilevel regression modelling to account for shared characteristics of individuals within regional living areas, as Government Office Regions (GOR), and account for the non-independence and correlation in repeated measures panel data. Non-drinkers were excluded from each study to avoid abstainer bias.

Data from the HSE found a gender convergence in exceeding the former weekly guidelines with binge drinking increasing in both sexes since 1998. Exceeding the guidelines was associated with smoking, higher income and education, retirement, cohabiting marital status and having no children in the household for both sexes. Binge drinking was associated with smoking, higher body-mass index, higher income, divorced marital status, no religious belonging and urban residence in both sexes with associations for having friends and no educational qualifications in men only. Entering or leaving a relationship were both associated with maintaining binge drinking over time in men compared to a stable relationship status but not in women. Moving to a rural area in both sexes, changing to no reported friends in men only, becoming a non-smoker in women only and entering employment in women only, were all negatively associated with maintaining binge drinking. Living in the North East and North West of England contributed to increased binge drinking in men independently of individual characteristics and was associated with higher household expenditures on alcohol. A £100 increase in income was associated with a £0.40 increase in alcohol expenditure in middle-aged headed households, accounting for household composition factors including household size, child status, sources of income and housing tenure.

Overall, this thesis contributes to the literature on excessive alcohol use by providing age and sex-specific analyses of a previously under-researched age group, discovering multiple risk factors associated with acute and chronic risk from alcohol use and spending on alcohol. These findings make use of multilevel modelling to account for regional contexts and individual trajectories of binge drinking and household spending over time, demonstrating the utility of secondary data to explore changing health behaviours.

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Research Thesis: Declaration of Authorship

Print name: Lauren Elena Wilson

Title of thesis: Longitudinal geographies of alcohol consumption: understanding middle-aged adult drinking in the UK.

I declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

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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. None of this work has been published before submission

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Abbreviations

AAF ..... Alcohol Attributable Fraction

ABI ..... Alcohol Brief Advice & Intervention

ABV ..... Alcohol by Volume

AUDIT ..... Alcohol Use Disorders Identification Test

BCS70 ..... 1970 Birth Cohort Study

BHPS ..... British Household Panel Survey

BMI ..... Body-Mass Index

BSQF ..... Beverage Specific Quantity Frequency (measure)

CAGE ..... Cut Down, Annoyed, Guilty and Eye Opener (questionnaire)

CAPI ..... Computer Assisted Personal Interviewing

CCA ..... Complete Case Analysis

CI ..... Confidence Interval

DALYs ..... Disability Adjusted Life Years

ELSA ..... English Longitudinal Study of Ageing

EFS ..... Expenditure and Food Survey

GP ..... General Practitioner

GPS ..... General Population Sample (of USoc)

GLMM ..... Generalized Linear Mixed Model

GLS ..... General Lifestyle Survey

GOR ..... Government Office Region

HRP ..... Household Representative Person

HSE ..... Health Survey for England

IMD ..... Index of Multiple Deprivation (SIMD: Scottish IMD, WIMD: Welsh IMD)

LCFS ..... Living Cost and Food Survey

LSOA ..... Lower Super Output Area

MUP ..... Minimum Unit Pricing

NSW ..... National Survey for Wales

NCDS..... National Child Development Study (1958 Birth Cohort)

NDNS ..... National Diet and Nutrition Survey

NIHS..... Northern Ireland Health Survey

ONS..... Office for National Statistics

OLS ..... Opinion and Lifestyle Survey

OR ..... Odds Ratio

PAF..... Postcode Address File

PSU ..... Primary Sampling Unit

QF ..... Quantity Frequency (measure)

RR..... Risk Ratio

RQ ..... Research Question

SD..... Standard Deviation

SES..... Socioeconomic Status

SHeS ..... Scottish Health Survey

US ..... United States (of America)

USoc ..... Understanding Society (study)

WHII ..... Whitehall II Cohort Study

WHS ..... Welsh Health Survey

WHO..... World Health Organisation

VIF ..... Variance Inflation Factor

Chapter 1 Introduction

This chapter serves as a background and overview of the thesis including its aims, research frameworks and structure. The chapter begins by describing the issue of an ageing population and the public health risk posed by excess alcohol consumption in middle-age. This is followed by a discussion on policy strategies incorporating the lifecourse framework. Issues for research are described concerning the current levels of alcohol consumption in middle-age and the lack of research into attributable factors to support multilevel interventions. Research frameworks to guide the development of research aims from social-ecological, lifecourse and health geography are described to support the analysis of complex relationships. Study overviews provide a summary of the rationale for the three distinct empirical chapters.

1.1 Research Issue

The UK population is undergoing a demographic transition by age (1, 2). Currently, adults aged 45-64 years constitute 25% of the UK population, a reflection of the post-war baby boom in the 1940s (3). As current fertility levels decline and life expectancies increase, a demographic shift is expected towards a greater percentage of adults aged over 65 years (4). Living longer is placing pressure on middle-aged adults to remain in the workforce and financially prepare for longer retirements (5). A mid-life reduction in premature mortality has been replaced with a rise in chronic disabilities with adults aged 50-69 years now more likely to suffer from back pain, falls, major depression and type II diabetes compared to in 2007 (6). As the economic pressures on health and social services grow with population ageing, the burden of care to the family level increases (7). These accumulating issues harm the health and quality of life of British middle-aged adults (8, 9).

Engaging in healthier lifestyle choices may reduce the number of years older adults live with poor quality health as part of an active ageing framework (10). Alcohol consumption is the second largest modifiable risk behaviour of lifetime disability and premature death in men and women aged 45-64 years after smoking (6). Whilst no level of alcohol is considered completely safe from harm to health, officials recommend consuming no more than 14 units[1] of alcohol per week (11). Drinking above these recommended weekly thresholds, and engaging in high volume drinking occasions, are referred to as ‘risk drinking’ in this thesis. Recent annual trend data suggests the

[1] A UK unit of alcohol is the equivalent of 8g of pure alcohol per 10ml.

average volume of alcohol consumed per week is consistently highest in adults aged 45-69 years with about 30% of those who drink exceeding the weekly guidelines (12).

As a modifiable health behaviour, reducing alcohol intake in this population group, to within recommended thresholds, could improve mental and physical wellbeing, increase economic output and reduce the burden of further health risk outcomes with ageing (13, 14). Current policy frameworks recommend multicomponent alcohol reduction strategies that target multiple levels of influence at the individual, social and structural levels, whilst tailoring strategies towards groups at most risk from harm (15-17). The World Health Organisation (WHO) "best buys" for reducing harmful alcohol intake include reductions in advertising, physical availability and increases in taxation whilst facilitating access to screening and advice (18, 19).

A recommended part of such health strategies is the incorporation of a lifecourse framework which considers the temporal and societal perspectives of health determinants (20, 21). By targeting risk behaviours at critical life transitions, the lifetime risk of developing health problems may reduce, forming a cost-effective investment for health services (22). Therefore, interventions of drinking behaviours that consider the specific needs and circumstances of middle-aged adults may prevent the development of alcohol-related morbidity in older age (20, 23). Alcohol screening and brief advice[2] (ABI) is considered one of the most effective methods of detecting and reducing higher-risk alcohol consumption (25-27). Qualitative research suggests that adults over 50 years of age respond well to personalised advice from health professionals for up to one year (28, 29). Therefore greater incorporation of ABI in health services enables the opportunity for early intervention and reduced alcohol-related harm within the lifecourse framework (30). However, for ABI to be applied most effectively in middle-aged risk drinkers, the factors associated with such behaviours in this population need to be identified systematically.

Compared to a reduction in alcohol units consumed in persons aged 16-44 years since 2011, there has been no change in the average volume consumed per week in adults aged 55-74 years (12, 31). This suggests middle-aged adults are unaffected by current population-level strategies to reduce intake (32-34). The identification of adults presenting with alcohol use problems may decline with age as late-onset drinkers (age 50+ years) are often missed due to their lack of alcohol-related medical history or may be subject to ageist assumptions (35-37). Whilst binge

[2] Alcohol brief interventions involve motivational counselling for behaviour change and individual empowerment as an early intervention for non-dependent drinkers (24).

drinking[3] (heavy drinking occasions) is less common in this age group compared to overall excess drinking per week, rates of this behaviour may be increasing, particularly in women (12, 38). With an increased sensitivity to intoxication with ageing, this presents a rising public health issue (39, 40). Therefore independent investigations of different risk drinking patterns are required to properly target the issue in middle-age due to the different situations that may promote such behaviours (38, 41).

A multilevel strategy could consider individual (improving risk awareness, brief advice), community (reducing ageism, tailoring treatment for older adults) and structural (alcohol affordability) levels of influence (42, 43). Such a strategy is considered to result in longer lasting and wider reaching impacts compared to only an individual-level intervention (19, 44). However, such an approach for alcohol consumption has not been well studied in ageing adults (45, 46). Utilising a range of strategies at various contextual levels will be more likely to support different subgroups of the population who may be at more risk due to their individual and cultural factors (47, 48). However, the risk factors of subgroups who would most benefit from a targeted alcohol intervention in middle-age are unclear (49-51). Therefore, understanding the individual and contextual factors that encourage higher risk drinking in middle-age to support behaviour change is a research priority. Using a longer-term preventative outlook aims to promote healthier choices across the lifecourse, socioeconomic spectrum and reduce health care costs.

1.2 Research Population

In the UK, alcohol is a historical part of its culture that has been a challenge for public health (52), particularly considering recent issues of licensing deregulation and increased normality for intoxication (53, 54). Many middle-aged adults consider drinking to be socially normal behaviour and may be sceptical of negative health impacts (55, 56). Compared to other ages, adults aged 45-59 years are now more likely to report lower personal wellbeing, higher anxiety and financial difficulties and may have greater socioeconomic inequality and lower social capital compared to previous generations (1, 57, 58). Adults entering the retirement phase of life are unlikely to change the trajectories of their lifecourse socioeconomic status, placing disadvantaged individuals at greater risk for poor health in older age (59-61). Child-rearing women may have lower pension contributions than men, a situation made worse by higher divorce rates for this generation (62, 63).

[3] Typically, 8 units in men, 6 units in women on occasion or heaviest drinking day.

In contrast, individuals who benefited from the greater availability of higher education, compared to pre-war cohorts, pensions and property boom and rising financial independence of some women, are likely to have more choices in their retirement (64-66). Therefore, research focussing on this age group needs to account for these changing factors of socioeconomic and family status, particularly if the evidence is to inform the targeting of lower socioeconomic groups who appear to be more susceptible to alcohol-related harm (67).

1.3 Research Frameworks

This thesis is grounded in overlapping concepts from social-ecological frameworks, lifecourse theory and health geography. Social-ecological models suggest that health behaviours are influenced by a combination of interlinked individual, social and environmental factors (44, 68). Health geography considers the relationship between social contexts and place and how this impacts health (69, 70). Lifecourse theory considers how these individual and structural contexts are shaped over time and during sensitive life periods (71, 72). Such frameworks are part of the social determinants of health which considers how individual circumstances and wider systems shape everyday life choices (73).

These concepts consider that behaviours are influenced by individual-level status factors (composition) but also external contextual factors that may be exerted in social groups, local communities or even population (macro) level policies (68, 74). In this way, forces beyond the control of the individual may encourage or discourage risk drinking behaviours, particularly in subpopulations who may be more influenced by their surrounding social norms and community availability (75, 76). As individual and place effects are not independent, it is considered that both are needed to explain health behaviours and health-related inequalities (77). Therefore, the social-ecological framework supports the understanding of risk within certain population groups by considering that the same context may not have the same impact on all individuals. The development of models for types of drinking patterns can explore the relevance of different contexts on such behaviours. Health geography considers the spatial issues of behaviour by recognising that different place contexts of purchasing locations, social groups, activity spaces and time of day lead to differences in availability and behavioural choices for drinking related events (78, 79) and that spatial scales of influence, neighbourhoods or entire regions, are dependent on the social or physical processes of the area being investigated (80).

Individual-level socioeconomic status affects lifecourse health outcomes but also impacts the environments that individuals reside (81-83). Individuals of the same status are more likely to

share work, social environments and activities which then feedback into the choices of the area they live in. Political and economic factors can affect the labour market which may influence the level of local employment and wealth brought into an area. An individual's socioeconomic status may change over time or be triggered by life transitions, such as retirement (84, 85). Lifecourse trajectories are complex, affected not just by individual choices and social interactions but also shaped by cultural and political contexts (71). Analysis of status over time is supported by longitudinal evidence to consider a direction of causality by establishing an order in which events occur (86).

Data that supports comprehensive multilevel analytical methods is most appropriate for this kind of research to determine the independence of individual-level factors to the wider level contexts including place (77, 87). By considering risk factors at different levels of context within the same analysis, their relative importance can be analysed. Qualitative research allows for the exploration of an individual's experiences and the attributions of their behaviour (88). However, it is poorly suited to quantifying the context of such behaviours at higher levels of influence or generalising to populations. The analysis of population surveys may reveal social structures, such as policy implementation (distal effects), that individuals may be unaware of or uninfluenced by in interview settings (proximal effects).

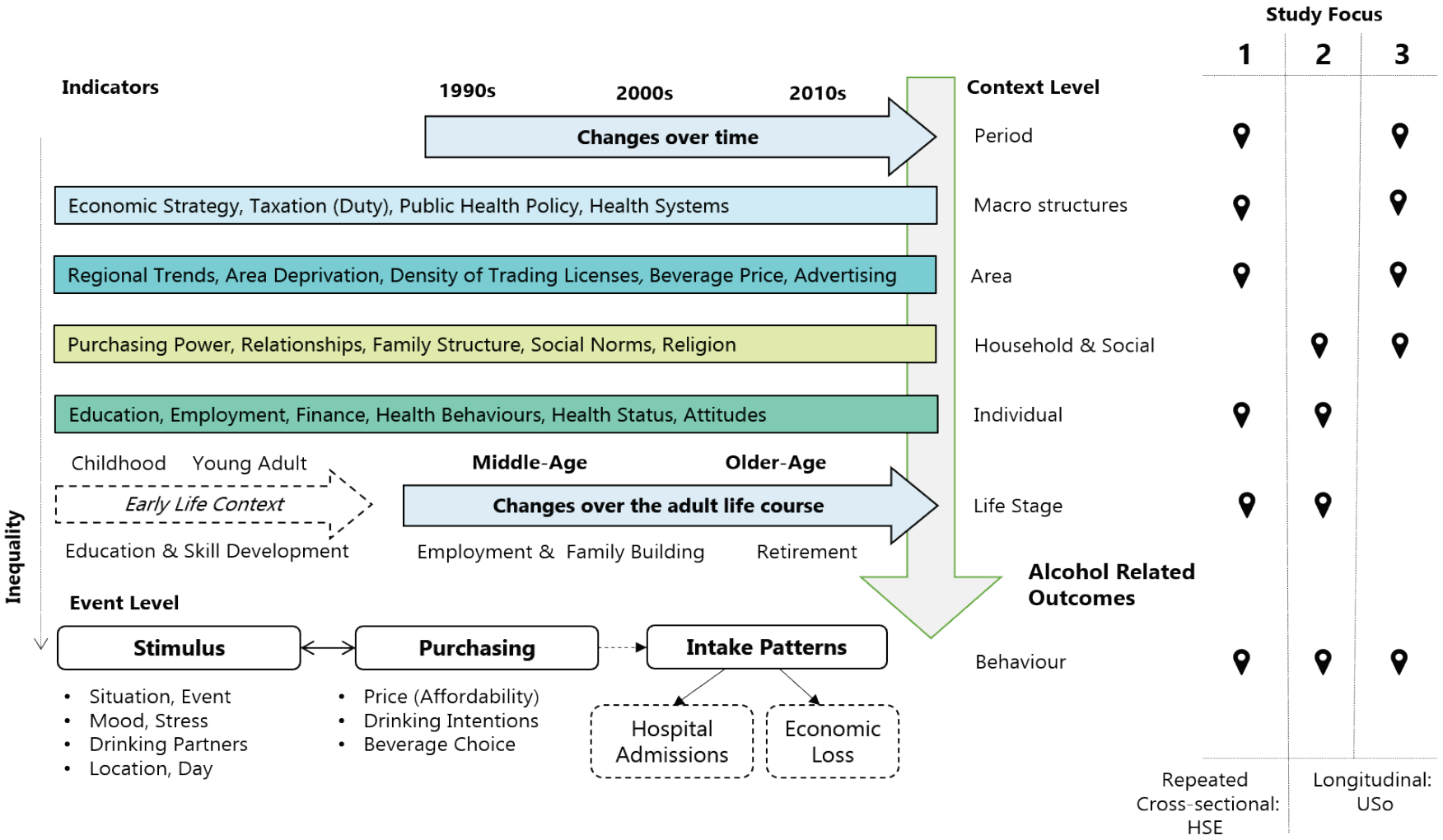
Social-ecological models can provide a framework to understand drinking behaviour but are limited by the evidence available to explain the variables included (44). Public health frameworks require such evidence to target health inequalities in the community. Through a better understanding of the reasons for higher risk drinking in middle-age, guidance for population-level modifications will be better supported.

1.3.1 Alcohol Consumption Model

A conceptual framework of the potential areas of influence on middle-aged alcohol consumption was developed to guide research questions and the direction of the literature review, summarised in Figure 1.1. Individual-level demographics, socioeconomic achievements and health status over the lifecourse may affect how much one drinks. Physical availability and social interactions may influence when, with whom, and where drinking occurs (78). Localities and environments where people reside, and work may encompass more proximal influences such as social norms. Period events may impact socioeconomic development and policy changes in control strategies. Therefore to fully understand higher risk drinking in middle-aged adults, the effects of both composition (socioeconomic and demographics of individuals) and context

(social, cultural and economic environments) on group inequalities needs to be considered (81, 89). Different types of drinking patterns, such as heavy occasion or frequent daily drinking, may result in separate theoretical models with different factors involved (90).

Figure 1.1 Conceptual framework of this thesis including different contextual levels on alcohol intake over the adult lifecourse.



1.4 Research Outline

1.4.1 Development of Research Questions

The lack of older age- and sex-specific recommendations in alcohol-related strategies has called for research to be more specific to population groups rather than only adjusting for age in population-level samples (91-93). This thesis was conceptualised to determine the characteristics of middle-aged risk drinking considering multilevel contexts. By understanding the contribution of different factors to alcohol consumption in middle-age, this evidence is designed to help inform groups working in multiple policy areas to translate the needs of the most at risk into more cost-effective targeted strategies for healthier lifestyles (43). With a focus on objective markers of status, the investigation of subjective wellbeing, mood, personality and adverse childhood experiences with risk alcohol consumption was considered out of the scope of this thesis.

1.4.2 Target Age Range

In this thesis, middle-age is described as 45 to 69 years. A lower end of 45 years was chosen as descriptive evidence from the Health Survey for England (HSE) suggested this is the age at which the percentage of drinkers exceeding the weekly guidelines (14+ units per week) becomes higher than the percentage of binge drinkers, suggesting a possible lifecourse transition point for alcohol use patterns (94). As there tends to be more attrition in longitudinal studies with ageing, an upper age of 69 years was chosen to retain a core sample and cover the retirement period for the majority of people. Excess weekly drinking begins to decline after the age of 65 years, with 86% of workers expected to retire by the age of 70 years (1, 95).

1.4.3 Study Overviews

The combination of theory and research gaps discovered by the literature review was used to develop research questions for each study. A brief overview of the rationale for each study is described below. The three studies build upon their outcomes found consecutively whilst contributing to the research area independently. Each study utilised only participants aged 45-69 years to determine the outcomes specific to this age group.

Study 1: Demographic, socioeconomic and co-risk factors associated with risk alcohol consumption in middle-aged adults in England: multilevel repeated cross-sectional survey analysis.
Dataset: Health Survey for England, Pooled Years 1998-2002 and 2011-2015 (10 years total).

Study 1 considered how exceeding the former weekly guidelines (>21/14 units per week) and binge drinking (>8/6 units on heaviest day) have changed over 17 years. Alcohol-related hospitalisations have increased over time in this age group but the long term consumption trends have not been examined (96). Individual-level factors associated with these behaviours were investigated by sex, accounting for the study period examined and regional context, as Government Office Region (GOR)[4]. There is a lack of evidence for individual-level and regional associations for both these alcohol behaviours covering middle-age due to various sample and measurement limitations in available studies. It was theorised that the 2008 Economic Recession and changes in alcohol affordability over time may impact the association of investigated socioeconomic factors (97, 98). The lack of this basic social-ecological evidence restricts age and sex-specific policy development (91).

Study 2: Binge drinking alcohol in middle-age associated with transitions in family, socioeconomic or co-risk status: multilevel analysis of UK panel data.
Dataset: Understanding Society Wave 2 and Wave 5 (Individual Level).

Study 2 investigated similar factors to study 1 taking into account patterns of binge drinking in the same individuals over two waves. Surveys do not measure the frequency of binge drinking but a longitudinal survey can account for individuals who do not necessarily report binge drinking in every wave surveyed. It was theorised that different factors associated with binge drinking in both waves or initiating binge drinking in the second wave may suggest different contributing circumstances (99, 100). Furthermore, the impact of changes in the investigated social-ecological factors between waves on binge drinking was investigated. The literature suggests that entering retirement or changes in family roles may be transitions associated with changes in unit volumes consumed per week (101, 102). However, such changes in status have not been studied for a risk alcohol threshold. Improving the understanding of temporal contexts for heavy drinking occasions is relevant as study 1 revealed an increasing percentage of binge drinkers in middle-age over time.

[4] Government Office Regions are the equivalent of the Nomenclature of Territorial Units for Statistics 1 level for the UK.

Study 3: The association of household income and composition with middle-aged monthly alcohol expenditure: multilevel longitudinal analysis of UK panel data.
Dataset: Understanding Society Wave 1 to 7 (Household Level).

Study 3 explored the role of income, household composition and geographic region with alcohol expenditure in middle-aged headed households over time. As study 1 revealed a statistically significant association of income with exceeding the weekly guidelines in both sexes, it was theorised that alcohol expenditure may be driven by similar factors related to household purchasing power including regional contexts, as GOR (103, 104). Trends in alcohol expenditure and disposable incomes over 7 waves of the same households were explored, as study 1 suggested that the association of income to excess weekly drinking risk had weakened over time. Therefore, it was theorised that this may be related to changes in alcohol affordability, defined by rises in post-recession incomes outpacing alcohol prices (98, 105). Such analysis contributes to the policy discussion on using price to restrict alcohol availability (106, 107).

1.4.4 Conclusion

Risk drinking in middle-aged adults has not reduced in recent years compared to other age groups suggesting the need for more targeted approaches. There is a general lack of social-ecological and multilevel research into the determinants of risk alcohol consumption specifically in adults between 45 and 69 years of age from the UK separated by sex. This lack of evidence may result in the application of population-level studies to intervention strategies for this age group which do not take into account their specific lifecourse needs. A social-ecological framework allows for the exploration of middle-aged alcohol consumption through the differences in individuals and contexts over time, providing a more holistic explanation of health behaviour.

The next chapter reviews the currently available literature for risk alcohol consumption in middle-aged adults in the UK including trends, harm, policy and associations of weekly risk and binge consumption at the individual, social, area and macro levels. This evidence was used to inform the objectives of this thesis by identifying gaps in the current research.

Chapter 2 Literature Review

This chapter provides an overview of the current literature related to risk alcohol consumption in middle-aged adults (aged within 45-69 years). Due to the importance given to social and policy contexts within this thesis, this review focused on literature using UK populations as it was considered that the differences in drinking cultures and cohort effects, even between higher-income countries, would likely impact the relevance of outcomes to this thesis (108-111). The chapter begins by describing the current attitudes towards alcohol use in the qualitative literature and how this outlook has been shaped by some historical contexts. This is followed by a review of the health impacts of alcohol consumption including its relationship with co-risk behaviours. This literature review was produced using examples of the search strategy in Box 1, based on concepts of the social-ecological framework in Figure 1.1 (Chapter 1.3.1). Factors associated with middle-aged drinking patterns are reviewed including socioeconomic status, life events such as marriage and retirement, area deprivation and alcohol affordability. The chapter ends with a description of the thesis objectives informed by research gaps from the literature review.

Box 1 Examples of search strategies for scoping review of the literature.

Search engines included PubMed (Medline), Web of Science, Google Scholar, CitNetExplorer. Year 2000+. Keywords: alcohol OR drink* + | survey OR longitudinal OR “repeated measures” OR cohort OR “panel survey” | retirement OR middle age OR middle-aged OR older adult OR mid life OR midlife | income OR socio economic OR deprivation OR education | neighbourhood OR region OR multilevel OR geography (each subject explored in separate searches).

2.1 Understanding Alcohol Use

2.1.1 Why Do Middle-Aged Adults Drink Alcohol?

Middle-aged adults today have a relaxed relationship with alcohol. In UK based qualitative interviews of middle-aged cohorts, drinking alcohol was considered socially normal or a habit for those experiencing well-being in later life (55, 112, 113). Alcohol use was associated with relaxation and an escape from everyday routine but also as a way of coping with stress (114, 115). An analysis of the Whitehall II cohort study (WHII) found that the most common reasons adults aged 60-69 years had increased their alcohol intake over the past 10 years was due to more social occasions and fewer responsibilities (116). Drinking for middle-aged men was reported as a way

of maintaining friendships, with pubs valued as a location for socialising (117, 118). Drinking for women in mid-life was valued as a way of taking time out of everyday life experiences, such as paid work and traditional female responsibilities, such as homemaking and childcare (119, 120).

Middle-aged adults tended to rationalise that their historical experiences of the physical symptoms of excess drinking prevented them from reaching undesirable levels of intoxication, particularly in women (115, 121). This control was rationalised by the ability to maintain key duties, such as employment and childcare, by restraining heavier drinking sessions to personal and social downtimes. Heavy youth drinking was seen as something that balanced out with age as people took on greater responsibilities in adulthood (122, 123). The greater experience of negative physical and mental side effects combined with such responsibilities was linked to reductions in more intense drinking with age (117, 124). Being critical of others drinking and expressing conformity to social norms was associated with lower risk drinking (125).

Some adults expressed scepticism of the risk of harm to health from alcohol and preferred to apply self-assessed limits on what is considered to be safe (121, 126). There may be a lack of awareness of the long term health risks associated with socially unproblematic drinking, or a reduced perception of risk in those maintaining good health (42, 127). The process of 'othering' by associating risk with perceived problem behaviours in others, is associated with an underestimation of one's own risk (112, 128). The interaction of alcohol with medication use may not be considered a serious issue for some and drinking alcohol for medicinal reasons, such as heart disease, is reported (42, 129).

In early mid-life, there may still be peer pressure to drink and become intoxicated, particularly in men, that was described as a loss of control (115, 130). Self-criticism and drinking to cope were associated with an increased risk of hazardous drinking that may be linked to poor mental wellbeing (125, 131). Whilst the UK qualitative literature provides a good discourse on the motivators and justifications for drinking in middle-age, studies do not separate the attitudes of 'responsible drinkers' and the 'problem drinkers' that they compare themselves to. However, interviews with hospitalised drinkers and former dependent mid-life drinkers found that risk alcohol consumption was driven by similar themes of drinking to socialise, the influence of others on behaviour, using alcohol to cope with difficult life events such as bereavement, and drinking associated with routine contexts (132, 133). The ease of drinking at home without having to consider transport or personal responsibility was reported as facilitating heavier drinking sessions (113, 132). Ageing individuals prefer to drink in private homes as this was associated with reduced cost, greater convenience and feelings of safety with drinking (134, 135).

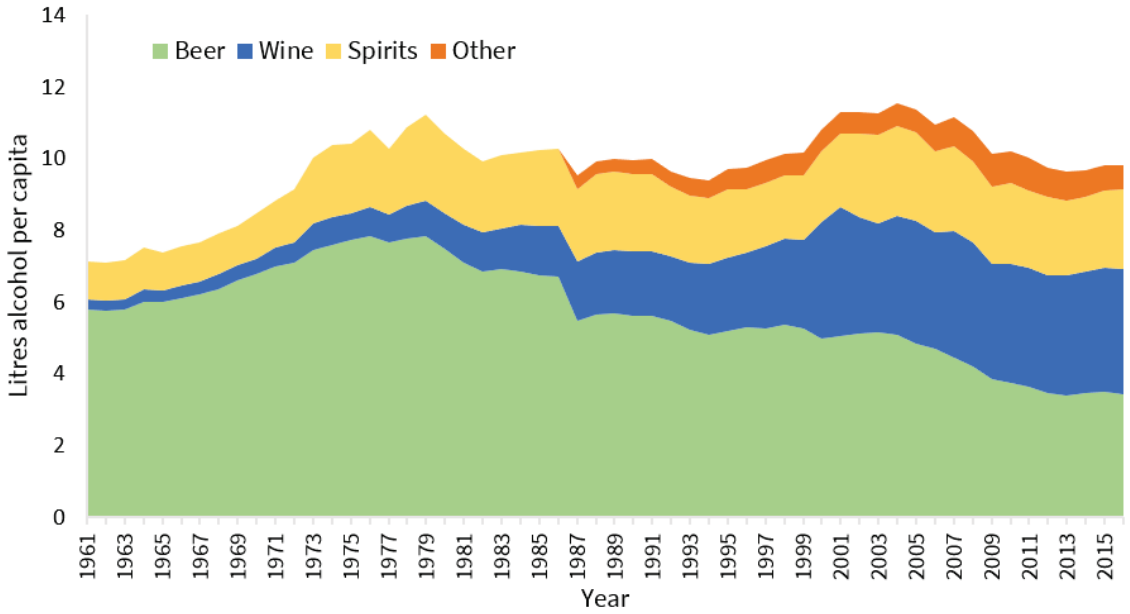
2.1.2 Temporal Contexts

This thesis focuses on adults aged between 45-69 years as a lifecourse stage, however age-specific trends in alcohol consumption can be impacted by further temporal processes involving events and attitudes of the time (period) of study and that of the era that an individual grew up through (birth cohort) (76). This section briefly considers the impact of potential period contexts on drinking behaviours to the current cohort of middle-aged adults in the UK.

The attitudes towards alcohol use by middle-aged adults in the UK are somewhat reflective of the ambiguity of risk by health campaigns until more specific unit guidelines were introduced in the late 1980s. Initially targeted only at heavier drinkers in the 1970s, population-level campaigns in the 1980s introduced the concept of 'sensible drinking', warning that too much was associated with undesirable intoxication including social and economic consequences, rather than specific health risks, a campaign that persists today (136). Population surveys suggest that today adults may be unaware of the link between alcohol consumption and cancer (137, 138). The notion of individual responsibility for one's own drinking risk is considered a response to the liberalisation of the market as alcohol becomes increasingly accessible and affordable, a topic discussed later in this literature review (139, 140).

Population-level alcohol consumption in Britain has risen since at least the 1950s, peaking in 2004 at 11.6 litres per capita, and remaining above nine litres since the 1970s as shown in Figure 2.1 (141). Until the 1980s birth cohort, successive post-war birth cohorts have been drinking greater alcohol volumes overall, particularly in lighter drinkers, raising levels of consumption in later life compared to previous generations (76, 142). Alcohol use has changed from a masculine pursuit limited to pubs in the 1960s to a socially accepted behaviour for both men and women, now available at home, accepted in public spaces and events, with greater tolerance, normalisation and pursuit of intoxication (122). This change in use is also associated with a change in beverage preferences with a shift from the beer to wine sector as shown in Figure 2.1 (141).

Figure 2.1 Population-level alcohol consumption in the UK by beverage type since 1961 (all ages).



Litres per capita, pure alcohol, aged 15+ years. Includes recorded (three-year average) and unrecorded alcohol (yearly estimate), adjusted for tourist consumption (assuming similar consumption abroad as in home country), submitted by the Office for National Statistics (Indicator metadata registry). Data source: World Health Organisation Health For All Database (141).

Analyses of the General Lifestyle Survey (GLS) since 1980 have noted a period increase in female consumption compared to male trends (76, 143). Drinking in women has become socially acceptable and more visible in public as women have entered the labour market and developed more economic independence (53, 144). There has been a notable convergence of male to female alcohol consumption internationally (38, 145). However, there is evidence that some women, particularly in lower-income groups, still feel a stigma towards alcohol use in a formerly male domain (64, 146).

Although the population level of alcohol consumption for the UK appears to have plateaued since 2012 (Figure 2.1), such trends cannot reveal the underlying nature of changes in subgroup consumption (76). The collectivity theory of alcohol consumption, developed in the 1980s, popularised greater application of policy to the population level where it was theorised that changes in median consumption were expected to be reflected through all quantiles of intake (147, 148). However, recent research endorses the importance of considering subpopulation trends as alcohol intake has been found to differ by age, sex and birth cohorts (76). Whilst the post-2004 decline in population-level consumption has been partially attributed to declines in

intake by young adults aged 16-24 years, the consumption trends in older adults and heavier drinkers over this time are less clear (31, 149).

2.1.3 Trends in Risk Alcohol Consumption

In the UK, there are no published studies that have analysed recent period trends in risk alcohol consumption specifically for the middle-aged population. In this thesis, risk alcohol consumption refers to intake above the UK weekly guidelines (former or current thresholds) or a high volume of units in a single drinking session (binge drinking), defined in greater detail later in this literature review (see section 2.2.3). The published age-period-cohort analyses only consider a linear unit intake per week, rather than risk thresholds, and no analysis has covered intake over the past decade (76, 93, 142). Such studies hide the extent of risk drinking in the middle-aged population as average weekly unit intake tends to appear stable or declining with age.

Descriptive trends from cross-sectional health surveys in 2017 suggested that 31% of English and 34% of Scottish drinkers aged 45-64 years were at risk of chronic alcohol-related harm by drinking more than the low-risk alcohol guideline in a typical week (14+ units in both sexes) (94, 150). These figures hide that almost twice the number of men in this age group are exceeding the guidelines compared to women (a ratio of 1.7) at 39% of male drinkers in England and 44% in Scotland. Between 2012 and 2018, the percentage of weekly risk drinkers aged 45-64 years has fluctuated between 31% in 2017 and 36% in 2013, suggesting a downward trend (12). The risk of acute harm by binge drinking is less gendered in middle-age with 29% of male drinkers and 22% of female drinkers in England binge drinking on their heaviest day in the previous week. These binge drinking figures have remained within 1-2% of estimates since 2012. Longer trends in intake are less clear due to changes in measurement methods and risk thresholds over time, as discussed further in Chapter 3.6.3 (151). These high levels of risk intake have translated into a high burden of alcohol-related harm as explored in the next section.

2.2 Alcohol Consumption and Health Impacts

Alcohol consumption is the second largest modifiable behavioural cause of death and morbidity in adults aged 45-69 years from the UK, after smoking (measured as the number of DALYs[5] per

[5] DALYs: Disability-Adjusted Life Years: Measures burden of disease through years of life lost due to premature death and years lost to due to disability (152). Calculated from health survey and recorded alcohol data, adjusted for unrecorded and tourist consumption.

100k persons in 2017) (6). Alcohol-related DALYs in this age group rose until 2006, largely coinciding with the peak of alcohol consumption per capita in 2004, as previously shown in Figure 2.1 (6, 153). Middle-aged adults suffer from more DALYs related to alcohol use than younger or older age groups due to their level of consumption and a higher risk of disease from ageing processes (6, 154). Ageing increases susceptibility to alcohol's biological effects due to slower metabolisms and higher body fat ratios and may be complicated by interactions with prescription medications (155, 156). This ageing effect causes a shift in the main cause of alcohol-related harm through middle-age (as DALYs), from alcohol use disorder[6] at age 45-49 years to alcohol-related cancers at age 60-64 years (6).

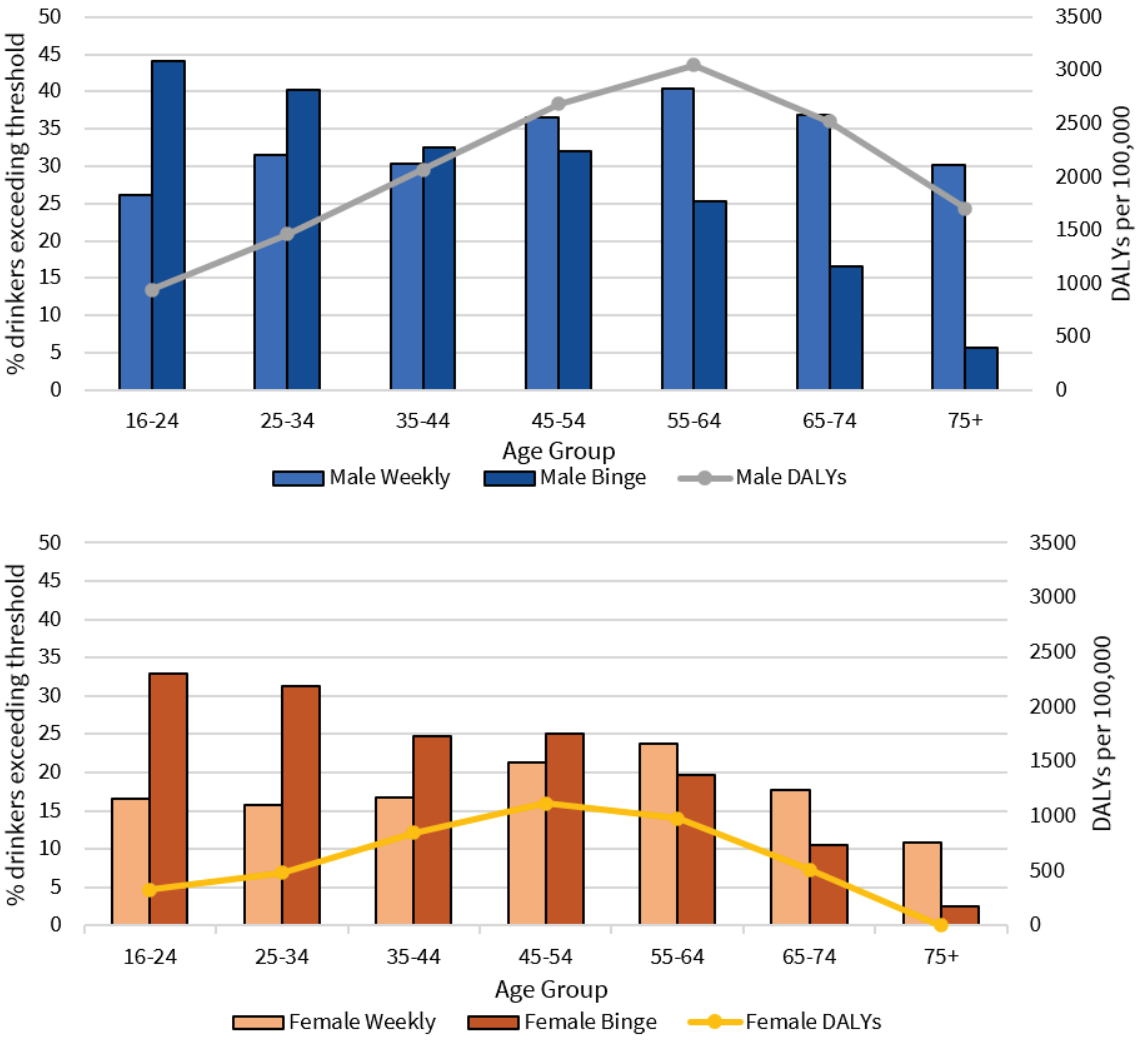
The greater susceptibility to alcohol's immediate effects tends to cause a decline in the average volume of alcohol consumed with age, particularly a reduction in heavy acute alcohol intake (binge drinking) after young adulthood as displayed in Figure 2.2 (93, 124). However, such analyses do not reveal that the heaviest drinkers are more likely to maintain their consumption with age compared to lighter drinkers and that consumption patterns become more associated with higher weekly volumes than acute drinking episodes (Figure 2.2) (76).

Ageing women are biologically at greater risk of negative health outcomes from alcohol consumption than men, even when consuming the same dose of alcohol, due to lower lean muscle mass and lower levels of alcohol dehydrogenase enzyme (41, 157). As a result, the burden of harm begins earlier in women with alcohol-attributable DALYs highest in women aged 45-59 years but in men aged 55-64 as displayed in Figure 2.2. Women are at a higher relative risk of liver cirrhosis at any intake of alcohol (41) and female problem drinkers (defined by CAGE[7]) are at more risk of developing depression or anxiety (159). However, as men tend to drink more alcohol than women overall, the burden of alcohol-related harm is greatest in middle-aged men (152).

[6] DSM-V Definition: Compulsive alcohol use, loss of control over intake and negative emotional state when not using.

[7] CAGE questions: *Have you ever felt you needed to Cut down on your drinking? Have people Annoyed you by criticizing your drinking? Have you ever felt Guilty about drinking? Have you ever felt you needed a drink first thing in the morning (Eye-opener)? (158).*

Figure 2.2 Exceeding the guidelines in drinkers versus alcohol-related harm (DALYs) by age group (England).



Weekly refers to chronic intake (exceeding the weekly 14+ guidelines), binge refers to acute heavy intake, the measurement of which is discussed later in this review. Data source: Health Survey for England (HSE 2017) (94), Global Burden of Disease 2017 (6).

The health impacts of alcohol can be separated by chronic exposure to the body from consumption over time or from the side effects of acute intoxication reducing inhibitions and co-ordination (41). The level of harm from alcohol to health is mostly dose-dependent affecting multiple biological systems including the liver, pancreatic and vascular systems, with both ethanol and its metabolic by-product acetaldehyde considered carcinogenic at any level (160). The time lag for chronic alcohol conditions to fully develop can be 5 to 20 years (23). Intoxication is associated with an increased risk of behavioural dysfunction, poisoning and injuries. Binge drinking may also be a risk for cardiovascular disease, even in usually light drinkers, due to its ability to raise blood pressure and increase the risk of arrhythmias (41, 161). Because of these

differing health outcomes and causal contexts, chronic and acute drinking tend to be measured as separate risk behaviours although inevitably some drinkers will perform both (162, 163).

2.2.1 Physical Harms of Excess Alcohol Consumption

Alcohol consumption contributes to approximately 8% of all deaths in adults aged 50-69 years mainly from alcohol-associated cancers (Breast, Colorectal, Oesophageal) and liver diseases (6, 164). Although rising until 2006, the number of alcohol-related deaths has plateaued in UK adults aged 50-69 years since 2012 (6). In England 2015/16, 39% of hospital admissions with an alcohol-related diagnosis (narrow measure[8]) were in persons aged 45-65 years (165, 166). The proportional contribution of alcohol to a hospital admission is calculated using alcohol attribution factors (AAF), displayed in Table 2.1 (165). Alcohol-related conditions are separated by the wholly or partial contribution of alcohol use and whether partial conditions developed due to acute intoxication or chronic exposure (166).

Table 2.1 shows that women aged 45-64 years have an unequal burden of partially chronic conditions due to breast cancer compared to men, whilst men have a higher percentage of partially acute conditions (injuries). About a third of admissions are wholly attributable with men more likely to be admitted for dysfunctional behaviour related to intoxication and women more likely to be admitted due to intentional self-poisoning (overdose). The impacts of alcohol are not limited to physical or mental outcomes but the associated reductions in health and social function can lead to negative social impacts as described in the next section.

Table 2.1 Alcohol-related hospital admissions in England for aged 45-64 years 2018/19 including alcohol attribution factors.

ICD-10 Code	**Condition**	**Alcohol Attribution Factor**		**Percentage of total admissions 2018/19**	
		Male %	**Female** %	**Men %**	**Women %**
Wholly Attributable				**34.0**	**29.9**
F10	Mental & behavioural disorders including acute intoxication and withdrawal	1.0	1.0	15.0	9.8
K70	Alcoholic liver disease	1.0	1.0	10.8	8.3
X65	Intentional self-poisoning	1.0	1.0	4.1	8.9
	All other wholly	1.0	1.0	4.1	2.9

[8] First line diagnosis or secondary diagnosis with an external cause recorded on hospital admissions form as opposed to an alcohol related condition appearing on any line of the admission form (broad measure).

(Continued from previous page)

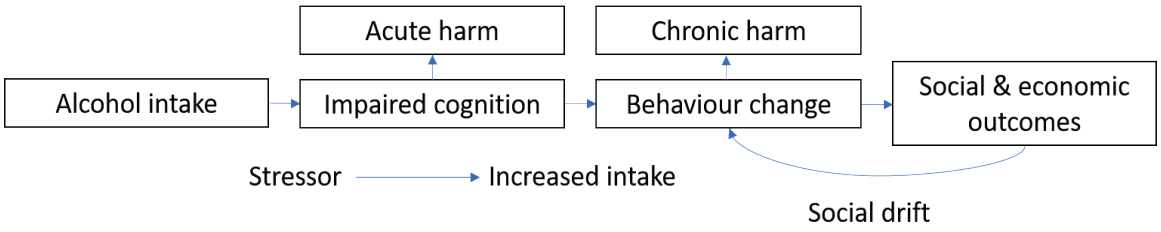
Partially Attributable - Chronic				**39.5**	**54.5**
C00-14	Oral cancer	0.46	0.41	5.4	2.7
C15	Oesophageal cancer	0.63	0.52	5.5	2.0
C18-21	Colorectal cancer	0.19	0.13	7.5	5.9
C50	Breast cancer	0.00	0.14	-	29.7
G40-41	Epilepsy	0.37	0.24	2.3	1.8
I110-15	Hypertensive disease	0.27	0.28	1.3	2.1
I47-48	Cardiac arrhythmia	0.18	0.12	5.2	2.6
K85-86	Acute and chronic pancreatitis	0.43	0.19	3.1	1.7
	All other chronic			9.2	6.0
Partially Attributable – Acute				**26.6**	**15.6**
Multiple injury codes V, X, Y	Road accidents	Depends on morbidity or mortality from injury		1.5	0.6
	Falls			6.0	4.2
	All other unintentional injuries			16.9	9.6
	Intentional Injury including self-harm, assault			2.2	1.2
Total Admissions				**86,980**	**54,420**

Based on narrow measure, AAF averaged for age group. Data source: Statistics on alcohol using hospital episode statistics (166), AAF from LAPE 2017 user guide (165).

2.2.2 Social Harm of Excess Alcohol Consumption

Alcohol's negative social impacts are related to its ability to reduce inhibitions and change personal behaviour (167). Lower cognition and hangovers associated with alcohol use were related to inferior performance and absenteeism from work (168). In a study of the Health Survey for England (HSE) 1998/99, CAGE problem drinking was associated with a statistically significant reduction in the probability of working in men aged 24-64 years (169). This potential impact on social status could lead to social drift (the downward movement in social class due to reductions in health), promoting further drinking, potential dependence and economic instability, as shown in Figure 2.3 (167). Heavy drinking (by exceeding the former weekly guidelines or CAGE) was associated with greater risk of early transition out of employment in the WHII and English Longitudinal Study of Ageing (ELSA) cohorts (170, 171).

Figure 2.3 Theoretical pathways to social harm from alcohol use.



Adapted from the Centre for Public Health (167).

The estimated cost to the National Health Service (NHS) and the wider effects of alcohol use on society and productivity is contested due to a lack of updates. Costs are likely to be at least 1% of gross domestic product (GDP), the equivalent of at least £19 billion in 2016 involving losses from health care, crime, work productivity and family problems (25, 172). In 2016, the income from alcohol receipts to HM Revenue and Customs was £10.9 billion (173). This has raised the discussion that alcohol taxation, a fiscal policy discussed later in this review, is too low to outweigh the costs from harm and lower economic productivity (174).

2.2.3 Low-Risk Drinking Guidelines

As part of strategies to reduce alcohol-related health outcomes, governments have developed 'low-risk' drinking guidelines. Such thresholds are designed to provide informed choice for limiting alcohol consumption to that associated with minimal consequences to individual health (175). Unlike smoking, alcohol is used within a harm reduction framework rather than encouraging total reduction (176, 177). This is typically 1 in 100 persons for a lifetime risk of alcohol-related harm to health (but not societal harm) (175). These thresholds are often used as outcomes in understanding risk alcohol consumption in research, although this can reduce cross-country comparisons that have different definitions (178).

The low-risk threshold is developed using dose-response relationship curves of consumption to health harms derived from epidemiological studies (41, 179). Selecting a threshold can involve different risk approaches such as the absolute risk of mortality from an average daily intake or the relative risk from the current population levels of consumption, taking into account the potential benefits of consumption, discussed later in the next section of this review (180). As average dose-response curves do not consider the impact of different drinking patterns, some guidelines have developed two limits to account for risk from chronic intake per week and intake during acute drinking occasions (181).

As a result of such development choices, guidelines vary across countries and are subject to updates in evidence, particularly as the definition of alcohol content by the use of units or standard drinks also varies by country (182, 183). In the UK, alcohol content is defined by units where one unit is equal to 8 grams of pure alcohol per 10ml. The UK government introduced a weekly low-risk guideline of 21 units in men and 14 units in women in 1987, accounting for the biological sensitivities between sexes (180). Due to concerns of individuals concentrating their weekly units for one heavy weekend dose, a daily guideline of no more than 4 units for men and 3 units for women was later introduced, which then gave rise to encouraging alcohol-free days (184). This definition fell out of favour as it was seen as incompatible with the UK's preference for inconsistent higher volume drinking patterns (185). Based on a review of the evidence, the weekly guidelines changed from 21 to 14 units in men in 2016 based on a 1% lifetime risk of mortality (11). This was related to new evidence of the risk with cancer, concerns about the reported relationship with cardiovascular health and that the risks from lower intakes of alcohol appear similar between sexes (175, 180, 186). The new guidelines retain the suggestion to take alcohol-free days to avoid habit making, although there is a lack of evidence to suggest this is beneficial to health other than in those who are problem drinkers (180). There were no specific guideline thresholds made for single occasion drinking or specific age groups (187).

The lack of a specific unit guideline to reduce binge drinking episodes may be due to limited epidemiological evidence for irregular drinking patterns on long term health outcomes, difficulties in determining an acceptable lifetime risk for alcohol-related injury and variations in individual tolerance for intoxication (41, 188). The 2016 alcohol guideline review suggested that risk in the hours after a single drinking occasion started above 5-7 units which is in line with evidence from event-level analysis (180, 189). In UK surveys, binge drinking is typically defined as consuming above 8 units in men and 6 units in women on their heaviest drinking day in the previous week, although former thresholds of 5 or 10 units have been used in older studies (190, 191). Rather than scientific, the 8/6+ definition represents double the former UK daily guidelines. This supports a newer definition of binge drinking to single occasions rather than an older concept of heavy drinking over several days (191). Appearing in surveys such as the General Household Survey (GHS) in 2002, the origins of the choice of this threshold are unclear with discrepancies such as the use of >8 units or ≥8 units in initial reports (191, 192). However, the >8/6 is now the definition of binge drinking used in most UK surveys and is in line with the WHO definition of at least 60g of pure alcohol on an occasion which is the equivalent of 7.5 units (190).

To summarize, Box 2 shows the main thresholds associated with alcohol consumption with raised risk to health for the purposes of this thesis, referred to as 'risk drinking'.

Box 2 Definitions used to define risk alcohol consumption in the UK.

- Increased risk for chronic harm is related to drinking over 14 units per week in both men and women. This was formerly 21 units in men and 14 units in women. Drinking below this threshold is referred to as moderate drinking.
- Increased risk for acute harm is related to drinking over 8 units in men and 6 units in women on a single drinking occasion or day. This is known as heavy episodic or 'binge' drinking. Extreme binge drinking consists of 16+ units in men and 12+ units in women.
- Problem drinking that is associated with harm, dependence or disorder is usually associated with thresholds above 50 units for men and 35 units for women per week. Problem drinking can be screened using an alcohol use disorder identification test (AUDIT) or CAGE questionnaire tools designed to detect this form of drinking (418).
- Drinking above the unit guideline threshold but below that related to problem drinking is referred to as hazardous drinking at 21-50 units in men and 14-35 units in women (465).

2.2.4 Cardiovascular Health and Non-Drinkers

As previously noted, some guidelines take into account the potential health benefits of low dose alcohol consumption. The consumption of up to 3 units of alcohol per day (<30g) is associated with a reduced risk for ischaemic heart disease and type II diabetes (193, 194). The specific mechanisms for this, such as a protective increase in high-density lipoprotein (HDL), are still being investigated (195). However, chronic risk volumes exacerbate hypertension and negatively impact vascular function (196-198). Binge drinking removes any cardioprotective effects that may be produced from regular low dose drinking and is a risk for acute hypertension and atrial fibrillation (188, 199). Moderate alcohol intake may be associated with a reduced risk of cognitive impairment in later life, however it is difficult to account for the social benefits of alcohol use on cognitive health and even moderate use was associated with hippocampal atrophy in the WHII cohort (200, 201). Accounting for alcohol's negative effect on other diseases, such as cancer, and the risk for unintended increases in consumption, the risk-benefit of alcohol use may only be positive in adults aged over 80 years or those at higher risk of cardiovascular events (152, 187, 202).

The cardioprotective effect of alcohol at low doses has been associated with a J-shaped or U-shaped curve between alcohol consumption and all-cause mortality suggesting that abstainers may miss a health protective effect (179, 194). However, this relationship has undergone

methodological scrutiny in recent years in terms of using non-drinkers as a reference group (203). Research suggests that choosing not to drink may be associated with health factors that may exaggerate the protective effect observed in moderate drinkers through selection bias (204, 205). Non-drinkers are associated with worse health status than low-level drinkers. Having a persistent chronic illness across adulthood was associated with remaining a non-drinker at follow-up in the National Child Development Study (NCDS cohort) (206). Similar results were found cross-sectionally in young adults in an analysis of the HSE, adjusting for income and education (207). Developing an illness with age was also associated with cessation or reduction in consumption, particularly in women, with the healthiest individuals being more likely to continue drinking (208, 209). Ex-drinkers are a form of abstainer that are more likely to report poor self-rated health and may have a greater risk for ischaemic heart disease even after cessation (210, 211). True lifetime abstainers are difficult to ascertain with most abstainers reporting some drinking occasions throughout life (212).

Non-drinking is associated with low income and deprived areas in the UK which may have indirect health impacts, as explored in the next section of this review (213-215), including ex-drinkers (216). A New Zealand based study found that when controlling for socioeconomic status, the positive effect of moderate drinking in older adults was no longer found as higher socioeconomic status was associated with better health (217). Ethnicity related non-drinking has been linked to greater socio-cultural and religious norms, particularly in regional communities where there are less external pressures to conform (218, 219). This norm may be changing with the acculturation of younger British born members of minority ethnic groups (220). A multilevel Dutch study found that the lower rate of risk drinking in deprived areas was due to the clustering of ethnic minorities in such areas (221). These characteristics suggest that studies need to consider the role of abstainers in low-risk reference categories to avoid selection bias, particularly for studies of populations where moderate drinking is the common behaviour (205).

2.2.5 Promoters of Alcohol-Related Harm

Although analyses have not been performed specifically in the middle-aged population, alcohol-related hospitalisations are higher in those who live in deprived areas in England (39, 222), Wales (215, 223) and Scotland (216, 224), including in individuals with low social class in two studies (215, 224). A similar relationship was found for social class or area deprivation and alcohol-related mortality in England, Wales (225-227) but not in Northern Ireland (228). By English regions, age-standardised alcohol-related deaths and DALYs are highest for the North East and

West regions (6, 229) with the North of England associated with health inequalities linked to regional economic decline (230, 231).

Whilst exceeding the low-risk guideline is associated with a greater risk of alcohol-related hospitalisation (179), low individual-level socioeconomic status or living in a deprived area was associated with a greater risk of harm that could not be explained by the volume of alcohol consumed (216, 224). The investigation into the cause of this inequality has been termed the alcohol-harm paradox (232). Scottish studies indicate that social drift is unlikely to explain this relationship where it was theorised that the social impacts of alcohol use, as previously described, could lead individuals to social disadvantage through a loss of work or job status (224, 233).

A limitation of hospital episode statistics is that they do not differentiate between residents and temporary migrants to an area (internal or external). Therefore, tourist-related alcohol consumption could account for high levels of retail purchases and hospitalisations where reported intake by surveys of residents is low. The South West region (defined as Cornwall and Devon) was found to have below average alcohol-related mortality despite its higher than average retail consumption (234). The majority of studies have investigated the relationship of alcohol-related hospitalisation with an area-based measure of deprivation (such as the index of multiple deprivation) rather than at the individual level, which has its own limitations by inferring neighbourhood level characteristics to individuals, as explored later in this literature review (235).

Part of the paradox relationship has been attributed to the impact of binge drinking patterns, which are more likely in deprived areas in studies using all ages, compared to only considering total weekly alcohol volume (216, 232, 236). Whilst an area socioeconomic gradient was found for wholly attributable and partially acute alcohol-related hospitalisations, particularly in men, this was not found for partially attributable chronic conditions that are caused by long term alcohol exposure (39, 222). Although not in a published study, descriptives suggest that the relationship of alcohol-related harm with North England reduces with age, with high morbidity rates in London and the South East after the age of 70 years (6). This may be due to the increase in partially attributable conditions in age, survivorship bias (mortality of the heaviest drinkers at younger ages) and reductions in binge drinking with age.

Behaviours found to exacerbate alcohol-related morbidity include smoking (237-239), sedentary behaviour (240, 241) and raised body-mass index (BMI)[9] (242). Such co-risk behaviours tend to cluster in individuals of low socioeconomic status or living in deprived areas (237, 243). However, a Scottish hospitalisation study found that alcohol-related inequalities in harm remained even when taking into account volume and pattern of alcohol consumption and both smoking and BMI (224). Having a long-term illness or poor mental health as comorbidities were associated with a greater risk of hospitalisation and worse alcohol-related outcomes (215, 244, 245).

Increased alcohol intake is associated with worse mental wellbeing scores and increased risk for acute mental health hospital admissions (246). However, the direction of causality is still unclear in that poor mental health may lead to increased consumption, but this may exacerbate negative mental health symptoms in the long term (247). Comorbidity for alcohol use disorder and major depression or anxiety is associated with slower recovery rates when hazardous drinking is maintained (248-250). Survey data from the HSE suggested that drinking volume was more important than drinking frequency in this relationship (251, 252). Improvements in mental health (SF-36) were associated longitudinally with a reduction in binge drinking frequency (10/7+ units) in problem drinkers (253) whilst poor mental health was associated with increases in weekly units over time in the WHII cohort (254). Drinking for coping reasons was an important motivator for alcohol use in those with poor mental wellbeing in a UK online survey, whilst low-risk drinkers were more likely to have higher wellbeing scores (Short Warwick-Edinburgh Scale) (131).

Smoking is an independent risk factor for numerous cardiovascular and lung conditions, however the combination of smoking with higher risk alcohol intake is associated with higher rates of oesophageal cancers and all-cause and stroke mortality (6, 239, 255). The consumption of alcohol in smokers is significantly correlated in surveys for both problem drinking, units per week and frequency of drinking in adults over 50 years (101, 256, 257). The causality of this relationship is less clear and has been attributed to cue behaviour, particularly during binge drinking, intoxication-related reductions in perceived risk and tandem motivation for healthier lifestyles with smoker quit attempts, rather than due to interacting substance use (258, 259). Changes in population-level smoking prevalence in England were associated with changes in AUDIT[10] problem drinking scores (260). Using pooled cross-sectional data up to 2014, the public smoking ban of 2007 led to a long term reduction in on-trade purchasing by smoker households. (261).

[9] Body-mass Index measured as weight (kg) divided by height (m^2) with >25kg/m^2 classified as excess weight.

[10] Alcohol Use Disorder Identification Test - a validated ten question test to determine if a person is at risk for chronic problem alcohol use.

Although it is unclear if drinking was replaced by off-trade purchases, as there was no statistically significant change in off-trade expenditure, it suggests a prioritisation of smoking behaviour to the social benefits of on-trade.

Obesity is an independent risk factor for cardiovascular disease and diabetes but raised body weight may interact with risk alcohol consumption to produce higher mortality rates for liver disease (6, 242). Alcohol consumption may also be a promoter of increased body weight however the investigation of this relationship is complex due to the potential for unmeasured confounders of weight gain and different drinking patterns leading to mixed outcomes (262, 263). Cross-sectional evidence from the UK suggests that drinking volume is more important to this relationship than drinking frequency and daily drinking may be associated with lower body weight (264, 265). Evidence for one such confounder is the clustering of higher alcohol purchases with other unhealthy food choices (high in added sugar or fat) and lower fruit and vegetable purchases, particularly in low-income households in the UK Expenditure and Food Survey (EFS) (266). Increasing alcohol expenditure was associated with lower food purchases overall. Whilst not evidence for actual consumption, lower quality nutrition could contribute to the inequalities of alcohol-related harm by exacerbating conditions such as cardiovascular disease (6). The impact of drink type to alcohol-related hospitalisations is still being investigated with a potentially elevated risk from beer and spirits but not wine, however this may be due to socioeconomic preferences (215, 223, 267).

So far, this literature review has considered the evidence for the role of alcohol use in middle-age, how this relationship impacts health and how such impacts may be exacerbated by co-risk behaviours. The next section of this review moves on from harm to consider the evidence for how risk alcohol consumption in middle-age is characterised at different levels of the social-ecological model including individual, area and macro-level factors. Studies using all adult ages samples are only considered in this literature review where no age-specific evidence is available, particularly for area and macro-level factors. Population representative studies using all ages may not report the adjustment for age in their analysis and such studies provide limited insight into the middle-aged population as they infer that statistically significant associations apply to the whole of the lifecourse (236).

2.3 Individual-Level Factors

2.3.1 Socioeconomic Status across the Lifecourse

Socioeconomic factors reflect measures of economic or social position within a society that may influence alcohol consumption through different levels of resources, social exposures and opportunity (268). There is no single measure of socioeconomic status and different measures at different ages may reflect lifecourse changes. Such factors tend to be correlated in that the gaining of skills and education leads to the acquisition of wealth and resources. Cohort effects may need to be taken into account for factors such as education where compulsory years have increased over time and higher education opportunities for women were previously limited (66). Childhood experiences and parental social class may impact later behaviours through the accumulation of social exposures and access to resources across the lifecourse (21, 269). Individuals who drank at least three units of alcohol in the previous week at age 16 were more likely to binge drink at age 42 than those who drank less or no alcohol (defined as 10/7+ drinks on a typical occasion) (270). However, the impact of childhood socioeconomic status on later alcohol use was inconclusive in a systematic review (271).

The relationship of socioeconomic markers with risk alcohol patterns has been investigated using various cohort studies to assess the impact over time. These include the 1958 Birth Cohort (NCDS), 1970 Birth Cohort (BCS70), an all-male Scottish cohort aged 35 from 1986 (Twenty-07), and ELSA which is the only cohort to investigate alcohol use in adults over 60 years of age. There have been no studies using cross-sectional health survey data to investigate middle-aged drinking and birth cohorts are limited by their use of older binge drinking measures, cohort selection bias (272) and lack of sex stratification in analyses.

Gaining educational qualifications reflects the acquisition and access to intellectual resources which has long term consequences on employment opportunities (268). Compared to no qualifications, degree education was associated with higher consumption of units in the previous week in men and women in ELSA, however this measure does not reflect risk drinking patterns (101). Problem drinking (50/35+ units) was negatively associated with degree education in both sexes in a further ELSA study (256). Similar statistically significant negative associations with degree education were found for binge drinking at age 42 years in BCS70 and age 50 in the NCDS (both defined as 5+ drinks on a typical day) (273, 274), and CAGE problem drinking at age 45 in the NCDS (275). Leaving school at an earlier age (12-14 years) compared to later (15-19 years) was associated with a greater risk of exceeding the former weekly guidelines and CAGE problem

drinking in Twenty-07 (276). Therefore, higher education may have a negative association with risk drinking in these middle-aged cohorts.

Housing tenure may be reflective of collective material resources if living in privately owned accommodation. This may vary by geography, such as in London where high income private renting is common (277). Non-private or rental tenure was associated with exceeding the former weekly guidelines in men aged 59 in Twenty-07 and CAGE problem drinking at age 45 in the NCDS (275, 276). Income is a more direct indicator of access to resources via expenditure and can be more reflective of short term changes in circumstances (268). In ELSA, higher income was associated with a higher intake of units in the previous week in both sexes and with problem drinking in women but not men (101, 256). There was also no association of income in men for exceeding the former weekly guidelines or CAGE problem drinking in Twenty-07 (276). The contrasting results with tenure and sex suggest a more complex relationship between risk drinking and material wealth.

Occupational social class may be used as an indirect measure of income and social position in employment which may be associated with different exposures from the working conditions or social networks (268). Social class may be difficult to apply to non-working positions such as homemaking or retirement. Manual social class compared to non-manual was associated with a greater risk of CAGE problem drinking at age 59 in Twenty-07 and age 45 in the NCDS (275, 276). Professional social class in both individuals and their parents at birth was negatively associated with binge drinking at age 42 in BCS70 (273). There was no association with social class at age 50 in the NCDS but there was a negative association of binge drinking with professional parental social class in separate and combined models with individual social class (274). Like education, higher occupational social class may be negatively associated with risk drinking in middle-age.

2.3.2 Retirement

Retirement is a major lifecourse event that is particular to those in late middle-age. The percentage of individuals in employment changed from 71% at age 50-64 years to 10% in those aged over 65 years, using the 2016 UK Labour Force Survey (95). Retirement may lead to changes in financial resources, routine structure, responsibility maintenance and social groups which were factors indicated with alcohol use in the previously discussed qualitative literature (116, 278). The evidence so far suggests that retirement is not directly associated with risk alcohol consumption but may play a role in changes to the aforementioned social and economic situations (279). In ELSA, being in retirement was not associated with problem drinking (256).

However, a transition to retirement was associated with a reduction in units consumed in the previous week in both men and women (101). Qualitative research from Scotland suggested that retirees adapted their pre-retirement drinking habits to new social contexts or reduced their drinking if social opportunities decreased (135). Although this qualitative research suggested that social isolation in later life may be a risk factor due to the privacy of lone drinking, loneliness (measured with the revised UCLA loneliness scale) was not associated with risk drinking in surveys of adults at least 50 years of age (256, 280). Retirement related changes may be associated with stress, particularly in those with mental health issues, involuntary retirement or lower social class that may lead to a temporary risk for excessive alcohol use in vulnerable individuals (279, 281, 282). No UK studies have assessed how transitioning to or long-term retirement is associated with exceeding the low-risk alcohol guidelines.

2.3.3 Marital, Employment and Family Roles

In the previous discussion of the qualitative literature (2.1.1), middle-aged adults expressed that heavy drinking was something that reduced with increased responsibility and experience with age (124, 130). This has been explored quantitatively using British birth cohorts considering the impact of employment, marital status and having children on alcohol consumption through mid-life.

In the NCDS birth cohort up to 50 years of age, being in employment was associated with consuming more units per week in both sexes than non-employment or homemaking (102). However, this linear association with units does not assess risk drinking and there was no statistically significant association of being in employment with CAGE problem drinking. Transitioning from homemaker to employment in women, adjusted for education, was initially associated with a statistically significant reduction in units per week, however intake was found to increase over time since this transition (283). There was no association with employment status with exceeding the former weekly guidelines or CAGE problem drinking in Twenty-07 (276) or problem drinking in ELSA (256).

Being single and not cohabiting was associated with consuming more units per week in both sexes than any other marital status, including divorce, but not CAGE symptoms in the NCDS up to age 50 years (102). Units per week were found to increase over time in those who remained single (age 33-50 years) (283). However, an analysis of the NCDS using AUDIT to indicate problem drinking at age 44-46 years suggested associations with being never married or divorced in both sexes or cohabiting in men compared to being married (284). No association was found for

marital status and exceeding the former weekly guidelines or CAGE drinking in Twenty-07 or for problem drinking in ELSA (256, 276). However, a literature review suggested that the association of marital status with risk alcohol consumption was more likely during a transition in marital status than in the long term and therefore may be less relevant for stable mid-life drinkers (285). A transition analysis of ELSA found that both being single and entering a partnership was associated with linear increases in average weekly units in men but not in women (101).

Having children under 16 years of age in the household was negatively associated with units consumed per week in the NCDS (102). In ELSA, having children in the household was associated with a reduced risk for problem drinking in women but no association in men, possibly as no age for children was specified and may include adult children (256). When considering combined roles, men and women who were married, working and with young children were associated with both lower past week unit intake and a lower risk of problem drinking using the CAGE questionnaire (102).

Marital partners may influence each other's drinking behaviour through regular exposure, acceptance of marital roles and use of alcohol as a bonding activity (286, 287). Marriage may have a moderating impact on men as women may be less likely to be heavier drinking partners if conforming to traditional gender roles and biological sensitivity (288, 289). The interpersonal effect of other's behaviour on alcohol intake is not restricted to the household level but can be extended to all social groups including friends and local communities as explored in the next section.

2.4 Area-Level Factors

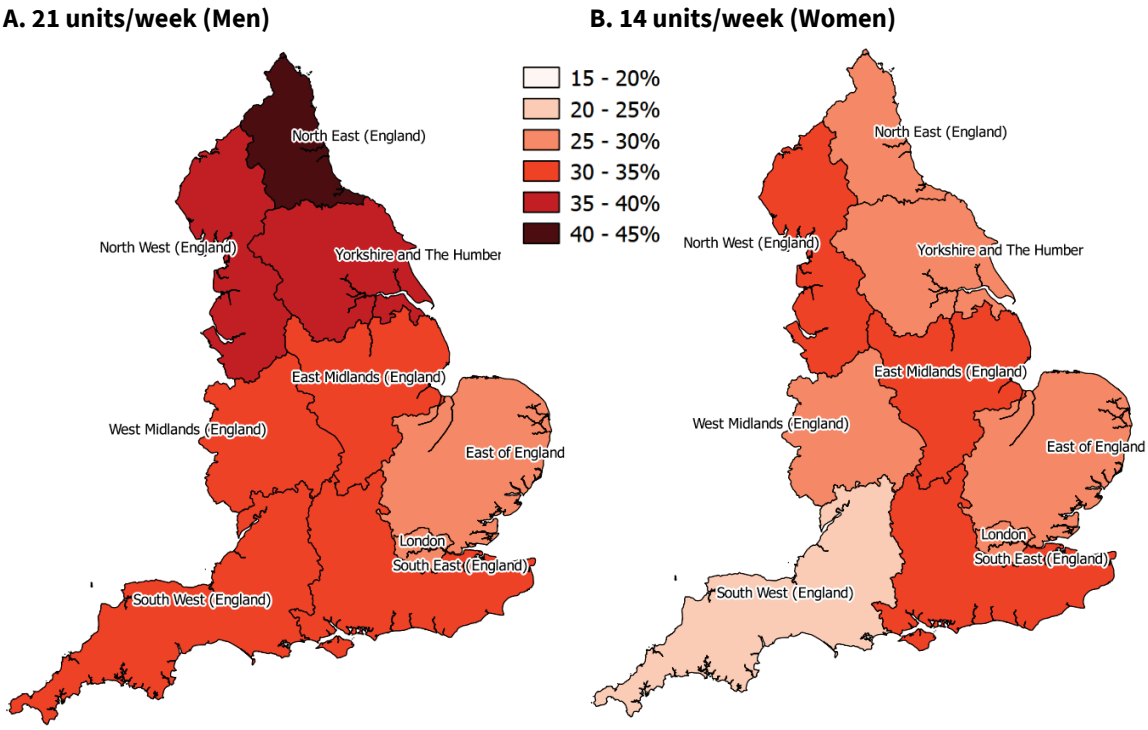
The areas that individuals live and work may have an independent impact on alcohol behaviours through both social and physical factors (290). Individuals may be influenced by the social norms of the behaviour of those in their local environment, or the area itself may contain differing access to resources or services, both of which could be sources of stress (291). Place effects are not entirely separate from individual-level factors but contextual factors may have differing impacts on residents and therefore both components should be considered in analyses (290, 292). The ecological fallacy may occur if area effects are incorrectly assumed at an individual level due to a lack of data or if assuming the same processes on an outcome occur at both levels (235). Selection bias may need to be considered if individuals choose to live in a certain area based on the area's characteristics (293).

2.4.1 Geographical Area

Regional associations for risk drinking have been published at the Government Office Region (GOR) level but not specifically in middle-aged adults. GORs are administrative regions of England which, despite their large area coverage, are able to demonstrate the health and economic inequalities that are present across regions and are therefore of interest to the investigation of regional health behaviours (294, 295).

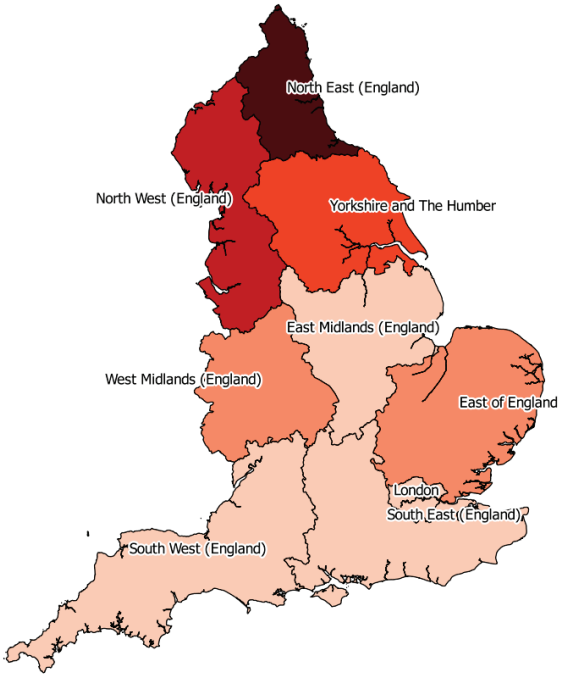
Compared to other regions in England, living in the North East had the strongest association with binge drinking in men and women after adjustment for age, ethnicity, socioeconomic status and area deprivation in analyses of the HSE using all ages (296-298). The North East, followed by the North West also had the strongest association with AUDIT scores of at least 8 for men and 7 for women, which remained after adjustment for demographics and socioeconomic status (299). No publications were available on the association of regional geography with exceeding the weekly guidelines. Figure 2.4 shows that descriptively, for adults aged 45-69 years in England, exceeding the former weekly guidelines and binge drinking was highest in the North East for men at over 40% of drinkers. A north-south gradient in the percentage of risk drinkers was strongest for male binge drinking but weaker for women exceeding the weekly guidelines. Descriptive data are limited as they do not account for the individual characteristics of the residents.

Figure 2.4 Percentage of drinkers exceeding the weekly guidelines and binge drinking aged 45-69 years by sex and GOR in 2011-15.

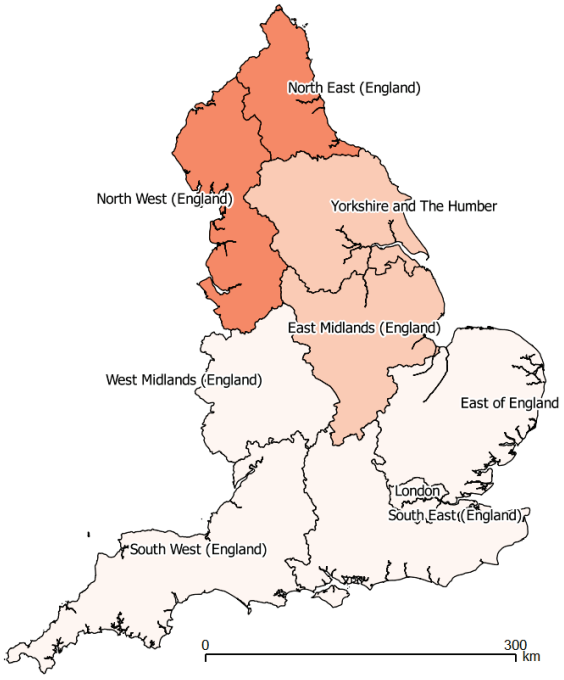


(Continued from previous page)

C. 8 units/heaviest day (Men)



D. 6 units/heaviest day (Women)



Percentage across pooled years of the HSE 2011-2015.

Regional differences provide broad trends but smaller geographical scales may suggest if there are further environmental contexts involved, such as contrasting area deprivation within regions. However, a Welsh multilevel study found that 77% of the variation in binge drinking was at the household level, with only 13% at the Lower Super Output Area (LSOA) level and 10% at the Unitary Authority level (300). Although the significance of these levels was not reported, this study suggests area-level effects on drinking may be small compared to individual or household effects. In an all adult age multilevel study of the HSE, 12% of the variation in binge drinking was found at the postcode sector level but this result was not statistically significant (214).

The analysis of geographical regions depends on the selection of neighbourhood boundaries in that the spatial scale and the positioning of boundary lines can lead to different outcomes (modifiable areal unit problem) and may not be relevant to the social processes being investigated (80, 301). One study suggested that geographical areas larger than Output Areas (OA) are not detailed enough for local-level analysis of sub-population groups (302). The common assessment of place effects related to home location ignores the relevance of 'activity spaces', such as work or leisure that may be of more relevance to the behaviour of interest (78). Alcohol may be purchased on various travel routes or shopping trips, particularly as rural locals, urbanscapes and home drinking are all part of British drinking spaces (79). Research investigating food outlets found that work and commuting routes were important contributors to the total exposure of food environments and that local neighbourhood access may not be as important to

older adults as theorised (303, 304). Without data on the locations that drinking activities occur, the appropriate spatial scale to apply in analyses of such behaviour is unclear.

2.4.2 Area-Level Deprivation

Area deprivation has been theorised to increase individual health risk through increased stress from fewer supportive resources or services and the pressures from the associated social and physical contexts (305). Lack of investment in deprived areas can result in less access to facilities and transport services leaving residents isolated. Living in large areas of deprivation may cause individuals to be less exposed to the more affluent social norms and behaviours of less deprived ones. Such place effects may last over a longer period compared to individual circumstances as area deprivation can be slow to improve and structures are fixed in place (306).

Composite scores are a common method to assess the deprivation level of small geographical areas with higher scores indicating a higher proportion of deprivation in the area on a relative scale. The index of multiple deprivation (IMD) is a combined score of seven weighted domains: income, employment, health, education, crime, living environment and barriers to housing and services applied at the LSOA geography level. IMD scores are available for the four nations but not the UK as a whole and are not directly comparable due to different calculation methods. The inclusion of health status as a domain has been criticised for potentially exaggerating the role of deprivation when associated with other health-related outcomes (307).

Area-level deprivation has been considered in cross-sectional surveys in England and Wales but not specifically in middle-age. An all-age multilevel analysis of the Welsh Health Survey, pooled for the mid-2000s and adjusted for demographic and socioeconomic factors, found that the most deprived neighbourhoods (using Welsh IMD 2005) were more likely to report binge drinking in the previous week (300). Age interactions found this association was statistically significant in adults aged 45-64 years but was weaker in women. Two multilevel all age analyses of the HSE through the 2000s, controlled for demographic and socioeconomic factors, found that individuals living in deprived areas (IMD) were more likely to have engaged in binge drinking in the previous week (214, 298). However, an all-age HSE analysis from the early 2010s, that did not use multilevel modelling, found no association of area deprivation with binge drinking or problem drinking, adjusted for socioeconomic factors (236). This difference in significance between studies may implicate different survey years analysed, not controlling for regional clustering or different demographic factors included.

2.4.3 Community Factors

Whilst measures of area deprivation can indicate the underlying socioeconomic issues of an area, the actual neighbourhood factors that contribute to alcohol consumption, whether physical or social attributes, are less regularly surveyed. International reviews have linked increased alcohol consumption to community social factors such as neighbourhood disorder, lack of social capital or community norms (46, 70). Such factors have begun to be examined in a UK based context but mostly the qualitative literature features any middle-aged focus.

Feelings of community insufficiency in deprived areas may lead to reduced social capital which has been defined as the resources available to individuals and groups provided by their social networks at an area or community level (308). Social capital may influence alcohol consumption by reinforcing behaviours linked to social identities, enhanced by factors such as social trustworthiness and lack of social conflict. As alcohol is used as a social tool, social capital may reinforce bonding forms of alcohol use but discourage use that leads to problematic or irresponsible behaviour (214). A multilevel study of the HSE found that low belief that people can be trusted, helpful or fair (social trust) increased the risk of binge drinking in men but good perceptions of the neighbourhood, measured as low levels of vandalism, enjoyment of living in the area or supportive neighbours reduced the risk of binge drinking in women (214). A similar older multilevel study of the HSE found that communities feeling as though neighbours supported each other and individuals who reported being part of a club or society (civic participation) were less likely to drink more than two units per day (309). An analysis of the Understanding Society panel survey found that attending voluntary organisations in middle-age may be protective against binge drinking (310). However, this may be due to self-selection in which lower risk drinkers prefer to associate with such activities. Religious association and participation may have similar protective effects, beyond prohibition for some, by shaping personal attitudes and community norms (311), although considering religion as important was not associated with problem drinking in ELSA (256).

Social norms theory suggests that individuals will be more likely to drink if they perceive their social group or community to be drinkers or are permissive of excess drinking. This may lead individuals to drink to meet social expectations (117, 312). A qualitative study of Scottish adults aged 35 to 50 years suggested even in early mid-life there was peer pressure to drink and motivation to get intoxicated when drinking in groups (130). Male interviewees particularly saw the pub as essential for maintaining friendships, compared to other food outlets, with beer drinking perceived as a masculine trait (118, 288). Believing that being drunk is acceptable

behaviour is associated with a greater risk of binge drinking (297). Social norms may also have a protective effect as was observed with British ethnic communities who may find drinking less acceptable, as previously discussed with the characteristics of non-drinkers in section 2.2.4 (218).

2.4.4 Retail Areas

Area deprivation has been linked to a greater concentration of access to alcohol outlets in those areas (313). In a cross-sectional analysis of neighbourhoods in Scotland, a positive relationship was found between neighbourhood deprivation by Scottish IMD score and the density of off-trade alcohol outlets, although there was no relationship with on-trade outlet density (314). A longitudinal study of England found that the mean number of outlets within 1 km of home was highest in the most deprived areas classified using IMD. However, between 2003 and 2013 the number of all on-trade outlet types decreased in these areas with a small, but not replacing, increase in convenience stores that may sell alcohol (315). In addition to greater outlet density, results of a survey of independent off-trade outlets in Glasgow found that the best-selling products in deprived areas by Scottish IMD were most likely to be the cheapest alcohol products (316). These issues of accessibility and affordability of alcohol are explored in the next section of this review.

A criticism of this research area is that it is difficult to separate the relationship of deprivation with urban population density. Therefore, it is difficult to determine if greater outlet density is due to economic demand for alcohol by residents and any tourism or if the presence of outlets promotes greater accessibility and use of alcohol (317). Initial longitudinal results from Wales suggest an increase in walking distance outlet density (within 10 minutes) was associated with an increase in binge drinking, particularly in men (318). However, the underlying cause for the increase in outlet density was not investigated, the outcomes of which may help support public health licensing decisions.

2.5 Macro-Level Factors

Macroeconomic factors have been found to impact health outcomes through market regulation of goods and advertising but also includes issues related to economic crises and working conditions (319). For alcohol, this includes factors such as taxation and reducing availability (320), which is the focus of this section. The persistence of high levels of alcohol consumption per capita, despite responsibility campaigns, introduced some leniency towards such population-level strategies in the UK (136). However, almost no research has been performed for the impact

of such policies on drinking outcomes specifically in middle-aged adults (321). Macro-level alcohol policies and attitudes differ across the four nations although some powers remain at the UK government level (322).

2.5.1 Regulating Availability

The deregulation of alcohol licensing and hours of sale over time has led to the widespread accessibility of alcohol in adults over 18 years of age (323, 324). The 2003 Licensing Act extended opening hours of licensed venues in an attempt to reduce concentrated drinking volumes but was associated with increased work absence in England (325). Alcohol purchasing has switched from the predominantly on-trade sector to off-trade consumption, particularly in the past 20 years, fuelled by falling supermarket prices, considered in the next section of this review (140, 149, 315). An analysis of EFS diary data using all ages found that 55% of male and 84% of female units consumed by hazardous and problem drinkers in the UK were purchased at off-trade locations (321, 326).

Systematic reviews of the literature suggest that increased availability of alcohol by longer trading hours and higher outlet density is associated with greater alcohol consumption per capita and acute alcohol-related harm (327-330). An analysis using the Scottish Health Survey found that problem drinking and binge drinking, in all ages, were associated with higher total and on- and off-trade outlet density (331). In England, higher densities of both on- and off-trade outlets were associated with wholly-attributable alcohol admissions but not partially attributable (332). The impact of outlet density on outcomes is rarely separated by age so the relevance of outlet density to middle-aged drinking remains unclear.

Studies in this area have been criticised for their lack of separation by outlet type, confounding from the aggregation of area types and lack of consideration for the non-linearity between outlet density and outcomes (333). For example in a New York based study, increases in binge drinking only occurred when outlet density increased above 80 per square mile (334). Few studies have considered further contexts related to outlets such as time use and purchasing location for example during work hours, or meeting friends rather than just distance from home (78, 324). One of the few British studies that considered contexts and drinking volumes found that binge drinking in an all-age sample was more likely after 5 pm, on the weekend in private homes and with other people but there was no information on purchasing location (79).

Although a licensing objective in Scotland, the regulation of licensing for public health reasons has not been implemented in England (335). This may be related to the lack of specificity and

heterogeneity in outcomes for policy recommendations (333). The 2003 Licensing Act introduced the ability to implement Cumulative Impact Policies by local authorities to limit outlet growth due to adverse social impacts (a permitted licensing objective) and this has been shown to reduce alcohol-related crimes in those areas implemented (336). By proxy, this has led to a reduction in alcohol-related hospitalisations in areas where these policies are present (337, 338). A Scottish ban on multi-buy promotions was introduced in 2011 to reduce the volume of alcohol available to be purchased at one time. In the short term, this ban was not found to be effective as the frequency of shopping trips for beer and cider increased to counter this (339). However, a further study using time series analysis suggested this ban did reduce wine and pre-mixed drinks sales by 2% but not other types of beverages (340).

2.5.2 Rising Affordability

In addition to greater accessibility over time, alcohol has become more affordable (105). Rather than simply representing price, alcohol affordability measures take into account changes in household disposable income (minus taxation but including benefits) and inflation so that decreases in purchasing prices or increases in average income both lead to alcohol becoming easier to afford (341). Since 2008, alcohol has become 13% more affordable in the UK yet in comparison, tobacco has become 30% less affordable over the same period (166, 342).

In the UK, an alcohol affordability index is calculated as a function of price indexes which show how the average price of an item has changed in comparison with the price of a baseline year (166, 343). The alcohol price index is compared to a retail price index to determine if the price of alcohol has increased in line with inflation. The retail price index uses the Living Cost and Food Survey (LCFS) to produce an average price of a sample of household retail items. This relative price index is then compared to changes in household disposable income per capita, allowing for inflation, over the same period to give a measure of alcohol affordability that accounts for both income and price changes over time:

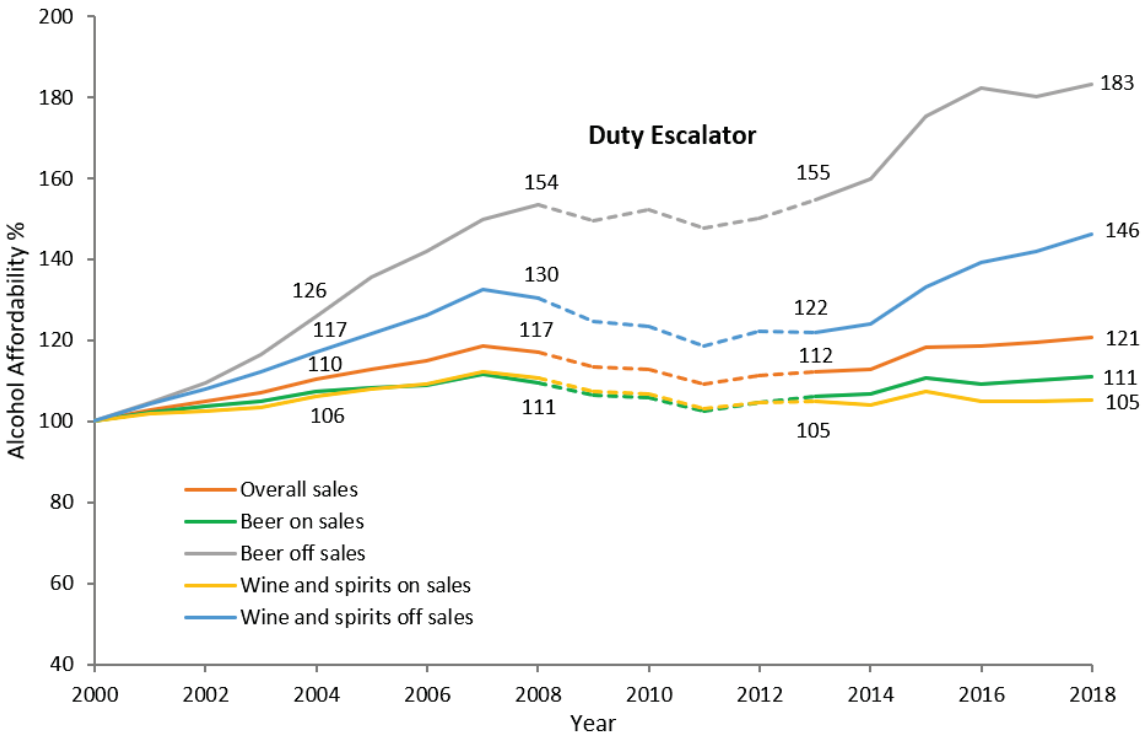
Equation 1: $\text{Relative Alcohol Price Index} = \text{Alcohol Price Index} \div \text{Retail Price Index} * 100.$

Equation 2: $\text{Alcohol Affordability Index} = \text{Household Disposable Income Index} \div \text{Relative Alcohol Price Index} * 100.$

Figure 2.5 shows how alcohol has become more affordable relative to prices in the year 2000 (343). The affordability of on-trade beverages has only slightly increased compared to the large increases in off-trade affordability. On-trade beer affordability has not changed since 2008 and on-trade wine and spirits have returned to the same level as in 2004. In comparison, off-trade

beer affordability rose by 28% and off-trade wine and spirits by 24% between 2013 and 2018. The duty escalator was a price control method introduced between 2008 and 2013 which is discussed later in this review. A criticism of the alcohol affordability measure is that it is unclear whether changes are due to income or price changes without looking at the original figures it was derived from, which is important for public health decisions. For example, disposable income rose by 25% between 2000 and 2007 but prices fell by only 10% (98).

Figure 2.5 Alcohol affordability index relative to the year 2000 for on- and off-trade sales (%).



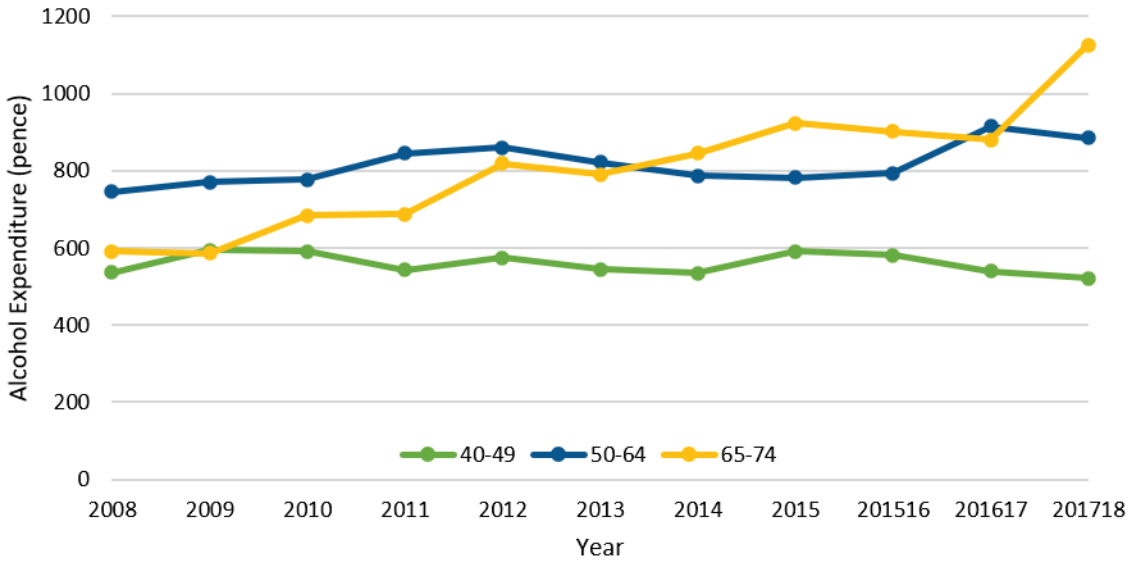
Dashes indicate period the duty escalator policy was in place. Data Source: MESAS Monitoring Report 2019 (343).

Rising alcohol affordability is not necessarily linked to changes in actual purchases and consumption. In 2008, the Great Financial Recession may have led to an increase in binge drinking in the unemployed population but per capita consumption reduced to the same level as in 1998 by 2009 (Figure 2.1) (97, 141). A similar reduction was observed in the middle-aged population elsewhere in Europe except in the recently unemployed (344, 345). A similar scenario has been predicted for the COVID-19 pandemic due to a combination of reduced availability but increased use as a coping method in some vulnerable individuals (346). Per capita, population consumption of alcohol has been declining since 2004 despite the recovery of the economy from the recession and continued rising off-trade affordability (141).

2.5.3 Responding to Changes in Price

Part of understanding alcohol demand is responsiveness to price, known as price elasticity. This represents the change in demand for a product in response to a change in price with no other change in circumstances (347). Individuals respond to price changes of a product in different ways due to the personal value of the product and individual circumstances (348). If the price of alcohol is perceived to be too expensive to afford, purchasing may be inhibited, purchased in lower volumes or an alternatively priced product is chosen (349). However, the investigation into price response or changes in alcohol expenditure are rarely considered in population subgroups, and therefore how this is characterised in middle-aged drinkers is unknown (321). Women appear to be more price responsive than men, possibly due to greater biological sensitivity to alcohol and therefore lower demand (350). Figure 2.6 shows how alcohol expenditure in adults aged 65-74 years has steadily increased since 2008 to overtake the expenditure of the second-highest spenders in the UK aged 50-64 years. However, it is unclear if this is due to higher volumes of alcohol purchased, lower price elasticity, or preference for higher-priced products (351).

Figure 2.6 Average household alcohol expenditure by age group of Household Representative Person since 2008.



Based on previous week of the survey. Data Source: LCFS /Family Food (352).

Current evidence suggests price responses are affected by beverage type, on- or off-trade purchasing and individual drinking patterns (353). In the UK, off-trade purchases, particularly beer, tend to be more responsive to price changes which may partly explain why the on-trade sector has managed to maintain lower levels of affordability (354). Individuals consuming higher volumes of alcohol have been shown to prefer low cost per unit choices to offset the expense of higher purchase amounts. The average price paid per unit by hazardous and harmful drinkers of

all ages was 40p for off-trade purchases, less than the average 45p for lower-risk drinkers (321). In a study of very heavy drinkers in Scotland (on average 198 units per week), 70% of units consumed were below 40p per unit (355). However adjusted for income, heavier drinkers including binge drinkers have also been shown to respond less to price changes, if cheaper substitutions are not available, due to their high demand for the product (356-358). Whilst higher income increases the affordability of alcohol, high volume problem drinkers of any income level are still more likely to choose low cost per unit options to meet demand (359, 360).

2.5.4 Control with Price Policies

Due to the potential for reductions in alcohol purchases in response to price, regulating the price of alcohol is considered an effective population-level public health strategy to control excessive alcohol consumption (19, 320). Alcohol prices in the UK are set by a combination of economic demand, industrial regulation and public health-related taxation or control policies. Broad increases in price are considered to promote reductions in aggregate consumption in a population (98, 348) leading to reductions in harm such as road accidents, violence, liver cirrhosis and alcohol-related mortality (361-363). The impact on middle-aged alcohol consumption and harm is less clear as much of this research has focussed on youth populations (320).

The UK has implemented price control through different strategies although this varies at a sub-national level (322). Alcohol duty is a form of fiscal revenue designed to raise price as a control mechanism and support costs arising from alcohol-related harm. In the UK, duty is based on factors related to the alcohol purchased including type, sparkling or still, alcohol strength above 1.2%, volume and brewery size (364). Duty rates must be raised regularly to keep in line with inflation as they are set against the alcohol content of a product rather than as a percentage of the price (365). Alcohol industries may compensate for tax increases by reducing prices to retain customer bases (366). In 2008, an alcohol duty escalator was introduced that imposed an annual 2% rise in tax above inflation but was subsequently dropped in 2013, with duty rates fixed since 2017 (174). Although initially also related to post-recession declines in disposable income (105), the effectiveness of the duty escalator on preventing a rise in affordability at the population level can be observed in Figure 2.5.

The disproportionate harms in some population groups have led to the development of more nuanced price control mechanisms to target problem drinkers (367, 368). Minimum unit pricing (MUP) is an alternative price control mechanism which prevents the selling of a beverage below a certain cost per unit. It is considered to be a more targeted method of price control by reducing

the availability and affordability of low-cost high strength options that are often preferred by high volume drinkers (359, 360). An MUP of 50p was found to be the most effective price control method for saving costs towards health and employment compared to other methods, such as a percentage increase or targeting specific beverages or license types (321).

The predicted impact of MUP specifically in middle-aged adults is unclear, however it is expected to impact hazardous drinkers under the age of 25 years less due to their preference for on-trade purchasing (321). Although MUP is expected to have a greater impact in lower socioeconomic groups (359), a recent report suggested that MUP was not regressive to low-income households as the amount of duty paid was largely the same across income groups (369). MUP was introduced in Scotland in 2018, after a legal battle with the whisky industry, at a 50p per unit minimum. Initial results suggest a reduction of approximately two units per week (15g of alcohol) in those who purchased the most alcohol and a reduction in purchases by low-income households (370). Follow up reports will be needed to determine if purchasing has adapted to higher prices in the long term. The main criticism of MUP is that it assumes that heavy drinkers will respond to a loss of low-cost substitutions by purchasing less alcohol at higher prices when it is low-risk drinkers that tend to be the most price responsive (356).

Local authorities in England have found some retailers may voluntarily remove high strength beer and cider (>6% Alcohol by Volume) in the 'Reducing the Strength' initiative. In an assessment of the intervention in Islington and Camden (London), this was related to reducing customer and neighbourhood disruptions (371). A ban on below-cost selling of alcohol was introduced in 2014 in England which prevents the selling of alcohol below the duty and VAT tax payable on the product. This was predicted to have a limited effect as less than 1% of alcohol is sold below tax rates (372). However, as the cheapest beverages tend to have the least increase in price compensation for duty charges, this may prevent the underselling of such products (373).

2.6 Conclusion

This literature review has revealed that middle-aged adults in the UK frame alcohol use around societal function and may underestimate the associated health risks unless undergoing their own health issues or adverse reactions to drinking. Risk alcohol consumption in this cohort has been facilitated by greater gender equality in women's drinking, more concentrated drinking patterns and liberalisation of the licensing market for home consumption. The burden of alcohol-related harm remains high in this age group, particularly in men, impacting both physical and mental

health and potentially social function. This harm may be exacerbated by other co-risk behaviours and other risk factors related to social deprivation.

However, there was a notable lack of evidence into the actual risk alcohol consumption patterns underlying this relationship with harm, how these patterns have developed over time and what individual-level characteristics are associated with these behaviours in middle-age. Such information cannot be obtained from the qualitative literature and this limits our understanding of what characterises those who engage in risk drinking in this age group, particularly when considering the burden of harm is known to be socioeconomically patterned but the contribution of area-level effects is likely to be small. Few studies utilise a social-ecological approach to consider risk alcohol behaviours and therefore focus on one aspect of behaviour or status without taking into account wider community level or temporal contexts.

Table 2.2 shows there has been some initial work on the relationship of alcohol consumption with socioeconomic status and family factors supported by birth cohort evidence using middle-aged adults from the UK. However many of studies focus on adults in the early part of mid-life (<50 years) with some not separating outcomes by sex, not clearly reporting their handling of abstainers and using older binge drinking definitions, short reference periods or linear thresholds that do not indicate risk behaviour. This lack of consistency may explain why outcomes for these factors are relatively inconsistent across studies and requires an analysis of risk drinking considering all ages by sex across middle-age and adjustment for all relevant factors.

There was some evidence from the literature on drinking associations with employment, retirement and marital status that the transition period associated with changes in such status factors may be more important than their long term role. However such transitions have only been considered in association with a linear intake of alcohol per week which does not reveal its association with risk drinking patterns as the majority of drinkers consume alcohol moderately.

No studies were found using middle-aged groups to consider aspects of place on alcohol consumption despite relationships found for area-level social and retail factors in studies using all age groups. Studies considering the impact of regional living area have rarely separated individual and contextual factors in models. Descriptive statistics suggested there may be gradients in middle-aged risk drinking across English regions that could be considered in further studies to provide a better understanding of the relevance of place in this age group.

The literature considering the role of macro-level factors specifically in middle-age was also absent. At the individual level, the relationship with income and employment status on alcohol

consumption was less clear than the longer-term lifecourse indicators of education and social class. This may indicate period changes in the relevance of such factors to this age group, particularly as the affordability of alcohol has increased over time. However, there is very little evidence of the factors associated with alcohol expenditure in this age group despite the use of price controls to dissuade risk drinking.

2.6.1 Thesis Objectives

This literature review was designed to inform the state of the evidence for the main aim of this thesis: To determine the objective characteristics of risk alcohol consumption in middle-age in the UK due to the burden of alcohol-related harm in this age group. Gaps in the evidence base were identified at all levels of the theoretical social-ecological model for this particular stage in the lifecourse and considering recent period trends. These have been translated into the following research objectives to be explored using secondary data sources and quantitative statistical methods:

Objective 1: To explore how the percentage of drinkers aged 45-69 years exceeding the weekly low-risk guidelines for alcohol and binge drinking has changed over time.

Objective 2: To explore how individual, social and community characteristics and co-risk behaviours are associated with such risk alcohol behaviours, and whether these relationships have changed over time.

Objective 3: To explore how transitions in individual life circumstances related to middle-age are associated with changes in binge drinking.

Objective 4: To explore the relevance of geographical area to place effects on risk alcohol behaviours in middle-age independent of individual-level factors.

Objective 5: To explore how household-level incomes and composition in middle-age are associated with alcohol expenditure and whether alcohol affordability has increased in this population.

Intending to answer these objectives, the next chapter of this thesis reviews the range of secondary data available by considering factors of design, sample size and quality of alcohol measures. This data landscape was used to inform the most appropriate choices of survey data for analyses in this thesis and the selection of statistical modelling method to handle this data.

Table 2.2 Summary of quantitative studies involving participants drinking alcohol at aged 40+ years in the UK.

Study	Sample	Design	Alcohol Measure	Variables	Statistically Significant Outcomes
Batty et al 2008 (276)	West Scotland 55 → 59y N=576 men	Longitudinal: Twenty-07 1987→92	21/14 units past week CAGE	Housing tenure Income Social class Marital status Car ownership	-Weekly risk drinking associated with lower social class, non-private tenure, no car ownership, earlier school leaving age. -Problem drinking. associated with lower social class, earlier school leaving age and no car ownership. -No association with income, employment, or marital status.
Britton & Bell, 2015 (116)	England 60+y N=6011	Cross-sectional: Whitehall II 2013/14	Subjective change in intake past 10 years.	Sex Age SES Position	-Adults over 70 years or of lower social class were less likely to have increased their intake. -No difference by sex.
Caldwell et al. 2008 (275)	Britain 33 → 45y N=9146	Birth Cohort: 1958 NCDS	21/14 units past week Binge: >5 drinks CAGE/AUDIT Excludes non-drinkers	Social class Housing tenure Education at 33	-No association with weekly drinking risk. -Binge drinking and problem drinking associated with manual social class, rental housing tenure, and lower educational attainment.
Cheng & Furnham, 2019 (273)	Britain 30→ 42y N=5190	Longitudinal: 1970 British Cohort	Binge: >5 units on typical day	Sex Education at 34 Social Class	-Binge drinking associated with male sex, lower educational attainment, and lower social class.
Cheng & Furnham, 2013 (274)	Britain 33 → 50y N=6478	Birth Cohort: 1958 NCDS	Binge: >5 drinks on typical day	Sex Education at 33 Social class Personality	-Binge drinking associated with male sex, lower educational attainment, and extraversion but not social class.
Colell, Bell & Britton, 2014 (283)	Britain 33 → 50y N=9960	Birth Cohort: 1958 NCDS Transitions	Past week units By sex	Employment Partnership Education	-In men, weekly unit intake reduced over time in those who developed an illness but increased in those without a cohabiting partner. -In women, weekly unit intake was negatively associated with homemaker status and entering employment but positively associated with lower educational attainment. However weekly intake increased over time in women who entered employment and without a cohabiting partner.

(Continued on next page)

Study	Sample	Design	Alcohol Measure	Variables	Statistically Significant Outcomes
Holdsworth et al, 2017 (101)	England 50+y N=3663	Longitudinal ELSA Wave 0, 1, 5 1998/2010 Transitions	Past week units By sex Excludes non-drinkers	Partnership Employment Income Education Smoking	-In men, weekly unit intake was associated with being without a partner all waves, entering a partnership, higher income, higher education, and smoking. It was negatively associated with entering retirement. -In women, weekly unit intake was associated with higher income, higher education, and smoking and negatively associated with retirement or entering retirement.
Iparraguirre, 2015 (256)	England 50+y N=8727	Cross-sectional: ELSA Wave 5 Transition: 4&5	50/35 units past week By sex Includes non-drinkers	Income Education Employment Smoking Marital status Children	-In men, problem drinking was associated with smoking and higher education. Becoming a problem drinker was associated with increasing income. -In women, problem drinking was associated with increasing income, higher education, smoking, better health, and no children in the household. Becoming a problem drinker was associated with increasing income and loneliness. -No association for employment or marital status.
Jefferis, Manor & Power, 2007 (213)	Britain 23 → 42y N=12229	Birth Cohort: 1958 NCDS	Binge: >10/7 units per occasion By sex Includes non-drinkers	Education at 33 Social Class at 33	-Lower educational attainment and lower social class were associated with binge drinking in men and women.
Keenan et al, 2017 (284)	Britain 23 → 46y N=10226	Birth Cohort: 1958 NCDS	Binge Frequency of >5 drinks AUDIT By sex	Marital Status	-Compared to marriage, men were more likely to be problem drinkers and binge drink more frequently if they were divorced and not remarried or cohabiting and not married. -Women were also more likely to be problem drinkers and binge drink more frequently if they were divorced and not remarried.
Staff et al, 2014 (102)	Britain 16 → 50y N=14589	Birth Cohort: 1958 NCDS	Past week units CAGE By sex Includes non-drinkers	Marital status Employment Children	-Men and women who were, employed, single and not cohabiting and had no children in the household under 16 years consumed more units in the past week. -No association of CAGE with employment or marital status and negatively associated with children under 5 years.

Chapter 3 Review of Data Sources, Alcohol Measures and Statistical Method

This chapter considers the most appropriate secondary data sources for answering the five thesis research objectives which were outlined at the end of the previous chapter literature review. After a brief review of the merits of survey data and its potential design issues, cross-sectional and longitudinal data sources that contain measures of alcohol consumption or expenditure are considered for their sampling structure, time coverage, and age relevance for the middle-aged population. This is followed by a report into the recommendations for measuring alcohol consumption in surveys and selection of the final choices of data for use in this thesis based on their quality and relevance for answering the thesis objectives. The review then considers issues around survey responses, including under-reporting of alcohol consumption, before ending with a discussion on the use of multilevel modelling, a statistical method that meets the structural requirements of the survey data based on a social-ecological framework.

3.1 Data Sources

The empirical work of this thesis is based on observational secondary data sources from surveys. This type of data enables the self-reporting of alcohol consumption volumes and the calculation of individuals exceeding risk drinking thresholds within samples, enabling the comparison of population subgroups without intervention. Population representative samples are required if results are to be inferred to that population which is difficult to obtain with clinical samples (374). Survey data has the advantage over other sources by enabling the observation of individual alcohol consumption patterns and subgroup trends which can be linked to individual-level characteristics and alcohol-related consequences. However, surveys used to measure alcohol consumption patterns are inherently limited by their design and the subjective answers of those surveyed (190). Survey data can be associated with an under-estimation of alcohol intake compared to retail sales data (375). This may be due to factors such as non-response, social desirability bias, sampling frames and questionnaire design, which are topics discussed throughout this review (376).

Cross-sectional survey data, measuring a sample at one point in time and longitudinal survey data, measuring the same sample at follow-up points over time were considered. An advantage of longitudinal data is that it can be used to assess consumption trajectories, by repeatedly

surveying the same participants on the same behaviour over time, including changes in behaviour or personal characteristics which may impact the outcome investigated (93). If the presence of an exposure or characteristic can be determined before the outcome then causality may be inferred, for example, present health status based on past alcohol consumption (86). Although cross-sectional data cannot infer any direction to the associations observed, it is included in this thesis as it provides a wider range of alcohol-related measures and data years that are facilitated by the easier application of such survey types. More data years allows for the assessment of trends over time and the inclusion of more measurement components improves the assessment of self-reported alcohol intake, as discussed later in this chapter. Cross-sectional data is not subject to participant attrition and selection bias that may be found in later waves of longitudinal data. Before reviewing the available UK surveys appropriate for answering the thesis objectives, some characteristics of survey design are discussed.

3.2 Issues of Survey Design

3.2.1 Sampling Design

Surveys are not usually based on entire populations but use individuals from a randomised sample of households from that population. The sample selection is designed so that it is representative of the characteristics of the population of interest. To obtain a representative sample, strategies involve the randomisation of postcodes and stratification by population characteristics such as by social class or local authority. Stratification tends to reduce standard errors, which indicate how much the sample population deviates from the true population, by ensuring that small subgroups are captured (377). The majority of the surveys reviewed in this chapter use a form of stratified random sampling of addresses from the small user version of the Postcode Address File (PAF), a database of deliverable addresses by the Royal Mail (378).

3.2.2 Sampling Frame

Most surveys are of private households and therefore exclude harder to reach populations, such as the homeless, hospitalised, military or institutionalised. Although such subgroups may be more likely to be risk drinkers, they may be only a small component of the middle-aged population (379). Surveys are typically performed throughout the year to avoid seasonal trends with festive periods, such as Christmas and New Years, avoided for the same reason to obtain a better reflection of typical consumption. However, questions on atypical or seasonal patterns are rarely asked which could lead to a net underestimation of overall annual intake (380-382).

Although the number of additional units from special occasion drinking was found to decrease with age, adults drinking over the former weekly guidelines tended to drink more than moderate drinkers on such occasions (380).

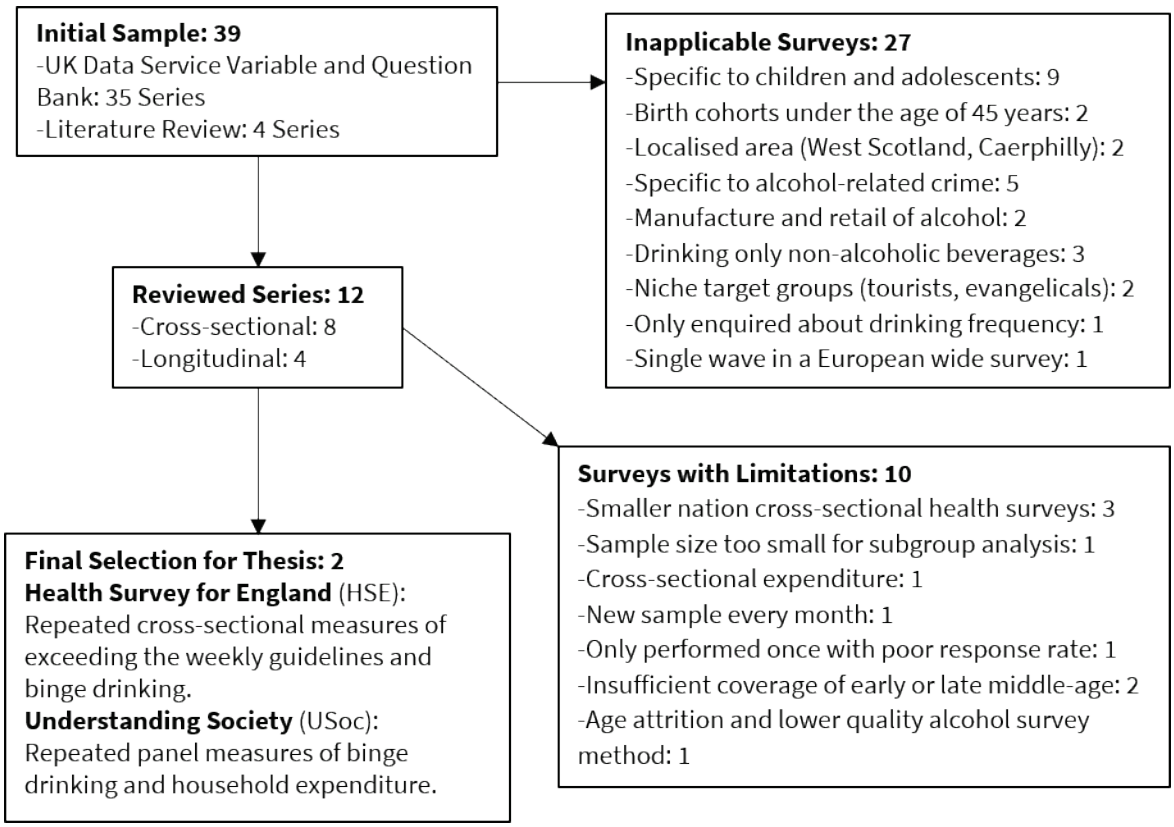
3.2.3 Survey Response Method

An in-person interview or a self-completion questionnaire are the most common forms of answering an alcohol consumption survey. Individuals may feel more comfortable using a self-completion questionnaire if they feel a stigma attached to their drinking behaviour (383). Such issues of social desirability bias are discussed later in this chapter. Self-completion can increase the rate of non-response as questions involving the interpretation of the number of drinks or servings could be a burden without prompts or assistance from an interviewer (384). A weekly drinking diary improves the estimates of the number of drinking days and drinking volumes compared to interview methods (385, 386). However, the burden of completion on participants and researchers tends to result in small sample sizes. Insufficient responses to surveys reduce statistical power, the ability to find a statistically significant outcome, and therefore the analysis of population subgroups (387).

3.3 Availability of Survey Data

Alcohol consumption measures have been surveyed in both repeated cross-sectional and longitudinal surveys in the UK. This section reviews surveys containing alcohol measures that can be analysed quantitatively, include adults aged at least 45 years and are population representative. Applicable surveys were searched for using the UK Data Service (UKDS) variable and question bank for ‘alcohol OR alcoholic OR drinks OR drinking’ (388). This resulted in 36 survey series that had at least one recent measure (since 2012), to provide some relevancy to current trends in alcohol intake, as shown in Figure 3.1. Four surveys were identified from the previous literature review, of which two were selected for further review: The English Longitudinal Study of Ageing (ELSA) and Whitehall II Study (WHII). This resulted in 12 current surveys which are discussed for their design components. Older surveys may be mentioned if they represent a previous form of the most recent version of the survey.

Figure 3.1 Flow chart for selection of datasets used in this thesis.



3.4 Cross-sectional Data

3.4.1 National Health Surveys

Each of the four nations of the UK run an annual cross-sectional health survey, covering all adult ages, with similarities in their design and contents. They aim to understand trends in the nation's health and health-related behaviours over time such as drinking, smoking and physical activity whilst also recording sociodemographic data. These surveys are the Health Survey for England (HSE) (389); the Scottish Health Survey (SHeS) (390); the National Survey for Wales (NSW) (391) and the Northern Ireland Health Survey (NIHS) (392). The Welsh Health Survey (WHS) was replaced with the NSW in 2015, which itself began in the year 2009/10, and functionally continues the work of the WHS. The NIHS began in 2010 to replace the Northern Ireland Health and Social Wellbeing Survey which was performed every 3-4 years.

The main advantage of the national health surveys is their long-running time with alcohol measurement data available from the late 1990s for England and Wales (see Table 3.3). Sample years can be pooled to create large, statistically powered datasets. Surveys are conducted annually providing recent data and are spread throughout the year to avoid seasonal bias. The

larger nation surveys involve a combination of an in-person interview, self-completed questionnaire and nurse interview for physical measurements.

England and Scotland use a multi-stage stratified random sampling design to obtain a nationally representative sample whilst the smaller nations use a simple random sample. For example in the HSE, a representative sample of the private residential English population is obtained using the PAF as the sampling frame with postcode sectors used as the primary sampling units (PSUs) (378). Complex stratified sampling has been used since 2003, sorting PSUs into Government Office Region (GOR), local authority, and percentage of adults in NS-SEC[11] groups 1 and 2 (higher professions). PSUs in the North East and East Midlands are typically oversampled due to their smaller population size (378). The average household response rate for the HSE has been about 60% in recent years with about 50% of these households having all members individually surveyed (389). In 2015, interviews were more likely to be obtained from women and adults over 35 years of age, with response rates highest in the North West and lowest in London (378). All members of a household are eligible for interview and in-person interviews for consenting individuals are conducted using CAPI[12] software.

3.4.2 National Diet and Nutrition Survey (NDNS)

NDNS is a repeated cross-sectional survey of a national sample of private households randomly drawn from the PAF (393). It provides an account of food and drinks consumed that is more detailed than those provided by the national health surveys. This is achieved through a four-day unweighted food diary, an in-person interview and a nurse interview. Sociodemographic information is obtained from the interview with alcohol intake covered by both the diary and interview sections. Fieldwork is conducted throughout the year to account for seasonal variation. The main limitation of the NDNS is its small sample size (1k per year for all ages) and the slower publishing of recent data, likely due to the intensity of analysing a food diary.

3.4.3 Living Costs and Food Survey (LCFS)

The LCFS aims to survey household expenditure on a variety of purchases to understand household budgeting and food consumption trends over time (394). This is achieved using a cross-sectional two-week individual level diary of a sample of private households across the UK

[11] National Statistics Socioeconomic Classification
[12] Computer Assisted Personal Interviewing software

for expenditure in British pounds. This includes alcoholic beverages with differentiation for drinks consumed away from home (on-trade) and in the household (off-trade). A household questionnaire component records long-term purchases, individual-level income and demographic factors at a household level.

The LCFS became a standalone survey in 2014 where it was previously part of the Integrated Household Survey and known as the Expenditure and Food Survey (EFS) module until 2008. The food component results are published by DEFRA as *Family Food*. The main limitation of the LCFS is the outcomes are only available at the household level with the main focus on expenditure rather than volumes of alcohol consumed. However, its separation of purchases by location provides unique contextual aspects and the sample size is larger compared to the NDNS.

3.4.4 Opinions and Lifestyle Survey (OLS)

The OLS is a regular cross-sectional survey of small samples of British private households randomly drawn from the PAF for certain months in a year (395). It was set up by the Office for National Statistics (ONS) for both government and non-government organisations to produce surveys with a fast turnaround. Drinking modules were performed every two months for 2015 and 2016 and every month for 2012 to 2014. The OLS was used by the ONS to produce its Adult Drinking Habits in Britain report which was discontinued in 2017 (396). Before 2012, data from the former General Lifestyle Survey (GLS) was used for this report, a rotating longitudinal survey conducted annually between 2006 and 2011 (397). Due to the inclusion of postcode data and birthday day, GLS data requires the use of a secure access lab.

3.4.5 Local Alcohol Consumption Survey 2016

The Local Alcohol Consumption Survey aimed to obtain alcohol consumption statistics at the local authority level (LA) which has been costly to collect for all LAs (398). Commissioned by Public Health England, this is a one-time postal survey of a simple random sample of individuals living in 25 local authorities. The postal survey was validated through a subsample of face to face interviews and comparisons with other national datasets. The response rate was only 20% resulting in 9,683 adult participants. In addition to questions on frequency and quantity of alcohol, the survey includes questions on where alcohol is consumed and purchased. The 25 local authorities represented the upper and lower tiers for alcohol consumption behaviour. This survey is only available for 2016 and it is unclear if further surveys will be performed. Differences in the survey measures used make it difficult to compare with consumption levels reported in

other surveys although the percentage of abstainers was considered comparable to the HSE (398).

3.5 Longitudinal Data

The target age group of this thesis was adults in middle-age aged at least 45 years, ideally covering the years surrounding retirement. However, it was found that there were no birth cohorts at a national level available that have measured alcohol consumption in individuals up to the age of 70 years in the UK. Alcohol measures were not available in the 1946 National Birth Cohort. The advantage of birth cohort data is that it can allow for the analysis of behaviour trajectories over different developmental periods. Panel data provides the best alternative source of longitudinal data by surveying a representative sample of individuals, similar to a cross-sectional survey, but re-surveying the same participants at regular intervals known as 'waves'. Unlike a birth cohort, panel surveys can invite new participants to join, reducing issues of attrition (survey drop out) and are usually conducted more frequently, providing regular updates. An issue to consider with longitudinal data is that longer-term follow-up data may be required to determine the full extent of a behaviour trajectory or the full impact of a change in circumstance or policy, such as the immediate and long term impacts of retirement or change in marital status (281, 285). A long-term longitudinal trajectory of middle-aged alcohol behaviour is difficult to achieve without using multiple sources of cohort data due to the age range required (93).

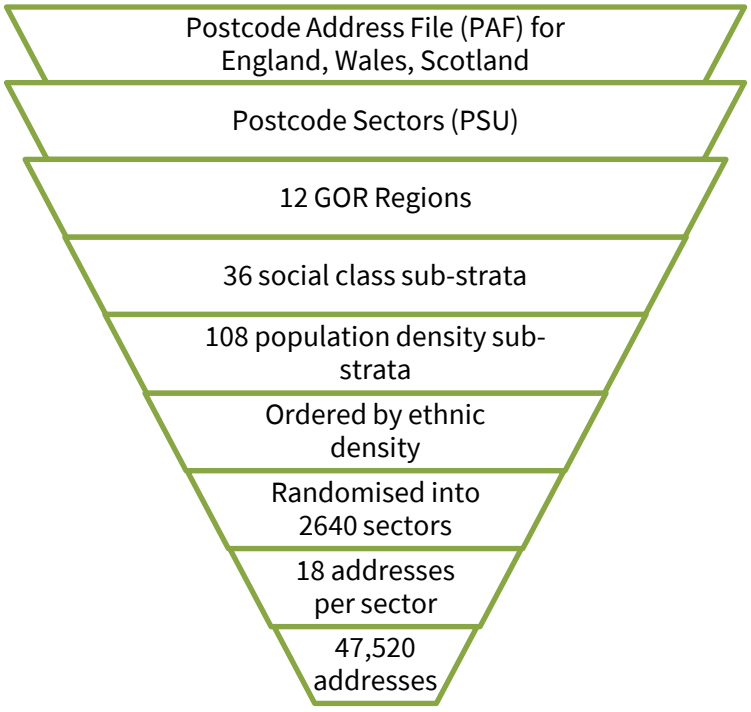
3.5.1 Understanding Society (USoc) - UK Household Longitudinal Study

The UK Household Longitudinal Study, also known as "Understanding Society" (USoc), is a national UK longitudinal panel survey covering a full age range of adults from across the UK, following the same individuals over time. Wave data has been released annually since the initial survey in 2009/10 with the surveying of participants in a wave conducted over two years (399). USoc is the largest household longitudinal survey of its kind, designed to study a variety of different topics about UK life including health, socioeconomics, and family issues (400). It incorporates participants of the long-running British Household Panel Survey (BHPS) in wave 2, which did not contain alcohol consumption measures (399, 401). Due to the number of topics considered, many question modules are rotated every other year including those on alcohol consumption. USoc also contains household level expenditure data for alcohol in every wave. This has a longitudinal advantage over the cross-sectional LCFS and the potential to link to the household characteristics surveyed. The main advantages of USoc are its large subpopulation sample size, full coverage of middle-age and high individual response rates from wave 2. Its main

limitations are the inclusion of alcohol consumption measures only in every other wave as part of a self-completion questionnaire and shorter running time overall.

To obtain representative samples of private residential households from England, Scotland, and Wales in wave 1 of USoc, the PAF was used as a sampling frame with postcode sectors as the PSUs (402). The Northern Ireland sample used a simple random sample of addresses from the LPS file (Land and Property Services) which is oversampled for subpopulation analysis. The randomised PAF sample used a complex stratification process, including non-manual social class of the household reference person (HRP)[13] and density of households per hectare, both derived from the 2001 census, resulting in 47,520 addresses issued in wave 1 as shown in Figure 3.2. An oversampling of ethnic minorities was also performed (minority boost sample) that was refreshed at wave 7.

Figure 3.2 PAF sampling strategy for USoc in wave 1.



Data Source: USoc Wave 1 Technical Report (402).

For eligible households, 57% of the general population sample (GPS) was cooperative with 82% of responding households also achieving individual level interviews and 87% of these individuals responding to the self-completion section in wave 1 (402). Compared to the 2011 census, there was a small under-representation of men, Londoners, and individuals with limiting illness in wave

[13] Household representative person is usually defined as the owner or renter of where the household lives and the oldest aged member if multiple owners.

1 (403). The GPS of USoc has not been refreshed but has incurred attrition over the years as shown in Table 3.1. As part of its attrition strategy, USoc allows new entrants to the survey from changes in household composition and maintains contact with non-responding households in later waves (404, 405). Data collection involves face to face interviews using CAPI software and a self-completion questionnaire, with CASI (computer-aided self-interview) used from wave 3.

Table 3.1 Longitudinal sample size change and response rates for the GPS in USoc, all ages, productive.

Wave	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Years Collected	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Household interview	57%	77%	77%	63%	65%	62%	64%
Eligible Household Base	45,431	27,193	24,661	21,497	19,653	18,590	17,505
Individual Interview	82%	84%	83%	84%	85%	85%	88%
Individual Base	50,138	40,625	36,762	34,445	32,533	26,877	24,369

Only households responsive in wave 1 were issued in wave 2. Data Source: Wave technical reports (405).

3.5.2 English Longitudinal Study of Ageing (ELSA)

ELSA is an annual panel survey of a representative sample of English adults aged 50 years and over living in private households since 2002 (406). Similar to the US Health and Retirement Study, it was designed to explore different aspects of ageing over time including health, socioeconomic circumstances and psychosocial wellbeing. ELSA involves both personal interviews and a self-completion booklet with alcohol-related questions located in the latter. Regional level data must be obtained through application to a monthly committee.

The original ELSA sample was drawn from the HSE 1998-2001. Non-responders to the HSE were not included in the ELSA sampling frame but should be adjusted for using weighting. Due to the level of attrition, new participants were added at waves 3, 4, 6 and 7 from HSE 2001-2011 to maintain sample representation and size. Compared to USoc, ELSA is limited by its smaller sample size, higher attrition rate, England only context and weighting requirements. The representation of younger age participants (aged 50) decreases as the initial ELSA cohort grows older, as shown in Table 3.2. Therefore by wave 7, the majority of the middle-aged sample would be from refreshment. This is not such an issue for USoc, which surveys a full age range, as younger participants can move into the analysis group when they meet the age requirements of the study.

Table 3.2 Sample size of wave 1 cohort in ELSA over time with increasing age of middle-aged participants.

Wave	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Year	2002	2004	2006	2008	2010	2012	2015
Cohort 1 n	11392	8780	7535	6623	6242	5659	4894
Cohort 1 Age Group	50-69	52-71	54-73	56-75	58-77	60-79	63-82

3.5.3 National Child Development Study - 1958 Birth Cohort (NCDS)

NCDS is a long-term cohort study of 17,415 births in 1958 from England, Wales and Scotland representing all recorded births in one week of March (407). It aims to study changes in health and socioeconomic status over time. There have been nine waves of follow up from the ages of 7 with the latest wave in 2013 when participants were 55 years of age. This cohort has been used in studies to understand socioeconomic factors affecting alcohol consumption over the first half of life (102, 274, 283). Contact methods have changed over the years from in-person or telephone interviews to self-completion questionnaires. The main limitation of this survey is that it does not fully capture the age range of the retirement period.

3.5.4 Whitehall II Cohort (WHII)

The WHII cohort began in 1985 comprised of London based civil servants aged between 35 and 55 years with participants now aged over 65 years (408). It is now considered a study of ageing, aiming to analyse the effects of socioeconomic status on health outcomes, including alcohol consumption (116). It is comprised of a nurse interview for physical measures followed up by postal questionnaire every 5 years. In 2016, 74% of the sample resided in London or South East England and therefore it is not nationally representative. The original sample size was 10,308 but attrition has lost 33% of the original participants which may also alter its representation (409). Because the sample is comprised of office-based civil servants there are limitations in representing all social classes such as manual workers. WHII is not available via the UK Data Service.

A summary of the design components of the surveys discussed is presented in Table 3.3, excluding WHII due to its lack of national and age representation. As the quality of the questionnaire measures used to record alcohol consumption varies between these surveys, the methods used to measure alcohol consumption and their inclusion in surveys are also reviewed before selecting the survey data most appropriate for answering the thesis objectives.

Table 3.3 Overview of quantitative datasets reviewed for sampling and design for use in this thesis (using latest year data at the time of review).

	National Health Surveys					Other Cross-sectional			Longitudinal Surveys		
Dataset	HSE 2015	SHeS 2016	NSW 2016/17	WHS 2015	NIHS 2013/14	NDNS RP Y5-6	LCFS 2015/16	OLS 2016	USoc 2015/16	ELSA 2014/15	NCDS 2013/14
Type	Repeated Cross-sectional	Repeated Cross-sectional	Repeated Cross-sectional	Repeated Cross-sectional	Repeated Cross-sectional	Repeated Cross-sectional	Repeated Cross-sectional	Omnibus Survey	Panel Study	HSE Cohort/ Panel	Birth Cohort
Sampling	Multi-stage stratified random	Multi-stage stratified random	One-stage stratified random	One-stage stratified random	Simple random	Multi-stage stratified random	Multi-stage stratified random	Multi-stage stratified random	Multi-stage stratified random	Multi-stage stratified random	All births in 1958
Sample size*	8,034	4,323	10,493	13,656	4,509	1,288	4,912 HH	908- 999 per month	21,444	5,659 from Wave 1	9,137
Analysis Level	Individual	HH Individual	HH Individual	HH Individual	Individual	HH Individual	HH Only	HH Individual	HH Individual	Individual	HH Individual
Geography	England GOR 2011 area	Scotland Health Boards	Wales UA Health Boards	Wales Health Boards	N. Ireland Health Boards	UK GOR	UK GOR	Britain GOR	UK GOR Special Secure	England GOR	Britain Special Secure
Method for alcohol data	CAPI interview	CAPI interview	Interview	Self-completion	Interview	Interview, Food diary	Interview, diary	Interview or self-completion	Self-completion	Self- completion	CAPI Interview
Response Rate**	57%	51%	54.6%	77.3%	66% (HH)	53% (adults & children)	46% (HH)	49%-54%	88% from previous wave	56% from Wave 1	78%
Weighting	Selection From 2003, NR Calibration	Selection NR Calibration	Selection Calibration Scale	Selection NR Calibration	Calibration	Selection Calibration	HH Level NR Calibration	Selection Calibration Scale	Selection NR	Core (waves 1&2) only NR	None
Dates with alcohol data	1997-2015	2008-2016	2016/17	1998-2015	2010/11-2016/17	2008-2014	2008-2016 2001-2007 EFS	2012-2016 +GLS	2010/11 - 2015/16	2004/05 – 2014/15	1981- 2013
Years with alcohol data	12 (of 16)	7	1	15	4	6	8	4	3 (of 7)	6 (of 7)	6 (of 9)

CAPI (Computer-aided personal interviewing software), GOR (Government Office Region), LSOA (Lower Super Output Area), HH (household), NR (Non-response). * Individuals, unweighted, all ages, with productive interview ** At least one adult with a productive interview in responding households.

3.6 Measurement of Alcohol Consumption and Expenditure

This section moves on from a review of survey design components to how alcohol consumption is measured through interview questions. After a description of the recommended methods, the availability of such measures is assessed for the main applicable surveys previously reviewed.

3.6.1 Survey Question Methods

Questions used to measure alcohol consumption in surveys have not been internationally standardised and can vary in content (410, 411). The most basic assessments of alcohol intake are the quantity-frequency measure (QF), the graduated frequency measure (using categories of intake, e.g. 1-3 drinks) and short-term recall (385). Guidelines for measuring alcohol consumption in population surveys have been produced by the World Health Organisation (WHO) in 2000 and the EU Commission's 'Standardising Measurement of Alcohol-Related Troubles' (SMART) in 2010 (190, 412). Such guidelines were developed through reviews of surveys and pilot testing. The minimum recommended survey measures are the establishment of drinking status (abstention), the volume of alcohol typically consumed and binge drinking volume and frequency, preferably using a one year reference period (190). Graduated frequency measures are considered less favourable compared to QF as it is associated with an overestimation of intake (413). Last occasion approaches, whilst avoiding issues of recall, tend to be poor reflections of typical intake due to the irregularities of most participants drinking patterns (414). Consideration of specific beverages (e.g. beer, wine) rather than a general intake is recommended, as discussed next, due to the difficulty for participants to average their typical intake across all occasions and beverage serving sizes which may lead to lower accuracy in reporting. A general QF measure that does not enquire about drink types is therefore only suitable for quickly capturing broad differences in intake.

Beverage specific quantity frequency methods (BSQF) take the form of a question of typical drinking frequency for a reference period (usually 12 months) and usual drinking quantity per occasion. Measuring both frequency and quantity for specific beverage types can be used to estimate typical units of intake per week, as described later in this chapter (section 3.8). BSQF is advocated by the latest EU recommendations as a greater volume of alcohol is reported when considering multiple beverage types (415). Referring to 'drinks' in general QF methods may lead to underestimation as the unit content of beverage servings can vary depending on a participant's preferred drink type. It is considered burdensome on the participant to consider

drinks in terms of units or serving sizes, therefore for BSQF methods, serving sizes are questioned related to specific beverages. This has made this method easiest to implement cross-culturally where serving sizes and strengths vary (413). The 12-month reference period is recommended as shorter reference periods do not capture occasional drinkers and are more likely to reflect seasonal patterns (411). Although longer reference periods are designed to capture 'typical' consumption, average intake cannot capture the irregularities of normal drinking patterns (380) and may raise issues with participant recall, as discussed later in this review.

As typical consumption questions cannot measure a binge drinking occasion, separate questions are used to assess if this occurred in the previous 7 days. This usually involves asking about a participant's heaviest day of drinking in the previous week of the survey and determining the quantity (using serving sizes) of different types of beverages consumed in the same day to produce a total intake for that day. Binge drinking measured in this way is only assessed in those who drank in the previous week. It does not enquire about how such drinks were spread throughout the day and therefore may not reflect the short drinking occasions that may be associated with intoxication. Although asking about the frequency of binge drinking is recommended in surveys (190), the current measurement of this in the UK relies on a participant's understanding of the 8/6+ unit threshold, which is subject to personal interpretation. The origins of this threshold were discussed in Chapter 2.2.3.

The short form of the AUDIT (Alcohol Use Disorder Identification Test), AUDIT-C is a broad QF measure developed for use in clinical settings to detect problem alcohol use (416). Recognising its poor ability to measure actual alcohol intake using a general QF measure, it creates a risk score based on answers to questions in Table 3.4. A score above 5 indicates use of the full AUDIT which includes a further 7 questions related to self-control and behaviour around alcohol (417). A score above 8 incorporating both AUDIT scores indicates alcohol use at increasing risk to health.

Despite its poor suitability to quantify lower levels of alcohol intake, the AUDIT is increasingly being used in population surveys (418, 419). A recent online survey of British adults found that a cut-off of 9+ using the AUDIT-C achieved 70% sensitivity and 71% specificity for capturing problem drinking in men (50+ units) (420). However, a 5+ cut-off used for detecting drinking above the former weekly guidelines in men (21+ units) achieved a 99% sensitivity and 25% specificity, suggesting many false detections.

Table 3.4 AUDIT-C from NHS Health Check

Score	**0**	**1**	**2**	**3**	**4**
How often do you have a drink containing alcohol?	Never	Monthly or less	2-4 times per month	2-3 times per week	4+ times per week
How many units of alcohol do you drink on a typical day when you are drinking?	1-2	3-4	5-6	7-9	10+
How often have you had 6 or more units if female or 8 or more if male, on a single occasion in the last year?	Never	Less than monthly	monthly	weekly	Daily or almost daily

3.6.2 Alcohol Expenditure Measures

Surveyed alcohol expenditure measures have an advantage over retail data in that the characteristics of the spenders can be examined and there is no misinterpretation between tourist-related and local resident purchases (421, 422). Retail data is collected from a random sample of on-trade outlets, volume data and electronic sales records of larger off-sale sources and is therefore considered more objective but can only be used to identify population trends (421). However, survey questions to collect alcohol expenditure data have not undergone development testing like those for consumption.

The measurement of alcohol expenditure as a general survey measure currently does not use complex methods and usually involves a single question of "*how much have you spent on alcohol?*". If measuring at the household level, this question involves only the HRP who is assumed to be the main spender. Reference periods vary such as four weeks (in USoc) or average week (in NIHS). Non-personal expenditure on alcohol is incorporated into the question with phrases such as "*you and other members of your household" or "you spend… including drinks you buy for other people?*" (see Table 3.5).

In household expenditure surveys such as the LCFS, alcohol expenditure is measured in an individual two-week diary for the HRP with expenditure coding available for specific beverage types "brought home" and "away from home" (266). As all members of a household can take part in a diary, the contribution to household spending is potentially estimated from actual data than the assumptions made for other members in household-level survey questions. However, the HRP spending alone may be unable to account for the expenditure of unrecorded household members. Some respondents interpret household spending as shared expenditures only and this can lead to under-reporting (423).

Because of its social use, estimating expenditure on alcohol is more complex than other grocery basics as alcohol may be purchased for others and more irregularly. Surveys do not use questions

to prompt the recording of this kind of irregular spending and this has been identified as a source of under-reporting in the LCFS (423). Questionnaires do not account for atypical spending (unless over £5000), such as for special occasions, for which a large amount of alcohol can be purchased.

3.6.3 Alcohol Measures in Reviewed Surveys

Considering the surveys previously introduced, the available questions related to measuring alcohol consumption and changes in survey continuity are presented in Table 3.5. All surveys, including the two longitudinal panels (USoc and ELSA), ask about the general frequency of drinking (not beverage-specific) using a 12-month reference period. This can be used to derive drinker or non-drinker status, although further questions are needed to establish lifelong abstainers, which are not available in ELSA. BSQF style questions, using a 12-month reference period to determine typical weekly drinking, are available in the SHeS since 2008, the four years of the NIHS but not the former WHS or OLS. BSQF questions featured in the HSE between 1997 and 2002 but were removed until reappearing in 2011. This may be due to the change in focus of the low-risk guidelines from weekly to daily drinking during this period (see Chapter 2.2.3).

In both longitudinal panels, ELSA and USoc, there is no reference to BSQF questions using a 12-month reference period and therefore typical weekly drinking cannot be calculated. In wave 4, ELSA introduced a BSQF measure using a reference period of only the previous 7 days. This short reference period removes the contribution of less frequently consumed beverages to typical unit intake, reduces the ability to assess low-risk drinkers as a reference group and takes less account of seasonal intake. As shown in Table 2.2, the assessment of only past week drinkers is an issue in British cohort studies such as the NCDS.

To determine binge drinking, all cross-sectional surveys, except the NIHS, determine the heaviest day of those drinking in the previous week and the beverage-specific intakes on that day. ELSA includes the heaviest day measure only in wave 2 and 3 before switching to its quantity for the previous week measure previously described. USoc includes heaviest day measures in wave 2 and 5 before switching its question design to the AUDIT-C in wave 7 (Table 3.4). This change removed any reference to specific beverages in its questioning which reduces its quality of reporting as previously discussed (415). The switch to AUDIT-C also changed the responses used for the 12-month frequency measure which could not be matched to the responses in wave 5 due to overlap in measures (see Appendix Table 7.2 for a comparison in wave responses). USoc only enquires about the three main types of beverage (beer, wine or spirits) in wave 2 and 5 compared

to the HSE which uses a broad range of drink types, including standard and strong strength beer. No surveys ask about the frequency of binge drinking except in the USoc switch to AUDIT-C.

The SHeS is the only survey to include some context-related questions about drinking location and company and has included the full AUDIT in its adult self-completion booklet since 2013. USoc includes household expenditure on alcohol for every wave available, using only a question rather than a diary as in the LCFS, however it is the only longitudinal measure of household expenditure data available.

Currently, data is not available in surveys that can properly explore the social contexts of obtaining alcohol and the 'activity spaces' related to purchasing in particular locations, travel routes and times (78). Such data is needed to further advance the current understanding of the relationship of place with alcohol-related outcomes, including relevant spatial scales and outlet availability, which is currently limited to spatial distances from home or area densities. Ecological momentary assessment may provide such data in the future (78).

This brief overview agrees with a published review on UK alcohol measures that most surveys are still in the process of meeting the recommendations for the inclusion of BSQF style questions except the HSE and the SHeS (190). The limitations in panel data questions are particularly concerning as apart from currently being lower quality, updates in question design limit the ability to assess outcomes longitudinally.

3.6.4 Selection of Survey Data for this Thesis

Most surveys in the UK are of good quality in terms of using stratified random sampling and response rates of at least 50%. However, some surveys are limited by their smaller sample size, age coverage for the middle-aged target population of this thesis, a fewer number of years performed or survey continuance. Therefore, the smaller national surveys, the NDNS, OLS, NCDS birth cohort and the two older age panel studies reviewed, ELSA and WHII, were considered less suitable for analysis in this thesis.

The HSE and SHeS are both high-quality cross-sectional surveys using BSQF style questions. However, the HSE provides alcohol-related coverage back to 1998, a decade more than the SHeS and twice the sample size. The HSE is limited by its removal of typical weekly drinking questions between 2003 and 2010. The GLS was considered as an alternative data source for these years, available from 2006 to 2011. However, upon access to the ONS Secure Data Lab, it was found that there was no id code to match participants longitudinally and the postcode and date of birth key

variables changed in structure over the years making it impossible to identify repeated observations. This change in structure could not be resolved through personal communication with the ONS. The HSE was chosen for analysis in this thesis due to its ability to provide insights into alcohol consumption prior to the period contexts of the 2008 recession and the peak of alcohol consumption per capita in 2004.

Both ELSA and USoc have limitations in their question design and continuity including the use of a self-completion booklet for alcohol consumption. In terms of survey design, USoc provides better age and UK coverage, a larger sample size and lower attrition compared to ELSA. Although ELSA technically provides a 7-day beverage-specific quantity measure for four waves, it would be difficult to interpret this outcome against the weekly guidelines due to its exclusion of non-weekly drinkers. Therefore, USoc was chosen for longitudinal analysis in this thesis due to its better sample coverage and use of a standard binge drinking measure, however wave 7 was excluded due to the change in question quality. USoc also contains annual alcohol expenditure data that has a longitudinal and sample size advantage over the cross-sectional LCFS, providing a unique data resource for subsample analysis in this thesis.

The state of the evidence for the association of alcohol consumption with outlet availability from the previous literature review in Chapter 2.4 suggested that future studies need to take better account of ecological biases and the aggregation of descriptors (333). Taking into account the difficulty of accessing such detailed outlet information, particularly longitudinal data (424), and the lack of contextual data available in surveys to understand the relevance of place to middle-aged purchasing activity, further investigation of the association of consumption with alcohol outlets to the target population was not pursued in this thesis.

Table 3.5 Alcohol consumption related questions in applicable surveys as indicated by [x]. Available for all years unless noted.

CROSS-SECTIONAL Survey Questions	Response Range	HSE	SHeS	WHS	NIHS	NDNS	OLS
Dates From *(Dates and survey acronyms indicate exceptions)*		1997	2008	2008	2010	2008	2012
Dates To		2015	2016	2015	2014	2014	2016
Abstainer status							
Do you ever drink nowadays?	Y/N	x	x	NSW	x	x	x
Does that mean you never have an alcoholic drink nowadays?	Never/Occasional	x	x	NSW	x	x	x
Have you always been a non-drinker?	Y/N	x	x	x '03	x	x	GLS
Did you stop drinking because of a particular health condition that you had at the time?	Y/N	x		NSW	x		GLS
Frequency: Past 12 months – General Frequency							
How often have you had an alcoholic drink of any kind during the last 12 months?	8 answers from every day to none at all	x	x	x	x	x	x
Frequency: Past 7 days							
Did you have an alcoholic drink in the seven days ending yesterday?	Y/N	x '98	x	x		x	x
In the last seven days, on how many days did you have an alcoholic drink?	1-7 days	x '98	x	NSW		x	x
Did you drink more on one of the days (some days than others), or did you drink about the same on both?	Same/More	x '98	x	NSW		x	x
Which day (last week) did you (last have an alcoholic drink/have the most to drink)?	Mon-Sun	x '98	x	x		x	x
Quantity: Heaviest day							
On the day you drank the most/last drank, what types of drink did you have that day?	Beer, Spirits, Wine Alcopops (varies by survey)	x '98	x	x		x	x
And how many … did you drink that day?	Pints, Measures, Glasses, Bottles	x '98	x	x		x	x
Frequency and Quantity: Past 12 months - BSQF							
How often have you had a drink of… in the last 12 months?	8 answers of frequency day to year, none	<2002 >2011	x	NSW	x		GLS
And how much … did you drink on any one day?	Pints, Measures, Glasses, Bottles	<2002 >2011	x	NSW	x		GLS
Self-reported consumption							
Compared to five years ago, would you say that on the whole you drink more, about the same or less nowadays?	More/Less	x			x	x	GLS
Would you say you hardly drink or drink heavily?	5 answer range				x		x

CROSS-SECTIONAL Survey Questions	Response Range	HSE	SHeS	WHS	NIHS	NDNS	OLS	
(Continued from previous page)								
Context								
In which of these places would you say you drink the most alcohol?	Pub, home etc		x					
Who are you usually with when you drink the most alcohol?	Friends, colleagues etc.		x					
On average, how much money would you spend each week on alcohol at off/on sales, including drinks you buy for other people?	£				x			
LONGITUDINAL Survey Questions	**Response Range**	**US: Understanding Society EL: ELSA W: Wave**						
Dates appeared *Arrows indicate a change in questionnaire design*		2004	2006	2008	2010	2012	2014	2016
Abstainer Status								
Have you ever had an alcoholic drink?	Y/N				USW2		USW5	
In the past 12 months have you taken an alcoholic drink?	Y/N						→	USW7
Have you always been a non-drinker?	Y/N							USW7
Frequency: 12 months - General								
How often have you had an alcoholic drink of any kind during the last 12 months? (AUDIT-C Q1)	8 answers from every day to none at all	ELW2	ELW3	ELW4	ELW5 USW2	ELW6	ELW7 USW5	USW7
Frequency: Past 7 Days								
Did you have an alcoholic drink in the seven days ending yesterday?	Y/N	ELW2	ELW3	ELW4	ELW5 USW2	ELW6	ELW7 USW5	
In the last seven days, on how many days did you have an alcoholic drink?	1-7 days	ELW2	ELW3	ELW4	ELW5 USW2	ELW6	ELW7 USW5	
In the last 7 days, how many … did you drink?	Pints beer, Glasses wine, Measures of spirits			ELW4	ELW5	ELW6	ELW7	
Quantity: Heaviest Day								
On the day you drank the most in the last 7 days, how many … did you drink?	Pints beer, Glasses wine, Measures of spirits	ELW2	ELW3		USW2		USW5	
How many drinks do you have on a typical day when you are drinking? (AUDIT-C Q2)	1-10 drinks any alcohol						→	USW7
Frequency: Heaviest Day								
How often have you had 6 or more units 8 or more units, on a single occasion in the last year? (AUDIT-C Q3)	Daily – Weekly							USW7
Context								
About how much have you and other members of your household spent in total on alcohol in the last four weeks?	£			USW1	to			USW7

3.7 Data Interpretation: Serving to Unit Conversions

This section describes how the survey questions on consumption are converted to practical unit data. As the HSE and USoc use forms of BSQF measures, a combination of the beverage-specific questions on frequency (for a reference period) and glassware volume (using available options in the survey) can be used to calculate estimated alcohol units for each individual (Equation 3.1). However as the strength of the alcohol content by volume (ABV) is not reported in surveys, it is assumed using known conversion factors for the beverage type as shown in Table 3.6. For example, using the UK unit definition of 8g of alcohol per 10ml, a standard strength 12.5%/v wine in a 175ml glass (standard serving) is assumed to contain 2.2 units.

Equation 3.1

$$Units = Alcohol\ strength\ by\ volume\ (\%) * Glassware\ volume\ (ml) \div 1000$$

The reported usual unit serving of a drink is then multiplied by its typical frequency of consumption for the referenced period (151). For example, a daily drinker of a standard serving of wine, using a 12-month reference period, drinks 2.2 units multiplied by 7 days for a total of 15.4 units per week. This outcome is added together for all drink types to determine the average unit intake per week.

In 2006 and 2007, the HSE revised their unit calculations for wine and beer to reflect current pouring practices, as shown in Table 3.6 (425). The largest change in assumed units was for wine where the previous use of one unit for a standard glass was increased to two to reflect more realistic serving volumes (426). Beer units also increased for some serving sizes due to an estimated increase in ABV for non-draught servings. This change in calculations is one reason why long term trends in the percentage of individuals exceeding the low-risk guidelines are not reported in trend tables of the HSE (12). This thesis overcame this limitation by calculating the units for all years available using the data from the original frequency and volume measures reported and used revised conversion factors to ensure continuity of unit measures across all years.

Both the HSE and SHeS use rounded unit assumptions in their calculations of intake as shown in Table 3.6. For example, a 440ml can of 4.0%/v beer is calculated to be 1.8 units but is rounded up to 2.0 units. As the exact ABV is not enquired about in surveys, it is unclear whether rounded or exact units are more representative of actual units consumed.

Table 3.6 Previous and revised factors for converting alcohol volume to units.

Alcohol type	Typical Strength	Measure	Calculated units	HSE/SHeS units	HSE prior 2006
Normal strength beer, cider	4.0%/v	Half pint (284ml)	1.1	1.0	1.0
		Small cans/ Bottle (330ml)	1.3	1.5	1.0
		Can (440ml)	1.8	2.0	2.0
Wine	12.5%/v	Small (125ml)	1.6	1.5	-
		Standard (175ml)	2.2	2.0	1.0
		Large (250ml)	3.1	3.0	-
		Bottle (750ml)	9.4	9.0	-
Fortified wine	18%/v	Standard measure (50ml)	1.0	1.0	1.0
Spirits and shots	40%/v	Single measure (25ml)	1.0	1.0	1.0
Alcopops	5.0%/v	Bottle (275ml)	1.5	1.5	1.0

The calculation of units is limited by the accuracy of the self-reported servings which are limited by the question design of the survey. Depending on the aims of the survey, BSQF can be limited to the three main alcohol types (beer, wine, spirits) and assume standard serving sizes for all measures, as found in USoc. Surveys do not usually enquire about alcohol strength, except for strong beer, despite wine varying between 10%-14% ABV and fortified wine up to 20% ABV. The use of glassware sizes assumes that survey participants are aware of their typical alcohol serving, the average of which has increased in size over time in the UK (427). Larger volumes of alcohol poured are associated with an underestimation of alcohol units in a glass (428).

3.8 Survey Response Issues

After the conversion of responses into practical unit data, there may be inherent biases remaining due to issues of under-reporting, abstainer bias and non-response (missing data), that need to be considered in the interpretation of study outcomes as discussed in the next section.

3.8.1 Under-reporting

Self-reported alcohol consumption may be under-reported (reporting fewer drinks than actually consumed) due to factors such as social desirability or poor recall (376, 383). Comparing figures to retail sales, survey measures of alcohol consumption in the GLS may be under-reported by up to 40% in one UK study, with retail overestimation considered small compared to underestimation (375, 421). Adjusting for under-reporting is difficult as it requires an understanding of the population distribution of this bias, which is unknown for the middle-aged drinking population, and was therefore not applied in this thesis (376). Using an equal ratio of

under-reporting across the sample may cause an exaggeration of outcomes in the subpopulations less prone to under-reporting (375).

There are two main reasons for under-reporting to drinking surveys which are social desirability bias and poor recall. Responses to surveys are affected by the personal interpretation of 'normal drinking' behaviour and individuals may be uncomfortable reporting heavier drinking (383). Participants may adjust their responses, intentionally or not, to be in line with perceived social norms to minimize negative judgements (429). An international study, including England, found that social desirability was more likely to occur in individuals of higher socioeconomic status (430). The form of drinking pattern being surveyed can also affect responses with women more likely to under-report binge drinking behaviour compared to average drinking volumes (431). In longitudinal surveys, answering questions that may expose an individual to their own alcohol use may prompt changes in intake at follow up surveys (432).

Recall of consumed alcohol by participants may be less accurate if the reference period is too long or if the individual is an infrequent drinker. Individuals who reported occasional drinking, engaged in binge drinking less frequently or had irregular drinking contexts were less likely to report their consumption correctly in surveys (376, 386, 433). Survey response methods, such as a diary, or shorter reference frames, can assist with recall but have inherent limitations as previously described.

3.8.2 Abstainer and Survivorship Bias

The literature review in Chapter 2.2.4 discussed how research is increasingly recognising that abstainers or non-drinkers have different characteristics to low-risk drinkers (206, 434). Individuals who consume no alcohol may have cultural or health issues, including ex-problem drinkers, that may bias outcomes compared to those who drink within the guidelines and have no specific reason to abstain (206, 434, 435). A survey of South East England found that non-drinkers clustered in the frail or disabled and in younger ethnic minority groups (435). Such differences may make it inappropriate to combine both non-drinkers and low-level drinkers into the same low-risk reference category when determining factors associated with risk drinking behaviours (434). Additionally, the consumption of alcohol even at low-risk levels is not considered entirely free from harm to health which creates a further separation of characteristics to those exposed and non-drinkers who are not exposed to alcohol (175, 436).

From a public health perspective, this thesis is concerned with understanding risk drinkers compared to moderate drinkers, rather than characterising the drinking behaviour of the

population in general. Therefore, those who reported no alcohol intake, with more details on how this was defined within each study chapter, were excluded from analyses in this thesis. This was also applied to the handling of USoc expenditure data in study 3 where years with households without at least £1 of alcohol spending were excluded. This was also in part due to the more complex econometric techniques that are required to handle non-spenders (£0) who by similar logic to excluding abstainers, are assumed to have different motivations to spenders which need to be accounted for in analyses (437).

Survivorship bias may occur in the sampling of older ages if the characteristics of responding heavier drinkers contributed towards their survival, for example the lower risk of mortality in less deprived areas (438, 439). This may be more likely to occur in repeated cross-sectional samples due to the new sampling of participants each year compared to panel data that follows ageing participants over time. Age-related declines may cause former heavy drinkers to appear as moderate drinkers in later life, increasing the difficulties of separating their lifecourse characteristics in analyses (440). This has contributed towards the methodical issues in understanding the relationship of alcohol with health as discussed in Chapter 2.2.4. However, accounting for this bias requires the use of long-term drinking histories which are only asked of former drinkers in surveys, not drinkers in general, and therefore such data was not available for this thesis.

3.8.3 Non-Response, Weighting and Missing Data Management

Response rates to a survey are affected by the inability to contact individuals or refusal to participate (441). This loss is important as it affects the sample size and intended population representation. Non-responders may have different characteristics to the responding population resulting in a biased sample towards characteristics of participators in analyses. Non-response is also problematic in long-running longitudinal surveys when drop-out (known as attrition) creates a sample whose characteristics, such as higher income, may be biased towards remaining in the survey (403). The application of weights is designed to reduce sample bias by adjusting the data to be more reflective of the larger population it was sampled from. This includes the oversampling of subpopulations in sample designs and the misrepresentation that may have occurred from the non-responding population (442). However, weighting can lead to sample size loss, increase standard errors in some cases and does not necessarily weight the sample towards responders with the behaviour of interest (377, 443).

As the main focus of this thesis was on a specific population age group and behaviour, models were analysed without the use of weights to retain a larger sample size and therefore improve statistical power. A larger sample size is more likely to support the minimum sample size needed to represent subgroups in analyses, even when impacted by non-response (399). When longitudinal self-completion weights were applied to USoc data, about a third of the sample aged 45-69 years was excluded. Practically, full weighting to adjust for non-response bias had not been developed for the HSE until 2003 (425). A post-hoc test of study 1 found that applying HSE 2011-2015 weights to all years of data had no discernible effect on multilevel logistic regression outcomes.

This thesis used Complete Case Analysis (CCA) in all three studies meaning that participants without a response to a variable of interest were dropped from the analyses. CCA risks increasing the size of non-response bias, therefore the main variable sources of missing data and the characteristics of the sample excluded due to CCA were reported in the first two studies of this thesis. The third study, using household-level responses, had low levels of variable missingness as a household interview is a required component before individual level interviews (444). An alternative to CCA is the use of multiple imputation, which can be used to support small sample sizes, by replacing missing data with a generated random subject drawn from the same sample population. However, missing data at the individual level of the first two studies of this thesis was found to occur in specific variables, the reasons of which are described in the study methods, rather than a random pattern of missingness across all variables. This kind of non-random missingness is less appropriate for use with multiple imputation and therefore it was not used in this thesis (445).

3.9 Statistical Analysis using Multilevel Modelling

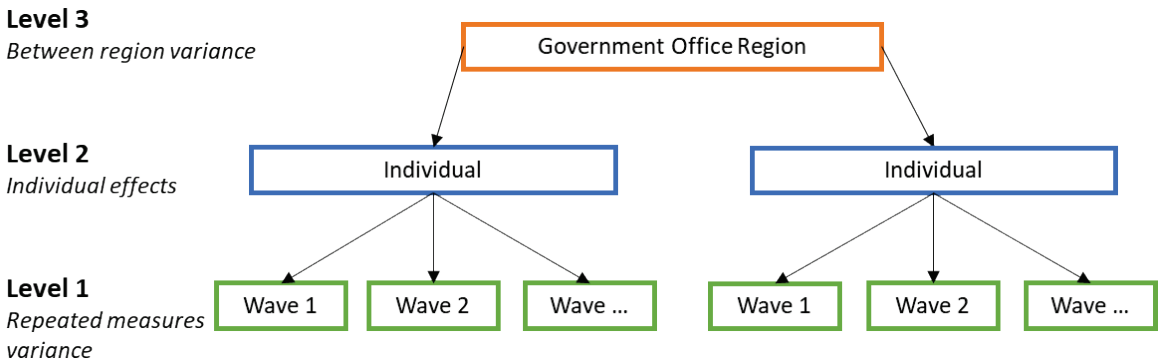
This section moves onto a descriptive overview of the statistical modelling method chosen for this thesis. Such a method must support investigations of individual or household level associations with alcohol measures, within large survey datasets, whilst accounting for issues of dependency and clustering. The main statistical modelling method chosen was multilevel modelling using the generalized linear mixed model (GLMM) also known as a multilevel, mixed effects, or hierarchical linear model (446). This procedure can fit regression models to clustered (hierarchical) and repeated measures (longitudinal) data and therefore account for its structural properties. Both clustered and repeated measures data involve violations of the independence of observations, assumed for regression, which can be accounted for using a multilevel method. A GLMM is not to be confused with a Generalized Linear Model (GLM) which refers to its ability to

account for non-linear relationships and categorical outcomes but does not account for hierarchical structures (447).

The mixed part of a GLMM refers to the combination of fixed and random effects in the same model (235). The effect of a random factor is considered to vary depending on the level of the factor being studied, for example neighbourhoods sampled from a larger population, with intercepts allowed to vary randomly across groupings. The effect of a fixed factor should be the same when studies are repeated as it is not randomly sampled from a hierarchy of levels, for example sex, and therefore estimated as an average across groupings. The GLMM is an advantage over the older generalized estimating equations (GEE), also developed to account for independence violations, that could only produce population-averaged estimates rather than modelling individual differences (448).

An example of a three-level model structure applied to longitudinal data is shown in Figure 3.3. This model represents the most complex structure used in this thesis in study 2. In this model, a GLMM accounts for the possibility that individuals within GOR may share characteristics that may be associated with the behaviour of interest (449, 450). Repeated measures are similarly clustered within individuals in that annual measures taken from the same person are likely to be correlated. As cross-sectional surveys interview a new random sample of participants each year, there is no within-person correlation of measures in cross-sectional data that occurs with longitudinal data.

Figure 3.3 Example of a hierarchical structure found in panel survey data of this thesis.



A GLMM is able to handle participants that do not have measures for each repeated measure (wave) (or level) in a study and can therefore handle imbalanced sample sizes over time (451). The advantage of this is that missing or problematic data can be excluded on a wave by wave basis rather than a participant's entire contribution to the dataset (452). This is useful for the analysis of panel data in that it can retain data entries from participants who respond

inconsistently, account for changing household structures and exclude data waves without the behaviour of interest. This can help with reducing attrition bias by allowing participants to return to the survey (404). A GLMM can include time-varying and time-invariant variables in the same model including changing continuous variables, such as age.

By accounting for clustering, the variation in outcomes attributable to the individual level and between regions can be observed (235). Residuals of the regression model can be analysed to determine the unexplained variance of random effects after the inclusion of predictor variables. Standardised residuals represent the difference between actual (observed values) and expected (predicted) values in the model. A residual value of zero indicates a match between observed and predicted values. Not accounting for hierarchical structures, including clustering in sampling designs, may lead to smaller confidence intervals and increase standard errors (type 1 error[14]) (377, 453, 454). Models in this thesis were adjusted for factors that were used in survey sampling strategies including ethnicity, socioeconomic markers and GOR within a multilevel model which can account for some of the complex design effects (455).

3.9.1 Accounting for Household Clustering

As well as clustering within geographical units, individuals can cluster within households that are likely to share characteristics due to shared living spaces or familial relationships (287, 456). However, household-level clustering was not pursued in the first two studies of this thesis, that were analysed at the individual level, as these studies stratified models by men and women to identify sex-specific associations with drinking behaviours. An exploratory study of the BHPS found that sex-specific modelling reduced the need to control for household-level clustering, the misspecification of which was considered to be empirically small (457). Another issue is individuals may move between households during a panel study that may create the need for a more complex multi-membership model (458). Therefore models in study 1 and 2 were controlled for household relationships through the inclusion of marital status, including cohabiting, and child status at the individual level, particularly as non-related sharers were expected to be lower in middle-aged households compared to other ages.

[14] Rejection of a true null hypothesis (false positive).

3.9.2 Application using Statistical Software

Data were prepared and analysed for this thesis in SPSS Versions 24, 25 and 26 due to annual software updates (451). All main models were analysed using the Generalized Linear function under Mixed Models (GENLINMIXED). The default estimation method for GENLINMIXED is parameter convergence which assumes convergence if the maximum absolute change in estimates is less than 1E-6 (459). Model convergence was reached for all models. Box 3 shows an example of SPSS syntax for a logistic regression model with repeated measures and GOR as a random intercept using parameter convergence as the estimation method.

Box 3 Example of SPSS syntax for GENLINMIXED command to produce a three-level random intercept model.

```
GENLINMIXED
  /DATA_STRUCTURE SUBJECTS=gor_dv*pidp
REPEATED_MEASURES=longwave COVARIANCE_TYPE=COMPOUND_SYMMETRY
  /FIELDS TARGET=units_di TRIALS=NONE OFFSET=NONE
  /TARGET_OPTIONS REFERENCE=2 DISTRIBUTION=BINOMIAL LINK=LOGIT
  /FIXED USE_INTERCEPT=TRUE
  /RANDOM USE_INTERCEPT=TRUE SUBJECTS=gor_dv
COVARIANCE_TYPE=VARIANCE_COMPONENTS SOLUTION=FALSE
  /BUILD_OPTIONS TARGET_CATEGORY_ORDER=ASCENDING
INPUTS_CATEGORY_ORDER=ASCENDING MAX_ITERATIONS=100
CONFIDENCE_LEVEL=95 DF_METHOD=RESIDUAL COVB=MODEL
PCONVERGE=0.000001(ABSOLUTE) SCORING=0 SINGULAR=0.000000000001
```

Specification of the distribution (shape) of the dependent variable and how it should be linked to the predictor variables was determined through investigation of the data and desired target outcomes. A GLMM can support multiple data distributions including continuous and categorical outcomes. A binomial distribution with logit link function was used in study 1 and 2 (binary response data using logistic regression). Study 3 used a normal distribution with identity link function (continuous data using linear regression with no transformation of the target). Random intercepts were retained in models without statistically significant variance to improve standard errors for a maximal model approach (460).

3.9.3 Ethics and Access

The Ethics and Research Governance Online for the University of Southampton approved the analysis of secondary data. Informed consent was obtained from all individuals who took part in surveys. Data was downloaded from the UK Data Service and subject to the End User Licence Agreement. ERGO ID: 27351

This chapter has provided a comprehensive overview of the available survey data with alcohol consumption measures, difficulties in assessing self-reported alcohol consumption and expenditure data and the statistical analysis method used in the next three empirical chapters. Chapter 4 to Chapter 6 contain three independent but linked studies to address the research objectives that were developed as part of the literature review in Chapter 2.6.1.

Chapter 4 Study 1: Factors associated with risk alcohol consumption in middle-aged adults in England: multilevel repeated cross-sectional survey analysis

This chapter describes the first study of this thesis using repeated cross-sectional data from the Health Survey for England (HSE). This study aims to address the research gaps, identified in the literature review in Chapter 2.6.1, posed by objective 1: To explore how the percentage of drinkers aged 45-69 years exceeding the weekly low-risk guidelines for alcohol and binge drinking has changed over time, objective 2: To explore how individual and socioeconomic characteristics and co-risk behaviours are associated with such risk alcohol behaviours, and whether these relationships have changed over time, and objective 4: To explore the relevance of geographical area on risk alcohol behaviours in middle-age, independently of individual-level factors. It does this by considering long-term trends in alcohol consumption the middle-aged English population for thresholds associated with both exceeding the weekly guidelines and binge drinking. This study investigates the association of a range of individual-level factors with these risk alcohol behaviours. The analysis accounts for the role of wider living location within England by Government Office Region (GOR) and considers the potential change in the association of these factors before and after the 2008 economic recession, a substantial macro-level event in the UK.

4.1 Background

Excess alcohol consumption is associated with numerous negative health outcomes both from chronic intake and short-term intoxication (23, 41). The UK has developed low-risk guidelines that recommend consuming a limited number of units per week (up to 14 for both sexes) and avoiding too many units in a single session (binge drinking) to avoid health risks including alcohol-related hospitalisation (11, 461). Middle-aged adult drinkers are the most likely to exceed the weekly unit guidelines yet are more susceptible to the biological effects of alcohol due to ageing (94, 113). Since 2008, age-standardised alcohol-related hospitalisations[15] have continued

[15] Narrow measure per 100k population - First line diagnosis or secondary diagnosis with an external cause recorded on hospital admissions form as opposed to an alcohol related condition appearing on any line of the admission form (broad measure).

to rise in adults over 40 years of age in England (39, 165, 166). Yet there have been no studies considering trends in drinking alcohol above risk thresholds specifically for the middle-aged population. The lack of a long-term description of middle-aged adults engaging in risk drinking limits the understanding of trends in alcohol-related harm and the direction of this behaviour over time in this population.

Fluctuations in population levels of alcohol consumption have been observed since the late 1990s to 2010s in period analyses using all adult ages but these outcomes are limited to a linear or quantile unit intake (76, 142). These studies suggest an increase in alcohol consumption by female drinkers of the heaviest quantiles of intake but a decrease across all intake quantiles by male drinkers over this period. Descriptive trends for exceeding the weekly guidelines from the HSE are limited to 2011 onwards due to a change in drink serving to unit conversion methods in 2006 and survey question changes (Chapter 3.6.3 and 3.7) (151). A linear change in average alcohol intake is limited as an outcome as this does not indicate how much of the drinking population is consuming levels of alcohol that have been deemed at risk to health or whether the pattern is related to chronic or acute harm (162, 175).

Calls have been made to create more targeted strategies and identification of risk alcohol consumption in ageing adults (32, 462, 463). However, research into understanding the individual and contextual characteristics of risk drinking in middle-age in the UK has been limited (49, 91, 464). Reviews from the literature suggest that alcohol consumption is influenced by multiple social-ecological factors at individual and social levels (42, 68, 70) interacting with period effects (76, 143) including macro-level contexts, such as affordability (98). Yet there have been limited studies considering how individual-level factors in the middle-aged population may increase drinking above risk thresholds.

Investigations into the associations of family and socioeconomic status factors with alcohol consumption are limited to birth cohort research in adults in their 40s to 50s that are at a greater risk of bias from long term attrition, use older definitions of binge drinking thresholds, do not stratify the analysis by sex (274-276) or are limited to a linear unit intake (102, 283). Two studies have analysed the English Longitudinal Study of Ageing (ELSA) cohort of adults aged 50+ years and were therefore the only studies able to consider the association of retirement with drinking. However, these study outcomes were restricted to problem drinking (50+ units men, 35+ women) and a linear intake of units, suggesting that being in retirement was associated with a reduced unit intake in women but not men (101, 256). Despite the interacting relationships of smoking and raised body-mass index (BMI) with alcohol consumption and alcohol-related harm (239, 259,

262), their association with exceeding the low-risk drinking guideline has not been investigated in middle-aged adults. Therefore, the individual level demographic, socioeconomic and co-risk characteristics associated with exceeding the low-risk guidelines or binge drinking in middle-age remain unclear.

A statistically significant association of GOR with binge drinking was found in two studies using a population of all adult ages and one study using multilevel modelling that accounted for this hierarchical structure (296-298). However, no studies have considered the association of GOR in the middle-aged population for exceeding the low-risk guidelines. Therefore, the impact of GOR residence, independently from resident characteristics, on risk drinking in this population is unclear despite known regional differences in alcohol-related harm (165, 229).

Between the early 2000s and 2010s population levels of factors such as smoking, household-level incomes and adults in higher education have changed (143). This period included the 2008 economic recession that in the literature was associated with overall reductions in alcohol consumption and increases in binge drinking in some sensitive groups (97, 344). It is unclear if population changes in middle-aged characteristics over time have led to a change in the association of such factors with risk alcohol consumption. Such evidence may support any trend changes observed for risk drinking in this age group.

The research gaps identified for understanding risk drinking in the English middle-aged population in this study were a lack of long-term trends in risk consumption, a lack of investigation into the associated individual and regional level characteristics and whether the association of these identified individual characteristics have changed over survey years. The following study-specific research questions (RQ) were developed to address such research gaps:

1) How has exceeding the weekly guidelines and binge drinking changed since 1998 in middle-aged men and women from England?
2) What demographic, socioeconomic and co-risk factors are associated with increased risk of these drinking behaviours?
3) Does GOR residence have an independent association with these drinking behaviours?
4) Has the association of these individual-level factors with these drinking behaviours before and after the 2008 Economic Recession changed?

This study addressed these research gaps by considering how the percentage of middle-aged adults that drink above the former weekly guidelines and binge drinking thresholds changed between 1998 and 2015 using ten years of survey data from the HSE (RQ1). It considered the association of various individual-level factors with these two risk drinking behaviours including

demographics, socioeconomic status by income, employment status and highest qualifications and the co-risk factors smoking and BMI, whilst taking into account the known relationship of poor health and lower alcohol intake (206, 208) (RQ2). Multilevel modelling was used to assess if the association of GOR residence was independent to the individual level associations observed (RQ3). The associations with risk drinking were compared by two pooled survey periods, (1998-2002) and (2011-2015), to determine if the individual level associations had changed over time (RQ4).

4.2 Methods

4.2.1 Study Population and Sampling Design

This study uses ten years of data from the HSE for the years 1998 to 2002 and 2011 to 2015 for men and women aged 45-69 years. These years were chosen to enable the analysis of long-term risk alcohol consumption trends in this age group and account for changing period contexts. The ten survey years were pooled into two periods to observe if associations had changed over time (1. 1998-2002 and 2. 2011-2015). These periods were chosen as this enabled a comparison of the period leading up to the peak of population-level alcohol consumption in 2004 (141) with the years after the economic crash of the 2008 recession (97).

The HSE is an annual cross-sectional survey using a random stratified sample of adults living across all regions of England with a new sample of private addresses obtained each year as explored in Chapter 3.4.1 (389). This dataset was chosen for its availability and quality of risk alcohol measures over many survey years (190). A repeated cross-sectional design enables the analysis of long-term population-level trends and maintenance of the target sample age required to answer this study's RQs. The sampling of new participants annually means that the dataset is not subject to ageing and cohort biases over time that may occur from longitudinal attrition.

4.2.2 Outcome – Risk Alcohol Consumption

Questions related to individual-level alcohol consumption were included in the HSE since the year 1998 (see Chapter 3, Table 3.5). Survey measures included an assessment of non-drinker status, typical volume of alcohol consumed per week and volume of alcohol consumed on the heaviest day of the previous week. Survey questions related to typical consumption per week were temporarily suspended from the year 2003, possibly in response to a change in the guidelines to recommended daily alcohol limits (4 units for men, 3 units for women) (see Chapter

2.2.3), but these questions were re-introduced in the year 2011 (465, 466). This study assessed two risk alcohol behaviours, exceeding the weekly guidelines and binge drinking (see Chapter 2.2).

Exceeding the Weekly Unit Guidelines: A typical intake of alcohol consumed per week was measured using recommended BSQF[16] style questions using a one-year reference period (Chapter 3.6.1). Frequency of consumption was assessed by the question "*How often have you had a drink of… in the last 12 months?"* Answers ranged from *1. Almost every day 2. About twice per week. 3. About once per week. 4. About once a fortnight 5. About once a month. 6. Only a few times a year. 7. I never drink alcohol now.* Servings of alcohol were measured by the question: "*And how much … did you drink on any one day?"* Answers were beverage-specific with multiple serving sizes available for beer, strong beer, wine, spirits, sherry, and alcopops.

After these serving sizes were converted to units (see unit conversions below), the average number of units per week was calculated based on the frequency response and then the weekly units of all beverage types added together to produce a typical unit intake per week. This response was used to determine if individuals drank above or below the former weekly unit guidelines of 21 units in men and 14 units in women (Chapter 2.2.3). These former guidelines were chosen over the current guidelines, introduced in 2016 (14 units for both sexes (11)) as this study aimed to consider risk drinking from a social-ecological framework rather than a clinical perspective. Therefore, the unit guidelines of the study period (1998-2015) would better socially characterise those attempting to drink within the recommendations promoted at that time. A sensitivity test using the 14 units guideline in men found that those with a limiting illness were less likely to drink over this threshold. There was no association with health status using a 21 unit threshold, suggesting a lower threshold better reveals the association of poor health and lower alcohol intake as previously discussed in Chapter 2.2.4 (208). A published analysis of the differences in the associations of characteristics between the 21- and 14-unit threshold, using all adult ages of the HSE, produced generally the same statistically significant associations with some weaker outcomes using the 14 unit threshold (467).

Binge Drinking: Binge drinking was assessed by the question: "*Did you have an alcoholic drink in the 7 days ending yesterday?"* followed by "*On the day you drank the most/last drank, what types of drink did you have that day?"* With servings assessed by the question: *"And how much … did you drink that day*?" Available responses were the same as those for typical drinking, using multiple

[16] Beverage Specific Quantity Frequency (385)

beverage specific serving sizes. As the reference period was the previous seven days, binge drinking was not assessed in those who had no alcohol that week. After servings were converted to units, all beverage intakes reported were added together to produce the number of units consumed on the heaviest day. Binge drinking was dichotomised as 8+ units for men and 6+ units for women as measured in other UK surveys (191).

Unit Conversions: The beverage-specific drink servings reported were converted into UK standard units that could be dichotomised into weekly risk and binge drinking thresholds, as previously described (151, 425). Unit serving conversion involves assuming that a reported serving size of a specific beverage is likely to contain an average number of units. The calculation of these conversions was discussed in Chapter 3.7. In 2006 the conversion factors used for these unit assumptions were upgraded to reflect larger serving size practices (151, 425). For this study, all unit calculations were performed from the original survey data responses so that the most recent 2006/07 conversion assumptions could be applied to all survey years and ensure a consistent standard serving size across years.

4.2.3 Predictor Variables

Predictor variables were chosen based on theoretical relevance from the literature review, use in previous studies and availability to be harmonised across 17 years of survey measures. Some factors had not been developed for use in the earliest years of the HSE, or changes in their measurement method prevented convergence across years and therefore could not be used in models. These included a lack of Index of Multiple Deprivation Quintile (IMD) until 2001 (including a change from IMD 2004 to IMD 2015 through the study years), NS-SEC[17] until 2001 and the removal of questions related to social capital in 2006. Therefore, the relevance of IMD quintile 2015 was tested only on period 2 data. Questions related to parental socioeconomic status were not measured. The Urban-Rural classification was updated in 2008 to reflect definition changes and could not be harmonised with former years due to overlap in categories. Primary Sampling Units (PSU) as postcode sectors were not used as a clustering factor as they are used for sampling convenience rather than a meaningful geographic boundary of areas (301) and had no statistically significant association with binge drinking in a previous analysis of the HSE (214). An overview of all outcome and predictor variables used in this study are displayed in Table 4.1.

[17] National Statistics Socioeconomic Classification

Table 4.1 Outcome and predictor variables used in study 1 analyses.

Stratification		**Literature**
Sex	Male or female	
Outcomes		
Exceeding weekly unit guidelines	Drinking at least 21 units in men, 14 units in women on average per week (using a one-year reference period). Pre-2016 definition used as reflective of the period studied.	(466)
Binge drinking	Drinking at least 8 units in men, 6 units in women on the heaviest day of drinking in the previous week of the survey.	(191, 468)
Level 1 – Fixed Effects		
Period	Combined survey years 1998 to 2002 and 2011 to 2015 to create two pooled survey periods.	(76, 142)
Age Group	Groups of 5 years from 45 to 69 years.	
Ethnicity	White British, Other Responses (Black, Asian, Mixed Heritage, Other White). HSE does not distinguish British or non-British minority ethnicity in older years.	(218, 435)
Marital Status	Single or Widowed, Cohabiting, Divorced or Separated, Married	(102)
Children	None, 1+ aged 2-15 years in the household	(102, 469)
Equivalised Gross Income	Gross income quintiles: £ (<=13,313), (13,314 to 20,073), (20,074 to 30,824), (30,825 to 49,367), (>=49,368). Equivalised to the number of household members initially equally but in later years weighted so the Household Representative Person contributed the largest percentage of the income.	(67, 256)
Employment Status	Paid employment or Self-employed, Retired, Other (disabled, non-working, school, homemaking – combined due to small numbers)	(283)
Education	Highest Educational Qualification: Degree or NVQ 4/5, Higher education below degree, A-level or NVQ 3, GCSE or NVQ 2, No qualification or other/foreign.	(470)
Smoker	Current, ex-smoker, Never	(101, 260)
BMI	Body-Mass Index derived from anthropometric measures. Normal (18.5-24.9 kg/m^2), Overweight (25-29.9 kg/m^2), Obese (30+kg/m^2).	(264)
Health	Limiting, non-limiting, no illness. Defined as longstanding illness or has activities limited by illness.	(208, 211)
IMD Quintile	Index of Multiple Deprivation 2015 in five quintiles - Applied to 2011-2015 data in a separate model only.	(214)
Level 2 – Random Effect		
GOR	9 English Government Office Regions	(296, 297)

4.2.4 Inclusion of Individuals in the Study

Analyses were restricted to the target group of adults aged between 45 and 69 years who had responded to the interview component of the survey for demographics and alcohol consumption and reported consuming, on average, at least one unit of alcohol per week within the past 12 months. This criterion excluded individuals who completely abstained from alcohol and those who drank very infrequently. This was chosen because the study focus was on the comparison between individuals engaging in risk alcohol behaviours and low-risk consumers rather than non-

drinkers. The justification for this was explained in Chapter 3.8.2. Non-drinkers may have certain characteristics that differ to low-risk drinkers and therefore it may not be suitable to combine them into a single 'low risk' reference group as explored in Chapter 2.2.4 (206, 434). A sensitivity test of the data found that including non-drinkers in the reference group increased the negative association of a limiting health condition with exceeding the low-risk guideline (21/14+) than when non-drinkers were excluded. Pregnant women who reported typical drinking were included (n=2).

Complete case analysis (CCA) was used meaning individuals were dropped from the study if they did not have entries for all included variables as justified in Chapter 3.8.3. Total loss of individuals to CCA was 6,878 with the largest loss of individuals from a lack of BMI entries (missing n=3,119) or income measures (missing n=3,503). A lack of income measures was more likely in individuals characterised as retired, with no qualification, older and living in the North West or London (chi-square analysis). There was no difference in loss by survey period. This may have introduced sample bias towards responders with a higher socioeconomic status, the implications of which are considered in this study discussion section 4.4.1. The final number of included individuals was 20,871 in exceeding the weekly guideline models and of these individuals, 18,244 in binge drinking models.

4.2.5 Statistical Analysis

Descriptive statistics were analysed using a paired z-test, with Bonferroni correction for multiple comparisons, to compare variable proportions across the two periods (471). Independent variables were checked for multicollinearity using Variance Inflation Factor (VIF) with no VIF values above 2 found indicating no collinearity issues, an assumption for regression models (472). *P* values less than 0.05 were considered statistically significant. IBM SPSS Statistics version 24.0 was used for all analyses. Weighting was not available for the earliest years of the survey, so data were used unweighted as justified in Chapter 3.8.3.

Multilevel logistic regression (generalized linear mixed model with logit-link function) was used to analyse associations of drinking behaviours at the individual level (level 1) accounting for clustering of GOR residence of those individuals (level 2). In this model, intercepts are allowed to vary across GOR as a random effect whilst also testing for the associations of individual-level fixed effects on individual drinking behaviour (473). Multilevel analysis is therefore able to account for the possibility that individuals within GOR may share characteristics, the non-independence of observations within groups, that violates an assumption of regression modelling, and is also able

to determine the independent contribution of grouping factors on outcomes (235). The justification and explanation of multilevel models were explored in more detail in Chapter 3.9.

Models were created to analyse exceeding the weekly guidelines and binge drinking separately, stratified by sex. The initial models utilised multilevel modelling with all years of survey data, adjusted for survey year by including pooled survey years as a binary variable described in section 4.2.1. Variables were added in a stepped process to determine the impact of adjustment, building three incremental models considering 1. demographics, 2. socioeconomic factors (SES) and 3. co-risk factors. Interactions for socioeconomic status factors (income, education, and employment) were tested with smoking and BMI due to the reported relationship with the alcohol harm paradox (Chapter 2.2.5). IMD quintile 2015 was tested in a separate model on 2011-2015 data only to assess relevance. Logistic regression analyses were then conducted for each period separately to determine any difference in associations on drinking behaviours between the two periods. Two-way interactions between linear period and individual-level factors were tested to assess changes in the association of factors over time with only statistically significant results reported.

4.3 Results

4.3.1 Descriptive Statistics

Table 4.2 shows that the average alcohol unit consumption per week for all included years was close to the former low-risk guidelines with men at 22.5 units and women at 13.5 units. The average unit intake on the heaviest day was slightly below the binge drinking threshold but above the former daily guidelines at 6.8 units in men and 4.6 units in women.

Table 4.2 Average unit intake and risk drinking in men and women by study period.

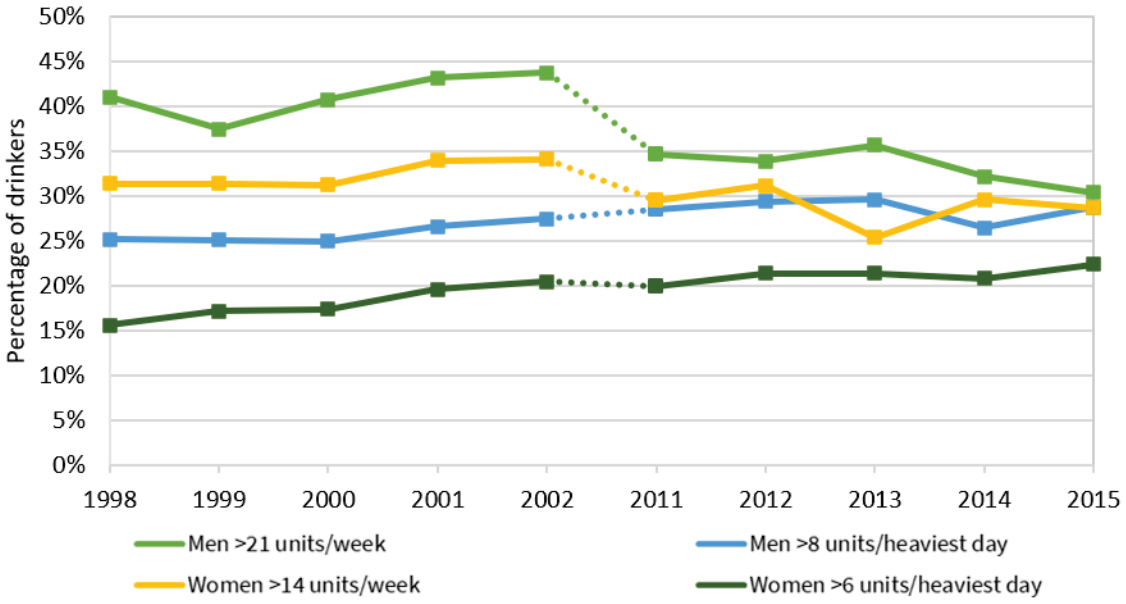
	Average intake per week					**Intake on heaviest day**			
	Units		21/14+ units			Units		8/6+ units	
Men n 10900	Mean	(SD)	%	n	**n 9728**	Mean	(SD)	%	n
1998-2002 n 6262	24.3	(25.1)	41.5	2599	n 5616	6.7	(5.8)	26.5	1490
2011-2015 n 4638	21.2	(27.9)	33.9	1573	n 4112	6.9	(5.8)	29.5	1212
Women n 9971					**n 8516**				
1998-2002 n 5534	13.9	(15.8)	33.0	1824	n 4765	4.4	(3.4)	18.0	860
2011-2015 n 4437	13.0	(18.6)	29.4	1304	n 3751	4.7	(3.7)	21.9	821

SD: Standard Deviation

RQ1: Figure 4.1 shows that between 1998 and 2015, the percentage of drinkers exceeding the weekly guidelines fell from 41% to 30% in men and from 31% to 29% in women. However, binge

drinking increased between these years from 25% to 29% in men and from 16% to 22% in women. Exceeding the weekly guidelines was highest in 2002 (44% in men, 34% in women) which corresponds to a known peak in per capita drinking in 2004 (141). This was followed by a decline in drinking as shown in the 2011 data which was also observed at the population level (see Chapter 2.1.2). The steeper declines in exceeding the male weekly guidelines have resulted in a convergence of male and female weekly risk drinking to 30% of drinkers in 2015. The percentage of binge drinkers has slowly increased in both sexes since the start of the study with the larger increase in women's binge drinking in the first period but stabilising in both sexes after 2010.

Figure 4.1 Percentage of English drinkers aged 45-69 years exceeding weekly guidelines and binge drinking from 1998 to 2002 and 2011 to 2015, by sex.



Dotted line indicates years not included in this study.

Sample descriptive statistics for the variables used in this study are available in Table 4.3 for men and Table 4.4 for women. Changes in sample composition were observed in most variables between periods 1 and 2 except for in most GORs. The largest differences by period were observed for a decrease in individuals with no qualifications by 22% and an increase in those with degrees by 12%, possibly as a result of improved cohort educational opportunities (66). This was also observed by a 5.1% increase for women in paid employment. The presence of children in the household increased by 20% whilst married individuals decreased by 8%. Current smokers decreased by 6.7% which may have been influenced by the smoking ban in 2007 (261).

Table 4.3 Male sample distribution of drinkers by predictors and risk drinking.

Men	Sample Composition					Exceeding Weekly Guidelines			Binge Drinking		
	1998 2002		2011 2015			1998 2002	2011 2015		1998 2002	2011 2015	
	%	n	%	n	*p*	%	%	*p*	%	%	*p*
Age (years)											
45-49	23.6	1476	21.3	988	*	25.0	19.8	*	30.3	25.9	*
50-54	24.0	1505	20.5	949	*	27.2	20.5	*	27.8	23.4	*
55-59	19.9	1249	18.0	837	*	19.4	18.4		21.3	18.4	
60-64	16.7	1043	20.1	930	*	16.0	22.1	*	12.4	17.8	*
65-69	15.8	989	20.1	934	*	12.4	19.3	*	8.1	14.4	*
Ethnicity											
Other ethnicities	2.9	181	4.2	196	*	2.1	2.4	*	1.3	2.1	
White British	97.1	6081	95.8	4442	*	97.9	97.6	*	98.7	97.9	
Marital Status											
Single	8.7	546	10.8	500	*	9.2	11.1	*	9.3	11.3	
Cohabiting	3.7	234	9.3	432	*	5.0	11.0	*	5.1	11.0	*
Divorced	9.4	586	11.3	526	*	10.7	12.5		12.1	13.5	
Married	78.2	4896	68.6	3180	*	75.1	65.5	*	73.5	64.2	*
Children											
None	84.3	5280	66.2	3071	*	84.5	69.9	*	82.1	66.8	*
1+	15.7	982	33.8	1567	*	15.5	30.1	*	17.9	33.2	*
Gross Income											
>£49,367	24.4	1531	28.7	1332	*	30.5	31.1		30.1	30.8	
>£30,824 <=£49,367	23.4	1465	25.8	1195	*	24.8	23.9		24.7	26.2	
>£20,073 <=£30,824	22.1	1385	19.6	908	*	20.4	18.6		19.7	18.3	
>£13,313 <=£20,073	16.0	1003	13.9	647	*	13.2	13.4		13.9	12.5	
<=£13,313	14.0	878	12.0	556	*	11.0	13.1	*	11.7	12.2	
Employment Status											
Other (Non-work/Disabled)	12.9	809	9.0	418	*	11.6	10.2		12.8	9.2	*
Retired	22.1	1381	24.6	1141	*	19.6	26.7	*	14.4	20.9	*
In paid employment	65.0	4072	66.4	3079		68.8	63.1	*	72.9	70.0	
Highest qualification											
Degree	17.8	1115	28.0	1300	*	21.2	29.1	*	18.9	23.1	*
Higher Education	15.2	952	17.3	804	*	15.7	15.6		15.2	17.3	
A-Level	9.2	575	12.6	583	*	10.6	13.4	*	9.8	14.9	*
GCSE	17.8	1115	20.0	929	*	17.9	19.6		19.0	21.8	
None or other	40.0	2505	22.0	1022	*	34.6	22.4	*	37.1	22.9	*
Smoker Status											
Current smoker	22.7	1419	16.6	768	*	25.2	20.6	*	29.7	20.5	*
Ex-smoker	41.6	2605	36.4	1688	*	44.7	40.7	*	43.0	39.2	*
Never smoked	35.7	2238	47.0	2182	*	30.1	38.7	*	27.3	40.3	*
BMI Category											
Obese	24.1	1512	32.5	1509	*	22.5	31.5	*	25.7	37.3	*
Overweight	52.5	3287	47.6	2208	*	53.7	48.6	*	53.0	46.5	*
Normal	23.4	1463	19.9	921	*	23.8	19.9	*	21.3	16.2	*
Health Status											
Limiting illness	28.5	1784	21.2	983	*	26.0	21.4	*	26.0	20.9	*
Non-limiting illness	23.9	1497	24.6	1139		25.3	26.1		25.1	25.5	
No illness	47.6	2981	54.2	2516	*	48.7	52.5	*	48.9	53.6	*
Government Office Region											
North East	6.8	427	8.1	375	*	7.3	9.9	*	8.5	11.6	*
North West	14.3	893	13.7	636		15.7	14.8		19.6	16.3	*
Yorkshire & Humber	10.7	670	10.0	462		11.3	10.4		12.7	11.1	

(Continued from previous page)										
East Midlands	9.3	585	9.0	418		8.9	7.8		8.0	7.1
West Midlands	10.6	664	9.5	440		10.0	10.4		9.1	9.9
East England	12.5	782	11.6	539		10.7	10.1		11.5	11.1
London	8.8	552	8.3	387		9.3	7.7		7.4	7.6
South East	15.8	991	17.6	814	*	16.5	16.8		13.2	15.1
South West	11.1	698	12.2	567		10.3	12.1		10.1	10.2

z-test * p <0.05 for period

Table 4.4 Female sample distribution of drinkers by predictors and risk drinking.

Women	**Sample Composition**					**Exceeding Weekly Guidelines**			**Binge Drinking**		
	1998 2002		**2011 2015**			**1998 2002**	**2011 2015**		**1998 2002**	**2011 2015**	
	%	**n**	**%**	**n**	***p***	**%**	**%**	***p***	**%**	**%**	***p***
Age (years)											
45-49	25.7	1426	25.1	1118		29.4	25.6	*	34.0	34.6	
50-54	26.6	1474	21.3	948	*	28.3	21.9	*	30.9	24.2	*
55-59	19.9	1103	18.6	830		19.7	19.2		20.7	16.8	*
60-64	15.5	859	18.3	814	*	12.4	18.7	*	9.3	14.0	*
65-69	12.4	687	16.7	742	*	10.1	14.6	*	5.1	10.4	*
Ethnicity											
Other ethnicities	1.9	108	3.4	153	*	0.8	2.1	*	0.7	2.1	*
White British	98.1	5441	96.6	4299	*	99.2	97.9	*	99.3	97.9	*
Marital Status											
Single	11.1	616	10.7	475		9.5	10.0		9.5	9.9	
Cohabiting	3.6	202	8.2	367	*	4.7	10.3	*	5.9	11.7	*
Divorced	13.6	755	16.1	717	*	13.5	15.0		14.1	18.0	*
Married	71.7	3976	65.0	2893	*	72.3	64.6	*	70.5	60.4	*
Children											
None	88.2	4894	66.2	2948	*	88.0	66.8	*	85.6	62.1	*
1+	11.8	655	33.8	1504	*	12.0	33.2	*	14.4	37.9	*
Gross Income											
>£49,367	23.4	1299	26.3	1170	*	33.1	31.0		34.8	28.1	*
>£30,824 <=£49,367	23.8	1322	25.6	1141	*	25.3	25.9		24.4	26.9	
>£20,073 <=£30,824	22.0	1219	20.3	903	*	20.2	19.4		19.1	18.8	
>£13,313 <=£20,073	17.0	945	14.7	653	*	12.3	12.7		10.1	13.5	*
<=£13,313	13.8	764	13.1	585		9.2	11.0		11.6	12.7	
Employment Status											
Other(Nonwork/Disabled)	20.5	1137	12.1	537	*	18.8	11.7	*	18.3	12.3	*
Retired	21.6	1197	25.0	1111	*	19.7	24.8	*	12.4	17.4	*
In paid employment	57.9	3215	63.0	2804	*	61.5	63.6		69.3	70.3	
Highest qualification											
Degree	11.3	629	25.7	1145	*	14.5	28.5	*	12.6	25.6	*
Higher Education	11.8	655	12.7	567		14.0	12.7		12.1	13.4	
A-Level	7.6	419	14.6	651	*	8.9	15.0	*	9.0	16.6	*
GCSE	23.0	1274	26.1	1164	*	25.7	26.1		25.8	26.2	
None or other	46.4	2572	20.8	925	*	37.0	17.8	*	40.6	18.3	*
Smoker Status											
Current smoker	22.9	1268	15.6	693	*	25.0	21.2	*	29.7	24.0	*
Ex-smoker	27.5	1527	29.2	1299		32.8	34.9		30.9	33.4	
Never smoked	49.6	2754	55.3	2460	*	42.2	43.9		39.4	42.6	
BMI Category											
Obese	25.1	1395	27.2	1210	*	20.8	23.5		22.9	27.2	*
Overweight	38.8	2154	37.2	1658		38.3	40.4		39.2	39.7	
Normal	36.0	2000	35.6	1584		40.9	36.1	*	37.9	33.1	*

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Health Status										
Limiting illness	25.7	1426	21.7	965	*	20.9	19.1		19.8	19.2
Nonlimiting illness	22.1	1228	21.6	960		22.8	22.0		22.1	19.4
No illness	52.2	2895	56.8	2527	*	56.3	58.9		58.1	61.4
Government Office Region										
North East	6.8	378	8.8	392	*	6.4	9.0	*	8.0	10.4
North West	14.0	779	13.1	581		14.4	14.6		15.2	17.5
Yorkshire & Humber	10.4	577	9.5	422		10.3	9.7		10.6	10.2
East Midlands	9.3	517	8.8	391		8.2	9.0		8.6	9.4
West Midlands	9.9	549	9.8	435		10.0	9.1		8.8	8.4
East England	12.5	694	11.4	509		12.0	11.5		13.0	10.2
London	9.2	513	8.3	369		8.9	8.0		9.1	8.0
South East	17.1	951	18.9	843	*	19.8	19.6		17.3	17.2
South West	10.7	591	11.5	510		10.0	9.4		9.3	8.6

z-test * p <0.05 for period

4.3.2 Multilevel Logistic Regression Models (RQ2 and RQ3)

Multilevel regression models with stepped adjustment are shown, stratified by sex, for exceeding the weekly guidelines in Table 4.6 and binge drinking in Table 4.7. Model fit by log-likelihood improved with the addition of further variables to each model. No statistical significance was found for GOR at level 2 in any model, suggesting there was no variation between regions for risk drinking in this population after accounting for individual composition factors. Odds ratios (OR) and Confidence Intervals [95%CI] described are from the final models of adjustment.

Exceeding the weekly guidelines: Results from the multilevel models agreed with the descriptive statistics that exceeding the weekly guidelines, adjusted for other model factors, had decreased in period 2 compared to period 1 for men (OR 0.72[0.65-0.77]) and women (OR 0.81[0.72-0.87]). Excess weekly drinking was more likely in individuals aged below the 65-69 years group in men and below the 60-64 years age group in women. Whilst a decline in weekly drinking risk with age was observed in women (youngest OR 1.43[1.14-1.68]), an age gradient was not observed in men (youngest OR 1.51[1.21-1.73]). Cohabiting, compared to being married, was associated with greater weekly drinking risk in men (OR 1.43[1.21-1.69]) and women (OR 1.23[1.03-1.48]) although this association weakened in women with the addition of further predictors to the model. Men's excess weekly drinking risk was additionally associated with divorce (OR 1.24[1.08-1.42]), but this association was not found in women. Having no children aged 2-15 years in the household was associated with increased weekly drinking risk in both men (OR 1.15[1.03-1.27]) and women (OR 1.13[1.00-1.27]).

Socioeconomic factors (SES) were added to model 2 including income, employment status and education. Incomes above £30k in men and £20k in women were associated with increased risk

of exceeding the weekly guidelines, with women showing a stronger association than men (50k+ OR Men: 1.63, Women: 2.15). Being retired compared to being employed was associated with weekly drinking risk in both men (OR 1.31[1.12-1.51]) and women (OR 1.38[1.17-1.60]). Higher-income retirees were more likely to engage in exceeding the weekly guidelines compared to low-income retirees (Highest Quintile, Men OR 1.53[1.03-2.29] Women OR 1.62[1.05-2.50]), but no statistically significant interaction was found between health status and retirement. Any educational qualification was associated with weekly drinking risk in both men and women compared to having no qualifications. There was only a small gradient for higher education in women but there was a larger difference in the association between GCSE (OR 1.14) and Degree (OR 1.41) in men. The association with education increased with the addition of co-risk factors to the model, with women showing a slightly stronger association with education than men (Degree OR Men 1.41, Women 1.52).

The final model included the addition of smoker status, BMI category and health status. Being a smoker had the strongest association of any factor in the model at twice the odds of exceeding the low-risk guidelines in men (OR 1.97[1.76-2.21]) and women (OR 2.01[1.80-2.28]). Being an ex-smoker was also associated with risk drinking compared to those who reported never smoking, although at a lower association compared to current smokers (OR Men 1.68, Women 1.86). There was no association of weekly drinking risk with BMI in men, but a negative association was found with obesity in women (OR 0.79[0.70-0.89]). Whilst a limiting illness was negatively associated with exceeding the guidelines in women (OR 0.77[0.69-0.86]), no such association was found in men. No statistically significant interaction with smoking or BMI and socioeconomic variables was found for weekly drinking risk in men or women.

Binge drinking: There were some contrasting outcomes for the binge drinking models compared to the models for exceeding the weekly guidelines. As found in the descriptive statistics, binge drinking was more likely in period 2 compared to period 1 for both men (OR 1.28[1.16-1.41]) and women (OR 1.37[1.24-1.56]), and this association slightly increased as further predictors were added to the model. Binge drinking was associated with a negative age gradient in that the youngest age group (45-49 years) was three times more likely to engage in binge drinking than the oldest age group (65-69 years). Whilst the addition of further predictors to the model increased the association of age in men, it slightly decreased the association of age in women. Being divorced or single was associated with binge drinking in both sexes, and divorce had a stronger association in men (OR 1.42[1.23-1.66]) compared to women (OR 1.18[1.01-1.39]). There was no statistically significant association with children in the household and binge drinking for either sex.

Model 2 showed a weaker association with socioeconomic factors compared to the excess weekly drinking models. Only the highest income quintile was associated with binge drinking in both sexes, with women showing a slightly stronger association (OR Men 1.39, Women 1.47). This association increased with the addition of co-risk factors to the model. There was no statistically significant association with binge drinking and employment status in either sex. Degree education showed a statistically significant negative association with binge drinking in men (OR 0.83[0.71-0.96]) but this association was lost in the final model for women, suggesting that co-risk factors may better explain women's binge drinking.

In the final model, being a smoker or ex-smoker showed a strong association with binge drinking, similar to that found in the excess weekly drinking model, for both men (smoker OR 2.06[1.81-2.35]) and women (OR 2.13[1.83-2.46]). Women with degree-level education who were smokers were more likely to binge drink (OR 1.90[1.16-3.1]) compared to smokers without qualifications. There was no statistically significant interaction with socioeconomic status in male smokers.

A positive gradient was found for increasing BMI category and binge drinking that was stronger in men (Obese OR 1.56[1.36-1.79]) compared to women (OR 1.23 [1.06-1.42]). No interaction was found for BMI and socioeconomic status factors. The association with health status was similar to that found for the excess weekly drinking model with a positive association with non-limiting illness in men (OR 1.17[1.04-1.31]) but a negative association with limiting illness in women (OR 0.81[0.70-0.94]).

IMD quintile was tested as a fixed effect in a multilevel model with GOR using data for period 2 (2011-2015) only. No statistically significant association of IMD quintile was found for either exceeding the weekly guidelines or binge drinking. The outcome of IMD quintile within a model containing all other individual-level factors discussed is shown in Table 4.5

Table 4.5 Association of IMD quintile with risk alcohol consumption as a fixed effect using 2011-2015 data.

	Exceeding the Weekly Guidelines				**Binge Drinking**			
	Men (21+ units)		**Women (14+ units)**		**Men (8+ units)**		**Women (6+ units)**	
IMD Quintile	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
1	1.03	0.81-1.31	1.15	0.89-1.48	0.93	0.71-1.21	0.91	0.68-1.23
2	0.90	0.71-1.14	0.99	0.77-1.28	0.88	0.67-1.14	0.83	0.62-1.12
3	1.00	0.80-1.27	1.04	0.81-1.35	1.00	0.77-1.29	1.00	0.74-1.34
4	0.91	0.72-1.16	1.07	0.82-1.39	0.92	0.71-1.21	0.91	0.67-1.24
5 (Ref.)	1.00		1.00		1.00		1.00	

1=Least deprived. IMD 2015. Adjusted for all previously included variables.

Table 4.6 Multilevel logistic regression model for drinkers exceeding the weekly guidelines in men and women aged 45-69 years, accounting for GOR clustering.

Unit Threshold	**21+ Units in men per week**						**14+ Units in women per week**					
	Model 1 Demographic		**Model 2 +SES**		**Model 3 +Health**		**Model 1 Demographic**		**Model 2 +SES**		**Model 3 +Co-risk**	
Level 1 Fixed Effects	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Model n	14212		12023		10900		13464		11185		9971	
Intercept	**0.52**	**0.45-0.60**	**0.32**	**0.26-0.41**	**0.20**	**0.16-0.27**	**0.35**	**0.30-0.41**	**0.19**	**0.15-0.25**	**0.15**	**0.11-0.19**
Survey Period												
2011-2015	**0.72**	**0.67-0.77**	**0.70**	**0.64-0.76**	**0.72**	**0.65-0.77**	**0.87**	**0.81-0.94**	**0.79**	**0.72-0.85**	**0.81**	**0.72-0.87**
1998-2002 (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Age (years)												
45-49	**1.25**	**1.12-1.41**	**1.41**	**1.13-1.57**	**1.51**	**1.21-1.73**	**1.46**	**1.28-1.66**	**1.47**	**1.20-1.72**	**1.43**	**1.14-1.68**
50-54	**1.34**	**1.18-1.47**	**1.48**	**1.24-1.70**	**1.59**	**1.33-1.88**	**1.36**	**1.20-1.54**	**1.38**	**1.16-1.66**	**1.30**	**1.07-1.57**
55-59	**1.17**	**1.04-1.31**	**1.29**	**1.10-1.50**	**1.33**	**1.13-1.58**	**1.23**	**1.08-1.40**	**1.30**	**1.10-1.57**	**1.26**	**1.05-1.52**
60-64	**1.19**	**1.06-1.33**	**1.33**	**1.15-1.53**	**1.41**	**1.22-1.66**	1.12	0.98-1.28	1.10	0.95-1.30	1.07	0.91-1.27
65-69 (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Ethnicity												
Other ethnicities	**0.53**	**0.43-0.65**	**0.56**	**0.44-0.71**	**0.53**	**0.41-0.68**	**0.49**	**0.38-0.64**	**0.46**	**0.32-0.60**	**0.47**	**0.32-0.64**
White British (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Marital Status												
Single	**1.15**	**1.03-1.29**	**1.21**	**1.06-1.38**	1.12	0.98-1.32	**0.80**	**0.71-0.91**	0.91	0.79-1.05	0.90	0.79-1.06
Cohabiting	**1.40**	**1.22-1.61**	**1.52**	**1.31-1.78**	**1.43**	**1.21-1.69**	**1.37**	**1.17-1.60**	**1.42**	**1.20-1.69**	**1.23**	**1.03-1.48**
Divorced	**1.25**	**1.12-1.40**	**1.31**	**1.15-1.48**	**1.24**	**1.08-1.42**	0.96	0.86-1.07	1.09	0.97-1.23	1.00	0.88-1.14
Married (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Children												
None	**1.15**	**1.05-1.26**	**1.17**	**1.06-1.29**	**1.15**	**1.03-1.27**	**1.12**	**1.02-1.24**	**1.12**	**1.00-1.25**	**1.13**	**1.00-1.27**
1+ (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Gross Income £												
>£49,367			**1.52**	**1.34-1.82**	**1.63**	**1.42-1.95**			**2.02**	**1.73-2.36**	**2.15**	**1.84-2.58**
>£30,824 <=£49,367			**1.24**	**1.07-1.43**	**1.26**	**1.09-1.48**			**1.45**	**1.25-1.69**	**1.53**	**1.31-1.82**
>£20,073 <=£30,824			1.12	0.97-1.30	1.14	0.99-1.34			**1.28**	**1.10-1.49**	**1.36**	**1.16-1.62**
>£13,313 <=£20,073			1.03	0.89-1.20	1.01	0.86-1.18			1.05	0.90-1.24	1.10	0.92-1.31
<=£13,313 (Ref.)			1.00		1.00				1.00		1.00	

Unit Threshold	**21+ Units in men per week**						**14+ Units in women per week**					
	Model 1 Demographic		**Model 2 +SES**		**Model 3 +Health**		**Model 1 Demographic**		**Model 2 +SES**		**Model 3 +Co-risk**	
Level 1 Fixed Effects	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
(Continued from previous page)												
Employment Status												
Homemaker/Disabled			1.05	0.92-1.21	1.02	0.88-1.20			1.11	0.99-1.25	1.14	0.99-1.29
Retired			**1.26**	**1.11-1.43**	**1.31**	**1.15-1.51**			**1.30**	**1.12-1.50**	**1.38**	**1.17-1.60**
Paid employment (Ref.)			1.00		1.00				1.00		1.00	
Highest qualification												
Degree			**1.25**	**1.11-1.40**	**1.41**	**1.23-1.58**			**1.38**	**1.20-1.57**	**1.52**	**1.29-1.72**
Higher Education			1.06	0.94-1.19	1.12	0.98-1.27			**1.38**	**1.20-1.59**	**1.45**	**1.24-1.67**
A-Level			**1.30**	**1.14-1.49**	**1.40**	**1.21-1.62**			**1.32**	**1.14-1.53**	**1.48**	**1.26-1.74**
GCSE			**1.13**	**1.01-1.26**	**1.14**	**1.02-1.29**			**1.33**	**1.19-1.49**	**1.41**	**1.25-1.59**
None or other (Ref.)			1.00		1.00				1.00		1.00	
Smoker Status												
Current smoker					**1.97**	**1.76-2.21**					**2.01**	**1.80-2.28**
Used to smoke					**1.68**	**1.54-1.85**					**1.86**	**1.68-2.05**
Never smoked (Ref.)					1.00						1.00	
BMI Category												
Obese					0.92	0.83-1.04					**0.79**	**0.70-0.89**
Overweight					1.04	0.94-1.16					0.98	0.89-1.09
Normal (Ref.)					1.00						1.00	
Health Status												
Limiting illness					0.94	0.85-1.05					**0.77**	**0.69-0.86**
Non-limiting illness					**1.13**	**1.03-1.26**					1.00	0.90-1.12
No illness (Ref.)					1.00						1.00	
Level 2 Variance	**Estimate**	**Std. Error**					**Estimate**	**Std. Error**				
GOR Intercept	0.012	0.008	0.019	0.011	0.024	0.014	0.004	0.003	0.005	0.005	0.005	0.005
-2 log-likelihood	61193		51955		47388		59232		49508		44499	

***p* <0.05.** OR: Odds Ratio SES: Socioeconomic

Table 4.7 Multilevel logistic regression model for binge drinking in men and women aged 45-69 years, accounting for GOR clustering.

Unit Threshold	**8+ Units in men on heaviest day**						**6+ Units in women on heaviest day**					
	Model 1		**Model 2**		**Model 3**		**Model 1**		**Model 2**		**Model 3**	
Level 1 Fixed Effects	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Model n	12640		10723		9728		11472		9539		8516	
Intercept	**0.18**	**0.14-0.22**	**0.17**	**0.12-0.23**	**0.08**	**0.06-0.11**	**0.10**	**0.08-0.13**	**0.10**	**0.07-0.14**	**0.07**	**0.05-0.10**
Survey Period												
2011-2015	**1.20**	**1.11-1.31**	**1.23**	**1.12-1.35**	**1.28**	**1.16-1.41**	**1.28**	**1.18-1.43**	**1.32**	**1.20-1.49**	**1.37**	**1.24-1.56**
1998-2002 (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Age (years)												
45-49	**2.61**	**2.27-2.98**	**2.75**	**2.25-3.36**	**3.02**	**2.44-3.74**	**3.12**	**2.67-3.80**	**2.94**	**2.32-3.85**	**2.75**	**2.15-3.69**
50-54	**2.16**	**1.89-2.48**	**2.30**	**1.89-2.80**	**2.51**	**2.04-3.10**	**2.45**	**2.10-3.01**	**2.44**	**1.92-3.18**	**2.26**	**1.74-2.98**
55-59	**1.90**	**1.66-2.20**	**2.02**	**1.67-2.44**	**2.14**	**1.75-2.64**	**2.01**	**1.66-2.42**	**2.01**	**1.56-2.57**	**1.90**	**1.46-2.48**
60-64	**1.34**	**1.16-1.56**	**1.40**	**1.18-1.68**	**1.51**	**1.25-1.83**	**1.38**	**1.14-1.70**	**1.35**	**1.08-1.71**	**1.32**	**1.03-1.69**
65-69 (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Ethnicity												
Other ethnicities	**0.40**	**0.30-0.52**	**0.44**	**0.32-0.60**	**0.42**	**0.30-0.59**	**0.44**	**0.29-0.62**	**0.47**	**0.30-0.70**	**0.51**	**0.32-0.79**
White British (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Marital Status												
Single	**1.29**	**1.13-1.48**	**1.33**	**1.15-1.55**	**1.29**	**1.10-1.51**	1.05	0.89-1.23	1.11	0.92-1.33	1.09	0.89-1.31
Cohabiting	**1.23**	**1.05-1.44**	**1.24**	**1.04-1.47**	1.18	0.98-1.42	**1.38**	**1.15-1.66**	**1.48**	**1.21-1.80**	**1.32**	**1.07-1.63**
Divorced	**1.49**	**1.32-1.70**	**1.51**	**1.32-1.75**	**1.42**	**1.23-1.66**	**1.25**	**1.10-1.43**	**1.33**	**1.15-1.54**	**1.18**	**1.01-1.39**
Married (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Children												
None	1.03	0.93-1.14	1.03	0.93-1.16	1.01	0.90-1.14	0.98	0.86-1.10	0.97	0.85-1.10	0.93	0.81-1.07
1+ (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Gross Income £												
>£49,367			**1.28**	**1.08-1.53**	**1.39**	**1.15-1.68**			**1.33**	**1.09-1.61**	**1.47**	**1.19-1.81**
>£30,824 <=£49,367			1.11	0.94-1.32	1.18	0.98-1.41			1.05	0.87-1.28	1.15	0.94-1.42
>£20,073 <=£30,824			1.04	0.88-1.23	1.03	0.86-1.23			0.96	0.79-1.16	1.01	0.82-1.24
>£13,313 <=£20,073			1.02	0.86-1.22	1.02	0.84-1.23			0.84	0.68-1.03	0.89	0.71-1.11
<=£13,313 (Ref.)			1.00		1.00				1.00		1.00	

Unit Threshold	8+ Units in men on heaviest day						6+ Units in women on heaviest day					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
Level 1 Fixed Effects	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
(Continued from previous page)												
Employment Status												
Homemaker/Disabled			0.91	0.77-1.07	0.88	0.74-1.05			0.94	0.81-1.09	0.94	0.80-1.11
Retired			1.06	0.91-1.24	1.11	0.94-1.32			0.99	0.81-1.20	0.98	0.79-1.21
Paid employment (Ref.)			1.00		1.00				1.00		1.00	
Highest qualification												
Degree			**0.71**	**0.62-0.82**	**0.83**	**0.71-0.96**			**0.78**	**0.66-0.93**	0.90	0.75-1.08
Higher Education			**0.87**	**0.75-1.00**	0.90	0.78-1.04			0.97	0.81-1.16	1.05	0.86-1.27
A-Level			0.99	0.85-1.16	1.07	0.91-1.26			1.03	0.86-1.24	1.14	0.94-1.39
GCSE			0.93	0.82-1.06	1.00	0.87-1.14			0.99	0.86-1.15	1.06	0.91-1.24
None or other (Ref.)			1.00		1.00				1.00		1.00	
Smoker Status												
Current smoker					**2.06**	**1.81-2.35**					**2.13**	**1.83-2.46**
Used to smoke					**1.49**	**1.34-1.66**					**1.63**	**1.43-1.85**
Never smoked (Ref.)					1.00						1.00	
BMI Category												
Obese					**1.56**	**1.36-1.79**					**1.23**	**1.06-1.42**
Overweight					**1.28**	**1.13-1.45**					**1.17**	**1.03-1.33**
Normal (Ref.)					1.00						1.00	
Health Status												
Limiting illness					0.99	0.88-1.13					**0.81**	**0.70-0.94**
Non-limiting illness					**1.17**	**1.04-1.31**					0.93	0.80-1.07
No illness (Ref.)					1.00						1.00	
Level 2 Variance	**Estimate**	**Std. Error**					**Estimate**	**Std. Error**				
GOR Intercept	0.067	0.035	0.068	0.036	0.074	0.040	0.023	0.014	0.028	0.017	0.025	0.016
-2 log-likelihood	57238		48554		44279		54666		45453		40864	

***p* <0.05.** OR: Odds Ratio

4.3.3 Risk Drinking by Sample Years (Period) (RQ4)

Further models were created for exceeding the weekly guidelines (Table 4.8) and binge drinking (Table 4.9) by each sample period, stratified by sex. Note that as the sample size for each period model was approximately half of the previous multilevel models, the statistical power to detect statistically significant outcomes may be reduced. Compared to the stepped adjustment models, there was no association of income or education with weekly drinking risk or income with binge drinking in period 2 for men. For women, there was no association with marital status in any period for either drinking behaviour. In period 2 for women, there was no association for age with weekly drinking risk and there was no association for income or BMI with binge drinking observed in the stepped adjustment models. Interaction tests found that the reduced association of the highest income quintile with weekly drinking risk across periods was statistically significant for both men (Period 1 OR 1.96 to Period 2 OR 1.23 p=0.004) and women (OR 2.57 to 1.73 p=0.021). The association with smoking was found to increase across periods in women for both drinking behaviours but not for men (Women 14+ units OR: 1.68 to 2.68 p<0.000; Binge OR: 1.80 to 2.67 p=0.010). A statistically significant increase in the negative association of degree education with binge drinking in men was found across periods (OR 0.97 to 0.66 p=0.013).

Table 4.8 Logistic regression models for associations with exceeding the weekly guidelines by sex for period 1 and period 2 separately with period interaction.

Unit Threshold	**21+ Units in men per week**					**14+ Units in women per week**				
	1998-2002		**2011-2015**		**Period Interaction**	**1998-2002**		**2011-2015**		**Period Interaction**
	OR	**95% CI**	**OR**	**95% CI**	***p*-value***	**OR**	**95% CI**	**OR**	**95% CI**	***p*-value***
Model n	6262		4638			5534		4437		
Age (years)										
45-49	**1.65**	**1.29-2.11**	1.30	1.00-1.69		**1.53**	**1.16-2.01**	1.29	0.96-1.74	
50-54	**1.75**	**1.39-2.22**	**1.37**	**1.06-1.77**		**1.32**	**1.01-1.71**	1.25	0.94-1.68	
55-59	**1.36**	**1.08-1.72**	**1.31**	**1.02-1.67**		1.21	0.94-1.56	1.29	0.97-1.71	
60-64	**1.44**	**1.17-1.79**	**1.39**	**1.12-1.72**		0.94	0.74-1.19	1.23	0.99-1.56	
65-69 (Ref.)	1.00		1.00			1.00		1.00		
Ethnicity										
Other ethnicities	**0.62**	**0.44-0.87**	**0.47**	**0.32-0.68**		**0.38**	**0.21-0.66**	**0.56**	**0.36-0.86**	
White British (Ref.)	1.00		1.00			1.00		1.00		
Marital Status										
Single	1.20	0.99-1.45	1.01	0.82-1.24		0.86	0.70-1.04	0.93	0.74-1.17	
Cohabitee	**1.58**	**1.21-2.08**	**1.33**	**1.08-1.65**		1.20	0.90-1.63	1.23	0.97-1.56	
Divorced	**1.33**	**1.11-1.60**	1.09	0.89-1.33		1.04	0.87-1.24	0.93	0.76-1.13	
Married (Ref.)	1.00		1.00			1.00		1.00		
Children										
None	1.08	0.92-1.27	**1.20**	**1.05-1.38**		**1.24**	**1.01-1.51**	1.05	0.90-1.21	
1+ (Ref.)										
Gross Income £										
>£49,367	**1.96**	**1.59-2.43**	1.23	0.96-1.57	**0.004**	**2.57**	**2.04-3.24**	**1.73**	**1.34-2.24**	**0.021**
>£30,824 <=£49,367	**1.53**	**1.25-1.87**	0.93	0.73-1.19	**0.002**	**1.67**	**1.33-2.08**	**1.37**	**1.06-1.76**	
>£20,073 <=£30,824	**1.25**	**1.03-1.52**	0.94	0.74-1.20		**1.47**	**1.17-1.83**	1.25	0.97-1.61	
>£13,313 <=£20,073	1.08	0.88-1.32	0.92	0.71-1.18		1.11	0.87-1.40	1.12	0.86-1.46	
<=£13,313 (Ref.)	1.00		1.00			1.00		1.00		

Unit Threshold	21+ Units in men per week					14+ Units in women per week				
	1998-2002		2011-2015		Period Interaction	1998-2002		2011-2015		Period Interaction
	OR	95% CI	OR	95% CI	*p*-value*	OR	95% CI	OR	95% CI	*p*-value*
(Continued from previous page)										
Employment Status										
Homemaker/Disabled	0.96	0.79-1.16	1.19	0.93-1.54		**1.22**	**1.03-1.43**	1.06	0.85-1.32	
Retired	**1.21**	**1.00-1.47**	**1.46**	**1.19-1.78**		**1.48**	**1.19-1.83**	**1.28**	**1.02-1.62**	
Paid employment (Ref.)	1.00		1.00			1.00		1.00		
Highest qualification										
Degree	**1.49**	**1.27-1.77**	**1.23**	**1.01-1.50**		**1.54**	**1.26-1.89**	**1.48**	**1.18-1.86**	
Higher Education	1.17	1.00-1.38	0.95	0.77-1.17		**1.51**	**1.24-1.83**	**1.30**	**1.01-1.68**	
A-Level	**1.46**	**1.21-1.78**	1.21	0.96-1.51		**1.52**	**1.21-1.91**	**1.36**	**1.07-1.74**	
GCSE	1.15	0.99-1.34	1.04	0.85-1.27		**1.43**	**1.23-1.67**	**1.28**	**1.04-1.57**	
None or other (Ref.)	1.00		1.00			1.00		1.00		
Smoker Status										
Current smoker	**1.89**	**1.64-2.19**	**2.02**	**1.68-2.44**		**1.68**	**1.44-1.95**	**2.68**	**2.20-3.25**	**0.000**
Used to smoke	**1.72**	**1.52-1.94**	**1.60**	**1.39-1.84**		**1.82**	**1.59-2.09**	**1.90**	**1.63-2.21**	
Never smoked (Ref.)	1.00		1.00			1.00		1.00		
BMI Category										
Obese	0.87	0.75-1.01	0.98	0.82-1.18		**0.73**	**0.63-0.86**	0.87	0.73-1.03	
Overweight	1.03	0.90-1.17	1.06	0.89-1.25		0.88	0.77-1.01	1.12	0.96-1.31	**0.021**
Normal (Ref.)	1.00		1.00			1.00		1.00		
Health Status										
Limiting illness	0.96	0.84-1.10	0.92	0.77-1.10		**0.75**	**0.64-0.87**	**0.78**	**0.65-0.94**	
Non-limiting illness	1.13	1.00-1.29	1.12	0.96-1.31		1.00	0.86-1.16	1.01	0.85-1.19	
No illness (Ref.)	1.00		1.00			1.00		1.00		

***p* <0.05.** OR: Odds Ratio *Only statistically significant period interactions shown.

Table 4.9 Logistic regression models for associations with binge drinking by sex for period 1 and period 2 separately with period interaction.

Unit Threshold	**8+ Units in men on heaviest day**					**6+ Units in women on heaviest day**				
	1998-2002		**2011-2015**		**Period Interaction**	**1998-2002**		**2011-2015**		**Period Interaction**
	OR	**95% CI**	**OR**	**95% CI**	***p*-value***	**OR**	**95% CI**	**OR**	**95% CI**	***p*-value***
Model n	5616		4112			4765		3751		
Age (years)										
45-49	**3.31**	**2.41-4.54**	**2.84**	**2.10-3.84**		**2.82**	**1.93-4.30**	**2.59**	**1.82-3.84**	
50-54	**2.75**	**2.03-3.74**	**2.39**	**1.77-3.21**		**2.43**	**1.64-3.63**	**2.02**	**1.39-2.96**	
55-59	**2.52**	**1.87-3.40**	**1.83**	**1.37-2.44**		**2.26**	**1.53-3.34**	**1.52**	**1.05-2.20**	
60-64	**1.66**	**1.24-2.21**	**1.40**	**1.09-1.82**		1.40	0.96-2.06	1.22	0.89-1.69	
65-69 (Ref.)	1.00		1.00			1.00		1.00		
Ethnicity										
Other ethnicities	**0.40**	**0.24-0.67**	**0.44**	**0.28-0.69**		**0.44**	**0.19-1.00**	**0.56**	**0.33-0.97**	
White British (Ref.)	1.00		1.00			1.00		1.00		
Marital Status										
Single	**1.38**	**1.10-1.72**	1.23	0.97-1.55		1.17	0.90-1.52	0.98	0.74-1.30	
Cohabitee	1.20	0.89-1.62	1.18	0.93-1.49		1.42	1.00-2.00	1.24	0.95-1.63	
Divorced	**1.47**	**1.19-1.80**	**1.37**	**1.10-1.72**		1.11	0.88-1.40	1.24	0.99-1.56	
Married (Ref.)	1.00		1.00			1.00		1.00		
Children										
None	0.92	0.76-1.10	1.10	0.94-1.28		0.94	0.74-1.20	0.91	0.76-1.09	
1+ (Ref.)										
Gross Income										
>£49,367	**1.46**	**1.13-1.89**	1.28	0.97-1.69		**1.58**	**1.19-2.11**	1.29	0.95-1.76	
>£30,824 <=£49,367	1.19	0.93-1.53	1.14	0.87-1.51		1.02	0.77-1.35	1.30	0.96-1.76	
>£20,073 <=£30,824	1.01	0.79-1.29	1.04	0.79-1.37		0.93	0.70-1.24	1.08	0.79-1.46	
>£13,313 <=£20,073	1.08	0.84-1.38	0.94	0.70-1.25		**0.70**	**0.51-0.96**	1.15	0.84-1.59	**0.030**
<=£13,313 (Ref.)	1.00		1.00			1.00		1.00		

(Continued on next page)

Unit Threshold	8+ Units in men on heaviest day					6+ Units in women on heaviest day				
	1998-2002		2011-2015		Period Interaction	1998-2002		2011-2015		Period Interaction
	OR	95% CI	OR	95% CI	*p*-value*	OR	95% CI	OR	95% CI	*p*-value*
Employment Status										
Homemaker/Disabled	0.87	0.69-1.10	0.87	0.65-1.17		0.91	0.73-1.12	0.97	0.75-1.27	
Retired	1.04	0.82-1.32	1.19	0.94-1.51		0.93	0.69-1.25	1.01	0.75-1.35	
In paid employment (Ref.)	1.00		1.00			1.00		1.00		
Highest qualification										
Degree	0.97	0.80-1.18	**0.66**	**0.53-0.84**	**0.013**	0.84	0.64-1.10	1.01	0.77-1.33	
Higher Education	0.87	0.72-1.06	0.88	0.70-1.11		0.92	0.71-1.19	1.18	0.87-1.60	
A-Level	1.03	0.82-1.30	1.03	0.80-1.31		1.04	0.78-1.40	1.20	0.90-1.61	
GCSE	1.04	0.87-1.24	0.90	0.72-1.12		1.07	0.88-1.30	1.04	0.80-1.34	
None or other (Ref.)	1.00		1.00			1.00		1.00		
Smoker Status										
Current cigarette smoker	**2.26**	**1.90-2.68**	**1.80**	**1.46-2.22**		**1.80**	**1.49-2.18**	**2.67**	**2.13-3.36**	**0.010**
Used to smoke regularly	**1.57**	**1.36-1.83**	**1.41**	**1.20-1.65**		**1.47**	**1.22-1.76**	**1.80**	**1.49-2.17**	
Never smoked (Ref.)	1.00		1.00			1.00		1.00		
BMI Category										
Obese	**1.41**	**1.18-1.70**	**1.74**	**1.42-2.15**		1.16	0.94-1.42	**1.31**	**1.06-1.62**	
Overweight	**1.27**	**1.08-1.48**	**1.32**	**1.09-1.61**		1.12	0.94-1.33	**1.22**	**1.01-1.48**	
Normal (Ref.)	1.00		1.00			1.00		1.00		
Health Status										
Limiting illness	1.00	0.85-1.18	0.99	0.82-1.21		**0.82**	**0.67-1.01**	0.82	0.66-1.02	
Non-limiting illness	**1.21**	**1.04-1.41**	1.11	0.94-1.32		0.99	0.82-1.20	0.89	0.72-1.09	
No illness (Ref.)	1.00		1.00			1.00		1.00		

***p* <0.05**. OR: Odds Ratio *Only statistically significant period interactions shown.

4.4 Discussion

This study presents an overview of demographic, socioeconomic and co-risk factors associated with two risk drinking behaviours in English middle-aged men and women across years since 1998, accounting for GOR clustering and considering a potential change in associations over two periods.

In response to RQ1, the results suggested that the percentage of drinkers exceeding the weekly guidelines declined in both sexes, with a greater decline in men, yet the percentage engaging in binge drinking increased between 1998 and 2015. This finding remained after accounting for individual characteristics and regional clustering. The percentage of drinkers exceeding the weekly guidelines converged between men and women to 30% in 2015, a finding also identified in an Australian cohort study (474). However, female binge drinking saw the greatest increase over time from 16 to 22% of drinkers. A similar trend was found in reports from the United States suggesting that binge drinking had increased in adults aged over 50 years, particularly in women, between 2005 and 2016 (475, 476). This contrasts with the gradual decline in binge drinking in adults aged under 45 years in England since at least 2007 (12, 31, 76).

In answer to what individual-level factors were associated with risk drinking behaviours (RQ2), differences were found by drinking behaviour and sex. Binge drinking was found to be sensitive to age with the youngest age group (45-49 years) three times more likely to engage in this behaviour, a trend which has been described in the literature (93, 124). Exceeding the weekly guidelines declined with age in women but this age gradient was weaker in men, suggesting the persistence of this behaviour throughout middle-age. Ethnic minorities were less likely to exceed the weekly guideline or binge drink which agrees with the literature on the socio-cultural norms of these populations (218).

Men and women who were divorced were more likely to binge drink whilst men and women who were cohabiting were more likely to exceed the weekly guidelines, with stronger associations in men compared to women. Further outcomes for marital status were mixed by sex suggesting that risk drinking is both associated with being in or out of a relationship and cohabiting is a distinct status from marriage in promoting risk drinking. Analyses of the 1958 Birth Cohort (NCDS) in early mid-life found that being single was associated with more units consumed (102, 283), and being

single or divorced was associated with AUDIT[18] problem drinking (284) but there was no association with marital status and problem drinking in two cohorts over 50 years of age (256, 276). However, none of these outcomes used the risk thresholds applied in this study. The negative association of having children in the household with weekly alcohol risk agrees with the association found for a reduced intake of units per week in the NCDS (102) and the lack of an association between children in the household and binge drinking has been found in studies from the United States (469, 477).

For socioeconomic factors, higher gross income was associated with an increased risk of both drinking behaviours, although only in the highest income quintile for binge drinking (£50k+), and this association was stronger in women compared to men. In the British literature, higher income was associated with a higher intake of units per week in both sexes (101), problem drinking in women but not men (256) and no association with exceeding the former weekly guidelines in a male only middle-aged cohort (276). These results suggest that income may have a greater role in women's risk drinking. Having educational qualifications, particularly degree qualifications was also more strongly associated with exceeding the guidelines in women compared to men. In the literature, degree education was associated with a higher intake of units per week in middle-aged adults (101) and exceeding the former weekly guidelines in a non-sex stratified all ages study of the HSE (236). However for binge drinking, there was no association with education found in women but there was a negative association with binge drinking found for degree education compared to no qualifications in men. In the literature, degree education has been negatively associated with problem drinking in both sexes (256, 275) and binge drinking (as 5+ drinks) in middle-aged cohort studies not stratified by sex (273, 274). This suggests that the two risk alcohol behaviours have opposite associations with educational attainment in men. Being in retirement compared to employment was consistently associated with exceeding the weekly guidelines in both sexes but not with binge drinking. This is a novel outcome as the association with retirement has only been tested in one cohort for problem drinking where it was not found to be statistically significant (256).

For co-risk behaviours, exceeding the weekly guidelines and binge drinking were both strongly associated with smoking, and to a lesser extent former smoking, in both sexes. This association has been observed in the ELSA cohort in both sexes for problem drinking and units per week (101, 256) and average weekly unit intake and binge drinking (5+ drinks) in the Irish Longitudinal Study

[18] Alcohol Use Disorders Identification Test

of Ageing (TILDA) (478). A raised BMI was associated with binge drinking, particularly in men, but not excess weekly drinking in both sexes, which is somewhat counter to the literature that suggests a correlation of alcohol consumption and body weight, although this has not been explored longitudinally (263-265). When tested, there was no statistically significant interaction of BMI or smoking with socioeconomic status markers (income, education, employment status) and risk drinking except for a greater risk of binge drinking in female smokers with degree education women compared to smokers without qualifications. This is a novel subgroup as there was no association of education and binge drinking for women in this study. Having a limiting illness was negatively associated with both drinking behaviours in women but not men. This sex-specific association was also found for problem drinking in ELSA where poor self-rated health was negatively associated in women but not men (256) and women were twice as likely as men to reduce their drinking with a limiting illness across the NCDS cohort (208).

In response to RQ3, no association with risk drinking was found for geographical residence, as defined by GOR as a random intercept. This suggests that the regional differences found in the descriptive statistics are better explained by the individual-level factors of the residents living within these regions rather than a larger regional effect. In the literature, the association of risk drinking with GOR has only been investigated in cross-sectional surveys using all ages suggesting that there was a statistically significant regional association for binge drinking in logistic regression models (296, 297) and a multilevel model (298). For the middle-aged sample used in this study, GOR as a geographical measure may be too large to present differences in drinking behaviour at finer geographical scales (301). However the addition of IMD 2015, available for period 2 (2011-2015), was also not associated with risk drinking behaviour, despite associations found with lower deprivation and binge drinking in HSE studies using all ages (214, 298). This suggests that lower-level area factors, as IMD is measured at the Lower Super Output Area level, may also not be relevant in this age group.

For the final RQ4, there were statistically significant changes in the associations found for education in men, income in both sexes and smoking in women across the two periods. These outcomes are novel as no other study has considered the change in the association of factors on risk drinking behaviours in middle-aged adults. The reduced association between higher income and weekly drinking risk between periods in both sexes may relate to increasing alcohol affordability in the UK as increases in disposable incomes exceed increases in alcohol prices (98, 105, 479). Between 1998 and 2015, adjusted for inflation, alcohol prices declined by only 2% whilst per adult disposable income rose by 44% (166) (see Chapter 2.5.2). This relationship is further investigated in study 3 of this thesis. The association of risk drinking with smoking

increased in women over time but not men, despite the increased difficulties in smoking introduced by the 2007 public indoor ban in the UK (261). This change may be related to the increases in binge drinking in women which may maintain smoking behaviour more than average drinking volumes (259, 480). The increased negative association of degree education with binge drinking in men may be related to the large decline in the percentage of individuals without qualifications in the period 2 sample. It is unclear if the recession contributed to a change in risk alcohol consumption in middle-age as the decline in alcohol intake per capita had already started after the peak of consumption in 2004 (141).

4.4.1 Strengths, Limitations and Further Research

This study addressed several research gaps that limited the understanding of risk alcohol consumption trends and the characteristics of male and female drinkers aged 45-69 years in England considering a social-ecological framework (68). The use of a repeated cross-sectional dataset with a random stratified sampling design achieved a pooled sample of 20,871 drinkers aged 45-69 years to provide statistical power (387, 389). This allowed for the analysis of trends for two risk alcohol behaviours over 17 years not available in other surveys. The HSE uses recommended BSQF questions for measuring alcohol consumption over a sufficient reference period (12 months) with multiple options for beverages and serving sizes as responses using in-person interviewing (415). The units of alcohol were recalculated to ensure all years used the same unit conversions as the updated measures in 2006 (151). The outcome used was a threshold of UK public guidelines which is more practical for interpretation than a linear unit intake as alcohol risk is used within a harm reduction framework (175). Multilevel modelling enabled the analysis of GOR as a clustering factor and was therefore able to separate the effects of regional residence and the characteristics of the individuals within regions (450).

Cross-sectional data can have reduced statistical power and a greater potential for survivorship bias (Chapter 3.8.2) from the sampling of new individuals in each year but avoids the issue of longitudinal attrition that can also lead to cohort biases (438, 481). The average household response rate of the HSE is 60%, which introduces possible non-response bias, as discussed in Chapter 3.8.3. An all-age study of the HSE 2011 suggested that individuals who required 7+ calls to contact were more likely to exceed the former daily guidelines and engage in binge drinking (482). Therefore, non-response may have led to a lower percentage of risk drinkers in the sample.

CCA for income and BMI entries may have biased the sample towards the younger, employed, educated population and therefore a higher socioeconomic status sample. This loss of

participants with known or unmeasured characteristics of interest to risk drinking may have impacted the size or precision of the estimates found, particularly if the relationship to alcohol behaviour is non-linear (483, 484). Similar conclusions were found in a report of the Millennium Cohort Study that found missing income data was more likely for the self-employed or lower-income families, leading to a form of non-response bias (485). Although a larger sample size may partially compensate this loss of participants, a sensitivity test for the impact of CCA on outcomes could be considered in further analyses.

Non-response weighting was not used (or available in the early years of the study period) as this would have led to a loss of participants specific to the target age group and was not found to impact outcomes in a sensitivity test, as discussed in Chapter 3.8.3. Self-reported alcohol consumption is known to be under-reported and difficult to account for, as covered in Chapter 3.8.1, due to issues with recall and social desirability bias (375, 376, 433).

Although trends in risk drinking were observed for this middle-aged population, it is not clear if these changes have occurred equally across the subgroups of characteristics identified. This would help determine if particular groups within high-risk drinkers are driving these trends, or if there are levels of population 'collectivity', where mean changes in consumption impact all quantiles of intake (76, 147). For example, descriptive statistics of this study suggested that binge drinking has increased in all ages for women but only in men over 60 years, despite binge drinking being more associated with younger age groups. Such research would also support an investigation into the shifts in peak age of binge drinking identified in the United States (486). The higher risk of binge drinking found for smoking in tertiary-educated women, despite smoking usually associated with lower socioeconomic status (487, 488), suggests there may be clusters of characteristics in subgroups that may be better identified through methods such as latent class analysis (489, 490). Such analyses may help separate the characteristics of those who take part in only binge drinking or those who engage in both a high average volume and heavy episodic behaviour (163, 461).

Further analysis could be performed to determine if the characteristics of drinking at hazardous thresholds differ to those for problem drinking. Differences in the characteristics of drinkers at these higher intake levels have been implicated as contributing to the alcohol harm paradox (see Chapter 2.2.5). For example, in an analysis of the HSE using all ages, exceeding the former weekly guidelines was associated with a higher income and education gradient, as found in this study, however there was no statistically significant association with these factors when consuming

above 50/35 units (236). The investigation of such thresholds in this thesis was limited by sample size.

This study contributes to the research into understanding middle-aged risk alcohol consumption by discovering rising trends in middle-aged binge drinking and statistically significant associations with demographic, socioeconomic and co-risk factors in this age group. Further insights may be found when considering the trajectories of the same individuals, rather than population groups, over time. This would enable the investigation of changes in an individual's circumstances and if such changes are associated with drinking behaviours. A change in status may be a sensitive transition period which may be linked to behaviour more than a long-term stable situation. Therefore, the next chapter of this thesis presents the second study that used longitudinal panel data to investigate binge drinking patterns and how changes in personal status are associated with binge drinking in the same individuals over time.

Chapter 5 Study 2: Binge drinking alcohol in middle-age associated with transitions in family, socioeconomic or co-risk status: multilevel analysis of UK panel data

This chapter describes the second study of this thesis using two waves of panel data from the Understanding Society (USoc) cohort. This study aims to address the research gap of the literature review in Chapter 2.6.1, posed by objective 3: To explore how transitions in individual life circumstances, related to middle-age, are associated with changes in binge drinking, and to provide further evidence to meet objectives 2 and 4 (individual and regional associations) that were addressed in the first study of this thesis. This study extends the investigation into individual-level factors associated with binge drinking as study 1 suggested that this drinking behaviour has increased in the middle-aged population. It does this by following repeated measures of the same individuals over two survey waves, allowing for the analysis of associations with both stable factors and changes between status categories, such as employment or personal relationships, with binge drinking behaviour. This study also considers if changes in binge drinking engagement between waves are associated with individual-level factors.

5.1 Background

Binge drinking (also known as heavy episodic or risky single occasion drinking) is a pattern of alcohol use involving a high volume of units in a single occasion or short period (40). In the UK, this is typically measured as drinking at least 8 units for men and 6 units for women in a single day (190). Although this threshold is not part of the official UK low-risk guidelines, they do contain a recommendation that the amount of alcohol consumed in a single occasion should be limited to reduce short term health and social outcomes from intoxication (11). Binge drinking in middle-age is a risk factor for falls, road injuries, self-harm, acute pancreatitis and atrial fibrillation (6, 41, 161). Any cardioprotective effects that may be produced from regular low dose drinking are essentially removed by binge drinking (161, 199).

Although cohort studies suggest that binge drinking typically declines after a peak in young adulthood (93, 124), study 1 suggested that binge drinking in those aged 45-69 years has increased by 4% in men and 6% in women between 1998 and 2015 with similar increases

observed in the General Lifestyle Survey (GLS) (396). Over a similar period, the number of DALYs[19] per 100,000 persons aged 50-69 years for unintentional injuries associated with acute alcohol consumption has increased, with alcohol-related fall injuries increasing by 10% in such adults in the UK (6, 39). Results from the latest Health Survey for England (HSE 2018) suggested that binge drinking patterns occurred in 31% of male drinkers and 22% of female drinkers aged 45-64 years (94). Therefore, continuing to provide evidence for the risk factors associated with binge drinking in this age group is important for understanding this increasingly prevalent alcohol pattern that is associated with contributing to inequalities in alcohol-related harm (232).

The cross-sectional analysis of the HSE in study 1 found novel associations for binge drinking in middle-age with divorced marital status, no educational qualifications (men only), smoking and a raised body-mass index (BMI) that had not been previously analysed using the 8/6+ threshold in the UK literature (213, 274). The lack of any comparative literature supports further analysis of these factors using a different cohort of middle-aged participants from across the UK. This also provides an opportunity for the inclusion of further variables that may indicate social or place factors that have been previously associated with binge drinking in the literature, such as social groups (79, 214, 297).

A panel analysis has an advantage over repeated cross-sectional data as repeated measures of the same individuals allows for the observation of individual change in both personal status factors and changes in binge drinking engagement over time (481). The analysis of transitions in such predictive factors may indicate sensitive life periods, such as entering retirement or becoming a parent, that may increase the risk of maintaining or starting binge drinking in middle-age (13, 22, 491). Such transitions can be analysed in different ways across time points: a change in individual status with maintaining binge drinking, a change in individual status and a change in binge drinking together, or a stable individual position with a change in binge drinking engagement over time.

In the UK, the association of a change in individual factors such as health, marital and socioeconomic status has been explored in the English Longitudinal Study of Ageing (ELSA) and 1958 Birth Cohort (NCDS) but only for a frequency or linear change of alcohol rather than risk drinking patterns (101, 208, 283, 492). Changes in drinking behaviour with stable individual health or employment factors in middle-age over time have also only been explored for changes in unit

[19] DALYs: Disability-Adjusted Life Years: Measures burden of disease through years of life lost due to premature death and years lost to due to disability (152). Calculated from health survey and recorded alcohol data, adjusted for unrecorded and tourist consumption.

intake and no studies have considered how transitions in individual status could increase the risk of maintaining risk drinking behaviours (208, 283). Each type of transition analysis contributes to an understanding of the association of status stability with maintaining or initiating binge drinking in middle-age that provide further depth than can be obtained from a one-time point cross-sectional survey (493-495). Although there has been some birth cohort research considering the impact of early lifecourse socioeconomic achievement on binge drinking in mid-life (as 5+ drinks) (213, 275), such trajectory analysis is more suitable for understanding long-term developmental predictors of drinking risk. This study is concerned with the shorter-term drinking risks that may develop during sensitive life changes (21).

Research gaps were identified for a need to continue the investigation of individual characteristics with binge drinking due to its increasing prevalence in middle-age. This includes an analysis of the association of individual change or stable characteristics over time with binge drinking risk. The following study-specific research questions (RQ) were developed to address such research gaps using a threshold in common with other alcohol-related health surveys. The outcomes of this study are compared to the first cross-sectional study of this thesis in the results and discussion section:

1) What individual-level demographic, socioeconomic, co-risk and community factors are associated with binge drinking in the same individuals across two waves of panel data?
2) How do the results of this analysis of the same individuals across two waves of data compare with the association of binge drinking in the repeated cross-sectional analysis in study 1?
3) What factors and transition of factors (such as a change in employment status) are associated with maintaining binge drinking between waves 2 and 5?
4) What factors and transitions in factors are associated with binge drinking in wave 5 only (indicating initiation) or wave 2 only (indicating cessation)?

The second study of this thesis addressed these research gaps by considering binge drinking in middle-aged drinkers over two waves of a longitudinal panel dataset, USoc, for the years 2010/11 to 2013/14. It considered the association of various individual-level factors with binge drinking using multilevel modelling to assess the variance across Government Office Region (GOR) residence and account for the correlation of repeated measures in the same individuals (RQ1). Similar predictor variables to the individual level factors analysed in study 1 were used to enable comparisons in binge drinking outcomes (RQ2). Three novel community-related factors, religious belonging, friendships, and urban residence at the individual-level were also considered. A reported change in such predictor variable status between the two waves was used to assess if

the association of transitions in status increased the risk of binge drinking in both waves (RQ3). A change in reported binge drinking behaviour between the two waves was used to assess the association of predictor variables and their transitions with binge drinking in only the second wave (wave 5) or in only the first wave (wave 2) to indicate risk factors associated with changes in the direction of binge drinking (RQ4).

5.2 Methods

5.2.1 Study Population and Sampling Design

This study uses data from wave 2 (year 2010/11) and wave 5 (2013/14) of USoc also known as the UK Household Longitudinal Study (UKHLS), in men and women aged 45-69 years. These years were chosen to allow for the analysis of change in binge drinking or individual circumstances with a relatively short follow-up time (three years) for considering the shorter-term impacts of transitions compared to lifecourse trajectories. USoc is a longitudinal panel survey using a random stratified sample of adults living across all nations of the UK, with annual re-surveying of sample members every year since 2009/10, as explored in Chapter 3.5.1 (399). This dataset was chosen for its large sample size, age range, variety of exploratory variables and a measure of binge drinking using a similar method to the HSE. A longitudinal panel design allows for the analysis of relatively frequent repeated measures in the same individuals, rather than population groups in repeated cross-sectional studies, over time and therefore follow changes in reported characteristics or behaviours, which are the target of this study.

5.2.2 Outcome – Binge Drinking

Questions related to alcohol consumption were included in a rotating module in the individual level self-completion questionnaire for waves 2 and 5 only. As described in Chapter 3.6.3, alcohol-related question content was changed in wave 7 and could not be harmonised with former waves and therefore was not included in this study. USoc does not include measures that allow for the measurement of typical weekly drinking and only includes measures for drinking on the heaviest day of the previous week. Therefore, this study only assessed associations with binge drinking, however the availability of repeated measures allowed for the assessment of binge drinking patterns over two waves.

Binge drinking was surveyed through the question of "*Did you have an alcoholic drink in the seven days ending yesterday?",* followed by *"On the day you drank the most, how many servings of … did*

you have?" Responses were available for beer, wine, spirits, or alcopops but no serving sizes were available and therefore standard serving sizes were assumed. Having a drink in the previous week was required before further questions on binge drinking were requested. Therefore, this study only included individuals who had consumed any alcohol in the previous week, the same as in study 1. Drink servings were converted to UK standard units using recommended serving assumptions and all individual beverages for the heaviest day added together for total intake that day (see Chapter 3.7) (151). Binge drinking was dichotomised as 8+ units for men and 6+ units for women as measured in other UK surveys to enable comparisons (190, 191).

Model Outcomes: Due to the ability to include responders of only one wave into repeated measure multilevel models, a full sample model was created that included all individuals present in either wave for the maximum available sample size and reduced attrition loss (451). To assess patterns in binge drinking across waves 2 and 5, further models were created that used only individuals that had repeated measures. These models analysed factors associated with maintaining binge drinking in both waves (consistent binge drinking), drinking in wave 5 only (indicating initiation) and drinking in wave 2 only (indicating cessation) as summarised in Table 5.1. The reference groups in all models, except for wave 2 binge drinkers, were individuals who did not binge drink (<8/6 units) but drank in the previous week. In the wave 2 binge drinking model, the reference group was consistent binge drinkers (binge drinking in both waves) as this represents the sample who did not change their behaviour.

Table 5.1 Description of outcome measures in binge drinking models.

Outcome - Binge drinking (Dichotomous)	Drinking at least 8 units in men, 6 units in women on the heaviest day of intake in the past week. Only asked of drinkers in the previous week.	
1. Full Sample	Binge drinking in any wave. Includes responders from only one wave. Reference group is no binge drinking in any wave (single or both wave responses).	Table 5.4
The following models require repeated measures responses from both waves for the outcome:		
2. Consistent Binge Drinking	Binge drinking in wave 2 AND wave 5. Reference group is no binge drinking in both waves.	Table 5.5
3. Wave 5 Binge Drinking	Binge drinker in wave 5 but Non-binge drinker in wave 2. Represents an initiation of binge drinking. Reference group is no binge drinking in both waves.	Table 5.6
4. Wave 2 Binge Drinking	Binge drinker in wave 2 but non-binge drinker in wave 5. Represents a cessation of binge drinking. Reference group in this model is consistent bingers (binge drinking in both waves) as this represents the unchanged behaviour.	Table 5.6

5.2.3 Predictor Variables

Predictor variables were chosen based on availability in both waves 2 and 5 at the individual level and their relationship to alcohol consumption based on previously included variables from study 1 and evidence from the literature. A description of these variables and any transformations to reduce the number of variable categories, to increase subgroup sample size, are shown in Table 5.2.

Transition Predictors: To examine the association of binge drinking with changes in predictor variables between wave 2 and 5, all time-variant factors were transformed to create models analysing transitions in status. Factors were included in the model as 'change' to or from one status to another and compared to individuals within the same category who did not change status between waves. These transition factors were analysed for consistent binge drinkers (Table 5.5) and wave 2 or 5 specific binge drinkers (section 5.3.4). As the number of individuals who changed demographic or social status was generally less than 10% for each factor, transitions were combined into smaller categories to increase subgroup size. For example, individuals who moved from employment to retired or disabled were categorised as entered non-employment whilst those who moved from retirement or disabled back to employment were categorised as started employment. These categories were compared to all individuals who had no change in employment status over the two waves. Models not analysing transitions used predictor variables as their original categories. Both forms are summarised in Table 5.2.

Table 5.2 Description of variables included in regression models for study 2.

Stratification		
Sex	Male or female	
Outcome		
Binge drinking (dichotomous)	Drinking at least 8 units in men, 6 units in women on the heaviest day of intake the past week. Only asked of drinkers in the previous week.	
Level 1 - Repeated measures		
Time	Wave 2 (2010/11), Wave 5 (2013/14)	
Level 2 - Fixed effects		
Variable	**Description**	**Transition form**
Age	Groups of 5 years from 45 to 69 years.	Included as a linear variable as age is unidirectional for all individuals

(Continued on next page)

Ethnicity	18 groups to 2 – White British (England, Wales, Scotland, Northern Ireland), all other responses	No change in the measurement of ethnicity as USoc measures this only in the initial participant interview [20].
Marital Status	De facto marital status – 10 categories to 4- single or widowed, married, living as a couple, divorced or separated.	Change to or from a relationship (married or couple) to or from not being in a relationship (single, divorced).
Religious belonging	Do you regard yourself as belonging to any particular religion? Yes, No.	Change to or from regarding self as religious.
Children in the household	Number of own biological or adopted children in household combined. Scale converted to either none or 1+. Aged 15 years and below.	Change to the number of children in the household above or below 1+.
Employment status	Which of these describes your current employment situation? 11 categories to 3 – employed or self-employed, retired, other (looking after family or long term disabled)	Change to or from non-employed position (disabled, homemaker, retired) to or from being employed.
Net Income	Continuous total net personal monthly income in £ was converted into five groups of even population size (quintiles). USoc utilises imputation methods to deal with missing cases in income. Original scale involves negative income due to irregular self-employment sources.	Change in any direction of income by tertile from higher to lower or lower to higher. Tertiles were chosen to simplify the creation of a transition in income variable.
Education	Can you tell me the highest educational or school qualification you have obtained? 6 categories to 3 – degree or higher degree, A-level or GCSE or other qualification, no qualification.	Gained a qualification (of any type).
Health	Long-standing illness or disability, Yes or No	Change to or from having a long-term illness.
Smoking	Ever smoked cigarettes? Yes or No	Change from never smoked (no) to smoking (yes) or smoking (yes) to non-smoker (no).
Friendship	Do you have any friends? Yes or No	Change to or from having friends.
Population density	Urban (>10k persons/hectare) or Rural	Change to or from living in an urban or rural area.
Level 3 - Random intercept		
Government Office Region (GOR)	9 England Regions + Scotland, Wales, Northern Ireland	

5.2.4 Limitations in Variable Availability

Index of Multiple Deprivation (IMD) score or quintile was not available in USoc without access to special license data to link IMD to small area geography. English IMD data would only apply to samples from England, when USoc provides UK data, which study 1 showed to have no

[20] Reported ethnicity measures may change over time from changes in identity perception and increases in available diversity categories in surveys (496).

contribution to binge drinking in the English middle-aged population. Special license local authority level data was considered too aggregate to show meaningful relevance to alcohol behaviours, particularly as study 1 showed no association with GOR or IMD measured at the Lower Super Output Area level (LSOA). Published studies suggest that place effects with binge drinking are largely at the individual and household level which were considered priorities for this study (214, 300). A household-level analysis was not pursued in this study as analyses were stratified by sex, as discussed in Chapter 3.9.1, and therefore family characteristics were controlled at an individual level.

The rotating question module format in USoc limited the inclusion of individual-level variables to those in the same wave as the alcohol module (wave 2 and 5). This excluded the use of theoretically relevant time-variant questions in other waves such as local neighbourhood conditions and belonging, self-reported mental wellbeing, loneliness, or pensions (400). This would require individuals to be present in both waves considered when as described next, individual wave responses are variable.

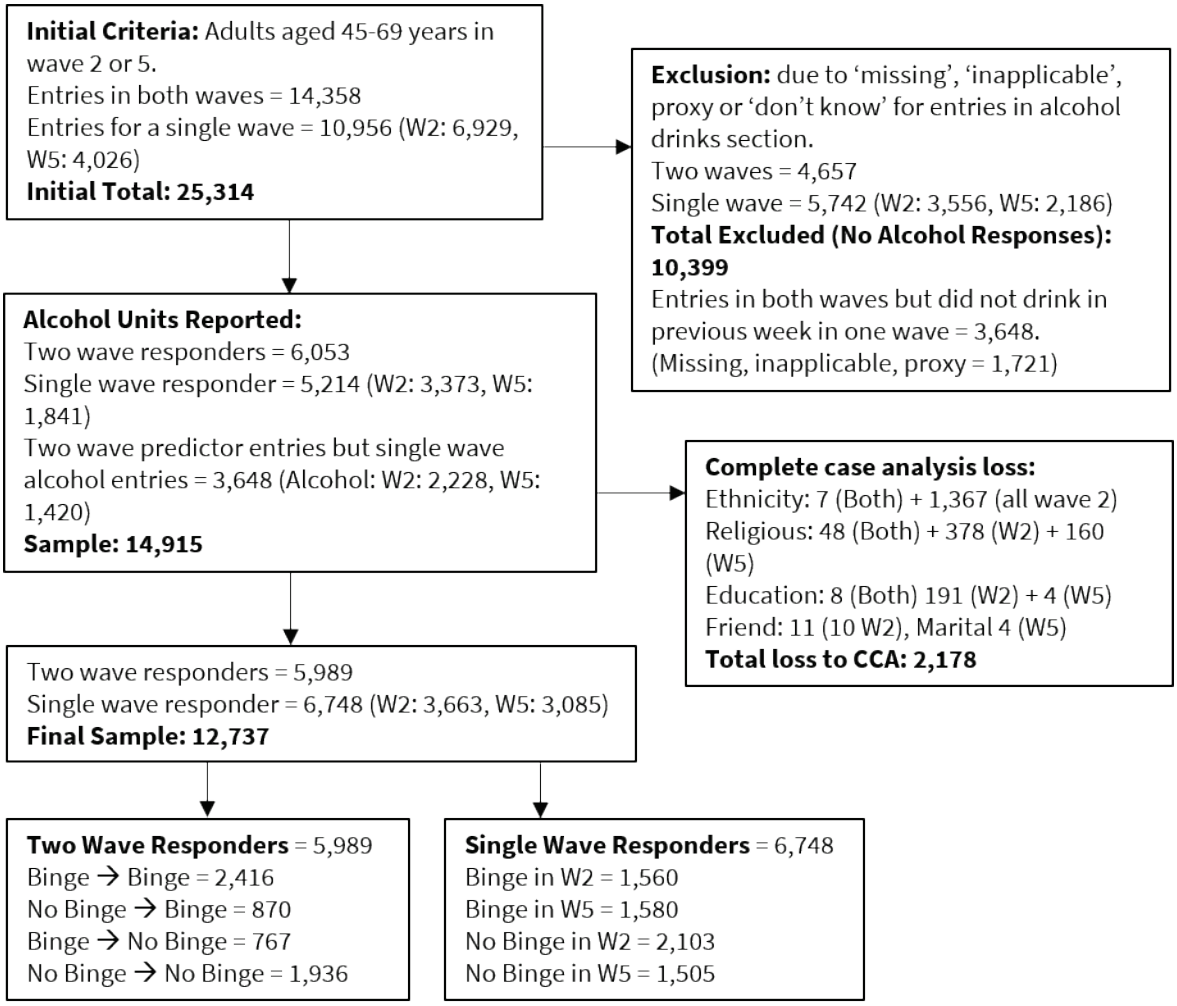
5.2.5 Inclusion of Individuals Across Waves

Individuals were initially selected if they met the 45-69 age criteria and had data entries for wave 2 or 5 or both waves by their cross-wave identifier (pid). This initial sample had a high number of single wave entries (n=10,956), some of which were due to the age criteria of the study with wave 2 responders aged 67-69 years moving out of the sample in wave 5 (n=1,633 of wave 2 single responders) and wave 5 responders aged 45-47 moving into the sample as they met the age criteria (n=2,183 wave 5 single responders). Other reasons for one wave response may be due to non-response in wave 5 or a decision to respond to wave 5 by other household members due to the flexibility allowed by USoc (405). Individuals were excluded from the analysis due to their lack of alcohol intake measures or due to complete case analysis (CCA). The flow of how the final sample was achieved is displayed in Figure 5.1.

Alcohol measures: Having a drink in the previous week was required before further questions on binge drinking were requested and therefore specific waves where individuals had no alcohol-related response for the previous week or reported missing or proxy as responses were excluded (n=10,399). There were 3,648 responders for both waves that reported drinking in the previous week in one wave but had no alcohol or a missing response in the other wave and were therefore used as single wave entries. The use of a one-week reference period and exclusion of non-drinkers is the same method used to measure binge drinking in study 1. It was justified that non-

drinkers may have different characteristics to low-risk drinkers and in USoc the consumption of non-weekly drinkers is not measured (see Chapter 3.8.2).

Figure 5.1 Flow chart for progression to final sample size for study 2. N= adults.



Complete case analysis and attrition: A known reporting error in USoc in which some baseline statistics of the British Household Panel Survey sample were not fed forward at entry to wave 2 led to some missing variable entries in some participants (497). Backcoding was used on three variables considered to be more time-invariant (ethnicity, education, and religious association), where follow-up waves with data were available (498). This led to a greater loss to CCA from single wave responders. Where no data for backcoding could be applied, individuals were lost to CCA by ethnicity (missing n=1,374), religious association (n=586) and educational qualifications (n=203), see Figure 5.1. Multiple imputation was not used as the missingness for these variables was considered non-random (445). Individuals lost to CCA were more likely to be in the oldest age category, retired, without qualifications and from the three minor nations in chi-square analysis.

Compared to both wave responders, single wave responders for wave 2 were less likely to be binge drinkers, more likely to be from the oldest age group (65-69 years), have lower education

or be an ethnic minority ($p < 0.001$). The main characteristic of single wave responders for wave 5 was being from the youngest age group (45-49 years) (50% of this sample) as they move into the age criteria of the study. Wave 5 single wave responders were also less likely to be binge drinkers and more likely to be an ethnic minority and of lower education. Attrition from ethnic minorities has been noted in previous reports of USoc (403). Figure 5.1 shows the final sample size was 12,737 individuals for the full sample model and 5,989 individuals for models requiring responses from both waves.

5.2.6 Statistical Analysis

Descriptive statistics were performed to explore sample composition and changes in variable proportions between waves 2 and 5. Independent variables were checked for multicollinearity using Variance Inflation Factor (VIF) as part of regression model assumption testing, with no values above 2 included in models (472). IBM SPSS Statistics version 25.0 was used for all analyses. Data were used unweighted to maximise the sample size of the specific target age group as explained in Chapter 3.8.3.

All models used multilevel logistic regression (generalized linear mixed model with logit-link function) to account for regional clustering of individuals by GOR and, in the full sample model, account for the non-independence of repeated measures within individuals (499). This three-level model including wave, individual factors and GOR was described in Chapter 3.9. Multilevel modelling allows repeated survey waves and individual-level fixed effects to remain independent and can account for wave correlation within individuals by using a covariance structure (see 5.2.7) (500). Survey wave was also included as a fixed effect at level 2 to observe if binge drinking changed over the two waves. Level 1 wave was only included in the full sample model to account for repeated measures as all other models implied wave by the binge drinking pattern being tested. GOR was included at level 3 as a random intercept in the full sample model to determine if regional residence had an independent association to the individual factors included as level 2 fixed effects. GOR was included as a random intercept in all other models at level 2 regardless of significance to improve standard errors unless no estimate at this level was produced (460).

For the full sample model, variables were added in a stepped process to determine the impact of adjustment, building three incremental models considering 1. demographics, 2. socioeconomic factors and 3. co-risk and social factors. All models were stratified by sex. Transition models of individual status factors were constructed for consistent binge drinkers and wave 2 or 5 specific binge drinkers, as described in Table 5.1.

5.2.7 Covariance Structures for Repeated Measures

A covariance structure was applied at level 1 in the full sample model to account for correlation between responses from repeated measures of the same individual (501). A standard regression model assumes independence of random errors and therefore assumes there is no relationship between values (covariance) and that values remain consistently spread around the mean value (constant variance). When this assumption is violated in repeated measures data, a covariance structure can be applied to the random errors that better accounts for the covariance associated with having multiple measures from the same individual. A covariance structure is a pattern of covariance in a matrix (similar to a correlation table) (502). This study utilised the compound symmetry covariance structure as the correlation between the two waves was found to be statistically significant (r=0.445 p <0.0001) suggesting that drinking behaviour in wave 5 was related to wave 2. The suitability of this structure was tested against other covariance structures in models, using the lowest log-likelihood values to assess model fit (501, 503). Figure 5.2 shows the covariance matrix for compound symmetry which has constant variance (σ^2) and constant covariance (σ_1).

Figure 5.2 Covariance matrix illustrating compound symmetry structure.

$$\begin{pmatrix} \sigma^2 + \sigma_1{}^2 & \sigma_1 & \sigma_1 & \sigma_1 \\ \sigma_1 & \sigma^2 + \sigma_1{}^2 & \sigma_1 & \sigma_1 \\ \sigma_1 & \sigma_1 & \sigma^2 + \sigma_1{}^2 & \sigma_1 \\ \sigma_1 & \sigma_1 & \sigma_1 & \sigma^2 + \sigma_1{}^2 \end{pmatrix}$$

5.3 Results

5.3.1 Descriptive Statistics

Table 5.3 shows the study sample composition by sex for wave 2 and 5 and the percentage of binge drinkers by predictors for each wave cross-sectionally and the percentage of responders to both waves undergoing a transition in status. Cross-sectionally (comparing wave samples), the percentage of binge drinkers is higher than reports from the HSE, the possible reasons of which are examined in the discussion section. The percentage of binge drinking men was slightly higher than the percentage in women, as expected. Individuals available for both waves were more likely to be binge drinkers (W2: 53%, W5: 55%) than single wave responders, particularly for wave 2 (W2: 43%, W5: 51%). Cross-sectionally, changes in sample composition across waves were less than 10% except for a 13.6% increase in binge drinking for women in Northern Ireland.

Frequent individual characteristics in the sample, for both waves cross-sectionally, included marriage (68.5%), employed (69.7%) and living in an urban area (70%) (Table 5.3). When considering the same individuals across waves, the percentage of individuals who changed status between waves was under 10% for most factors except for changes in income (>12%), changes in health (11%) and leaving employment (11%). Particularly small numbers of changing characteristics across waves were observed for moving GOR (<1.5%), urban change (<1.5%), gaining children in the household (<1.9%) and gaining friends (from none) (<1.5%).

Table 5.3 Descriptive statistics for the male and female sample and binge drinkers by wave and transitions in predictor variables.

	Sample Composition – Cross-sectional									Binge Drinking – Cross-sectional				Transitions - Drinkers in both waves		
	Men					Women				Men		Women			Men	Women
	Wave 2		Wave 5			Wave 2		Wave 5		Wave 2	Wave 5	Wave 2	Wave 5	Change between waves		
	n	%	n	%		n	%	n	%	%	%	%	%		%	%
Binge drinking threshold														**Binge frequency**		
Exceeding 8/6+ units	2455	51.9	2487	55.2		2288	46.5	2380	52.1					Binge drinker wave 2 only	12.3	13.4
Below 8/6+ units	2278	48.1	2017	44.8		2631	53.5	2190	47.9					Binge drinker wave 5 only	13.8	15.3
Total	4733	100	4504	100		4919	100	4570	100					Binge drinker both waves	42.9	37.7
														Non-binge drinker both waves	31.1	33.6
Age group (years)																
65-69	658	13.9	897	19.9	*	574	11.7	757	16.6	*	41.8	47.0	36.9	40.7			
60-64	1002	21.2	806	17.9	*	989	20.1	794	17.4	*	46.1	52.5	39.4	47.5			
55-59	961	20.3	834	18.5	*	1001	20.3	881	19.3		51.6	56.2	44.8	51.2			
50-54	1003	21.2	971	21.6		1108	22.5	1015	22.2		58.1	60.2	53.2	58.0			
45-49	1109	23.4	996	22.1		1247	25.4	1123	24.6		57.6	59.0	52.0	58.3			
Ethnicity																	
Other	400	8.5	374	8.3		374	7.6	398	8.7	*	44.5	48.1	46.5	45.5			
White British	4333	91.5	4130	91.7		4545	92.4	4172	91.3	*	52.6	55.9	46.5	52.7			
Marital Status																	
Single	463	9.8	472	10.5		467	9.5	462	10.1		51.4	54.0	44.1	49.8	Single to other	2.7	3.6
Living as a couple	524	11.1	570	12.7	*	522	10.6	554	12.1	*	60.1	59.8	53.8	57.0	Relationship to other	2.7	2.6
Divorced	346	7.3	319	7.1		644	13.1	566	12.4		57.2	61.1	48.9	53.0			
Married	3400	71.8	3143	69.8	*	3286	66.8	2988	65.4		50.1	54.0	45.2	51.3			
Children in household																	
None	2842	60.0	2728	60.6		2891	58.8	2613	57.2		50.7	54.5	45.1	50.5	None to 1+	1.9	1.6
1+	1891	40.0	1776	39.4		2028	41.2	1957	42.8		53.6	56.3	48.5	54.2	1+ to None	8.1	8.5
Religious belonging																	
Yes	2279	48.2	2122	47.1		2971	60.4	2698	59.0		48.4	52.4	44.2	49.5	Yes to No	5.6	5.3
No	2454	51.8	2382	52.9		1948	39.6	1872	41.0		55.1	57.8	50.0	55.8	No to Yes	7.2	5.7

	Sample Composition – Cross-sectional										Binge Drinking – Cross-sectional				Transitions - Drinkers in both waves		
	Men					Women					Men		Women			Men	Women
	Wave 2		Wave 5			Wave 2		Wave 5			Wave 2	Wave 5	Wave 2	Wave 5	Change between waves		
	n	%	n	%		n	%	n	%		%	%	%	%		%	%
(Continued from previous page)																	
Employment status																	
Disabled	270	5.7	194	4.3	*	499	10.1	352	7.7	*	50.0	54.6	45.9	53.4	Non-employed to other	1.6	3.1
Retired	998	21.1	1080	24.0	*	1163	23.6	1132	24.8		45.6	49.8	38.7	42.2	Employed to other	11.8	11.1
Employed	3465	73.2	3230	71.7		3257	66.2	3086	67.5		53.8	57.1	49.4	55.5			
Net income £ (month)																	
>£2386	1199	25.3	1366	30.3	*	555	11.3	625	13.7	*	52.0	55.6	50.3	57.9	Gained income	21.0	16.9
1665-2386	1045	22.1	1097	24.4	*	731	14.9	872	19.1	*	51.6	55.2	51.2	54.0	Lost income	12.4	14.8
1188-1664	1005	21.2	896	19.9		927	18.8	917	20.1		50.4	53.5	47.2	52.1			
751-1187	789	16.7	639	14.2	*	1227	24.9	1077	23.6		52.6	54.5	45.5	51.9			
<=750	695	14.7	506	11.2	*	1479	30.1	1079	23.6	*	53.4	58.3	43.2	47.3			
Highest qualification																	
Degree	1738	36.7	1885	41.9	*	1919	39.0	2026	44.3	*	46.0	51.4	46.6	52.4	Gained a qualification	2.2	2.1
Secondary	2459	52.0	2292	50.9		2432	49.4	2193	48.0		55.1	58.1	47.2	51.8			
None	536	11.3	327	7.3	*	568	11.5	351	7.7	*	56.2	57.2	43.3	52.1			
Health																	
Limiting illness	1829	38.6	1598	35.5	*	1890	38.4	1642	35.9	*	49.9	52.3	44.6	49.9	Lost illness	11.3	11.3
None	2904	61.4	2906	64.5	*	3029	61.6	2928	64.1	*	53.1	56.8	47.7	53.3	None to illness	11.6	10.9
Smoking status																	
Smoker or ex-smoker	3081	65.1	2792	62.0	*	2769	56.3	2419	52.9	*	55.3	58.6	52.1	57.6	Started smoking	3.6	3.2
Never smoked	1652	34.9	1712	38.0	*	2150	43.7	2151	47.1	*	45.5	49.6	39.3	45.8	Became a non-smoker	6.1	5.5
Friendships																	
No	165	3.5	224	5.0	*	109	2.2	128	2.8		38.8	42.9	46.8	50.8	Gained friends	1.5	1.1
Yes	4568	96.5	4280	95.0	*	4810	97.8	4442	97.2		61.2	57.1	46.5	52.1	Lost friends	3.2	1.6
Population Density																	
Urban	3361	71.0	3361	70.9		3429	69.7	3117	68.2		52.7	56.7	47.8	53.2	Rural to urban	0.9	0.7
Rural	1372	29.0	1372	29.1		1490	30.3	1453	31.8		49.8	51.5	43.6	49.6	Urban to rural	1.3	1.5
GOR																	
North East	187	4.0	191	4.2		201	4.1	199	4.4		64.7	63.9	55.7	60.3	Change <1		

	Sample Composition – Cross-sectional									Binge Drinking – Cross-sectional					Transitions - Drinkers in both waves		
	Men					Women				Men						Men	Women
	Wave 2		Wave 5			Wave 2		Wave 5		Wave 2	Wave 5		Wave 2	Wave 5			
	n	%	n	%		n	%	n	%	%	%		%	%	Change between waves	%	%
(Continued from previous page)																	
North West	533	11.3	469	10.4		534	10.9	456	10.0	59.1	60.3		51.9	55.5			
Yorkshire & Humber	343	7.2	340	7.5		368	7.5	333	7.3	46.4	54.7	*	46.2	52.6			
East Midlands	403	8.5	376	8.3		388	7.9	347	7.6	51.4	56.1		45.6	54.8	*		
West Midlands	379	8.0	362	8.0		357	7.3	314	6.9	50.9	56.6		45.6	54.8	*		
East England	435	9.2	404	9.0		438	8.9	425	9.3	46.2	49.3		39.7	46.4	*		
London	331	7.0	331	7.3		335	6.8	334	7.3	44.1	49.2		47.2	47.9			
South East	663	14.0	602	13.4		694	14.1	668	14.6	47.8	52.7		46.1	51.2			
South West	438	9.3	444	9.9		477	9.7	474	10.4	44.7	51.6	*	43.8	49.2			
Wales	358	7.6	327	7.3		374	7.6	346	7.6	56.4	58.4		46.8	51.7			
Scotland	418	8.8	460	10.2	*	495	10.1	481	10.5	58.1	57.4		49.3	53.2			
N. Ireland	245	5.2	198	4.4		258	5.2	193	4.2	* 63.3	59.1		43.4	57.0	*		

z-test * p <0.05 for wave

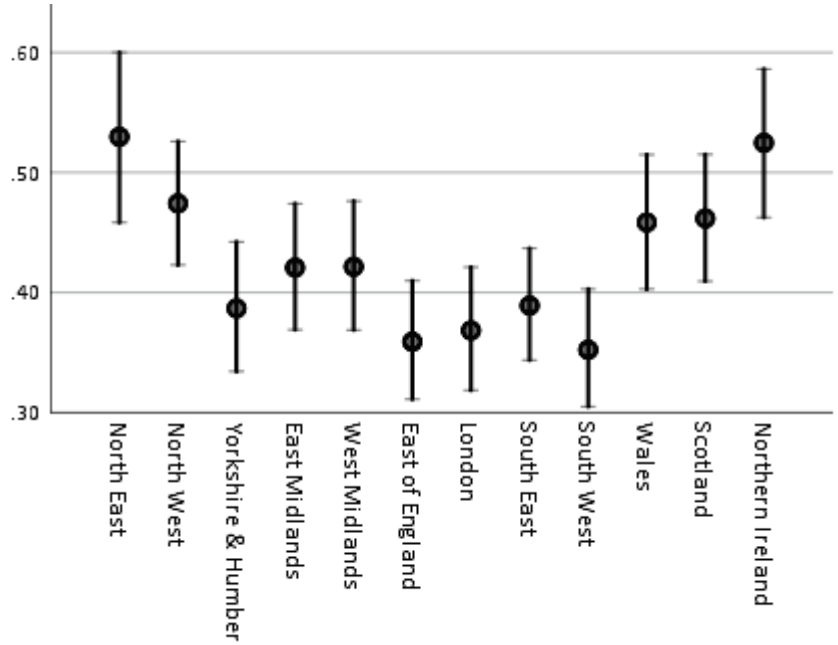
5.3.2 Multilevel Logistic Regression Models for Any Binge Drinking (RQ1 and RQ2)

Multilevel logistic regression models for men and women's binge drinking, using the full sample of individuals (single and both wave responders), accounting for repeated measures and GOR with a stepped adjustment, are shown in Table 5.4. Odds ratios (OR) and Confidence Intervals [95%CI] described in these results are from the final models of adjustment. Model fit by log-likelihood was stable with the addition of variables to each model. Overall, the stepped addition of factors to models did not particularly change the outcomes of the previous models (except for female marital status) suggesting that the addition of later factors did not better account for the binge drinking associations.

Binge drinking in the full sample model increased between waves 2 (2010/11) and 5 (2013/14) (OR Men 1.20, Women 1.26). In study 1, binge drinking over this period increased by only 1% and was therefore stable compared to this study. The increase in binge drinking in this two-wave study may reflect the attrition of non-binge drinkers, which is considered in the discussion section.

A small statistically significant variation in binge drinking by GOR residence at level 3, accounting for individual factors at level 2, was found in the full sample model for men (estimate 0.05) but no variance with GOR was found for women in this model. This contrasts with results from study 1 that found no statistically significant variance for binge drinking across GOR despite differences found in the descriptive statistics. As a fixed effect, binge drinking in men was found to be highest in the North East of England and Northern Ireland as shown in Figure 5.3.

Figure 5.3 Estimated marginal means[21] with 95%CI for binge drinking by GOR in men as a fixed effect (full sample model).



Binge drinking was found to decline with age, as was found in study 1, with the oldest age group (65-69 years) half as likely to binge drink than the youngest (45-49 years) in the final model for both sexes (OR Men and Women 0.52). Compared to being married, living as a couple (OR 1.25[1.08-1.45]) or being divorced (OR 1.23[1.02-1.47]) were both associated with binge drinking in men whilst being single in women was negatively associated in the final model (OR 0.85[0.73-0.99]), although borderline significant. The lack of a positive association of marital status in women is in contrast to study 1 where divorced status was associated with binge drinking in both sexes. Non-White British ethnicity was negatively associated with binge drinking in both sexes (OR Men 0.74 Women 0.81), as was found in study 1. Having no children in the household was associated with an increased risk for binge drinking in women (OR 1.13[1.02-1.25]) but not for men, although no association was found for both sexes in study 1. Reporting not belonging to any particular religion was associated with an increased risk of binge drinking with similar OR in both sexes (OR Men 1.19, Women 1.15) and is a novel variable for this study.

There was no statistically significant association of binge drinking with income in men but there was a significant positive income gradient in women above £1664/month (Highest quintile OR 1.32[1.13-1.56]). In study 1, an association with equivalised gross income was only found for the

[21] Estimated marginal means is a relative scale, representing the mean response adjusted for other variables in the model but the scale itself has no specific meaning (504). Therefore the outcomes may differ to descriptive statistics.

highest income quintile but was found in both sexes. There was no statistically significant association of education in women but there was a reduced risk of binge drinking in men who had degree-level education compared to no qualifications (OR 0.66[0.56-0.79]). There was no association with employment status in either sex in the final model. The associations found for both education and employment agree with outcomes of study 1.

Having a limiting illness was negatively associated with binge drinking in women (OR 0.91[0.83-0.99]) but not men, although borderline significant in both sexes. This difference for limiting illness by sex was also found in study 1. Being a smoker was associated with binge drinking in both sexes with this association stronger in women (OR Men 1.48, Women 1.66) with the highest positive OR found for any variable in the study, as was found in study 1. Whilst reporting no friendships was associated with a lower risk for binge drinking in men (OR 0.60[0.49-0.74]), there was no association with reporting friends found for women. Living in an urban area compared to a rural area was associated with binge drinking in both men and women (OR Men 1.20, Women 1.12). Friends and urban residence are both novel variables for this study.

Table 5.4 Multilevel logistic regression model for binge drinking in any wave using the full sample available from USoc waves 2 and 5, accounting for repeated measures and GOR residence.

	Any Binge Drinking vs. No Binge Drinking											
	8+ units in men on heaviest day						**6+ units in women on heaviest day**					
	Model 1 Demographics		**Model 2 +Socioeconomic**		**Model 3 +Health & Social**		**Model 1 Demographics**		**Model 2 +Socioeconomic**		**Model 3 +Health & Social**	
Level 2 Fixed Effects	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Intercept	1.16	0.98-1.37	**1.51**	**1.18-1.94**	1.09	0.83-1.44	0.97	0.85-1.10	0.96	0.78-1.18	0.69	0.55-0.87
Wave 5 (Ref. Wave 2)	**1.16**	**1.08-1.24**	**1.17**	**1.09-1.26**	**1.20**	**1.12-1.28**	**1.25**	**1.17-1.34**	**1.24**	**1.16-1.33**	**1.26**	**1.18-1.36**
Age												
65-69	**0.59**	**0.51-0.68**	**0.54**	**0.45-0.65**	**0.52**	**0.43-0.63**	**0.49**	**0.42-0.57**	**0.54**	**0.44-0.65**	**0.52**	**0.43-0.64**
60-64	**0.68**	**0.59-0.78**	**0.66**	**0.57-0.76**	**0.65**	**0.56-0.75**	**0.58**	**0.50-0.67**	**0.62**	**0.53-0.72**	**0.61**	**0.52-0.72**
55-59	**0.82**	**0.72-0.93**	**0.81**	**0.71-0.92**	**0.81**	**0.71-0.93**	**0.71**	**0.62-0.81**	**0.73**	**0.64-0.83**	**0.73**	**0.64-0.84**
50-54	1.01	0.89-1.14	1.00	0.89-1.13	1.01	0.89-1.14	1.01	0.90-1.14	1.02	0.91-1.15	1.04	0.92-1.17
45-49 (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Ethnicity												
Other	**0.73**	**0.61-0.87**	**0.75**	**0.63-0.89**	**0.74**	**0.62-0.89**	**0.84**	**0.70-0.99**	**0.84**	**0.70-0.99**	**0.81**	**0.68-0.96**
White British (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Marital Status												
Single	0.98	0.84-1.15	0.98	0.84-1.15	0.97	0.82-1.14	0.93	0.80-1.08	0.89	0.76-1.04	**0.85**	**0.73-0.99**
Living as a couple	**1.28**	**1.11-1.49**	**1.27**	**1.10-1.47**	**1.25**	**1.08-1.45**	**1.18**	**1.02-1.36**	1.14	0.99-1.32	1.08	0.94-1.25
Divorced	**1.27**	**1.06-1.52**	**1.27**	**1.06-1.52**	**1.23**	**1.02-1.47**	1.07	0.94-1.23	1.03	0.90-1.18	0.95	0.83-1.10
Married (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Number of children												
None	1.02	0.92-1.14	1.02	0.92-1.13	1.02	0.92-1.14	**1.12**	**1.01-1.24**	**1.13**	**1.02-1.25**	**1.13**	**1.02-1.25**
1+ (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Belong to religion												
No	**1.19**	**1.09-1.31**	**1.20**	**1.10-1.31**	**1.19**	**1.08-1.30**	**1.19**	**1.09-1.30**	**1.19**	**1.09-1.30**	**1.15**	**1.05-1.26**
Yes (Ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Employment status												
Disabled or homemaker			**0.81**	**0.66-0.997**	0.82	0.66-1.01			0.96	0.82-1.12	0.95	0.81-1.11
Retired			1.08	0.94-1.24	1.09	0.95-1.26			0.90	0.78-1.03	0.90	0.78-1.04

	Any Binge Drinking vs. No Binge Drinking																	
	8+ units in men on heaviest day									**6+ units in women on heaviest day**								
	Model 1 Demographics			**Model 2 +Socioeconomic**			**Model 3 +Health & Social**			**Model 1 Demographics**			**Model 2 +Socioeconomic**			**Model 3 +Health & Social**		
(Continued from previous page)																		
Employed (Ref.)				1.00			1.00						1.00			1.00		
Net income (monthly)																		
>£2386				1.08	0.92-1.25		1.09	0.94-1.27					**1.31**	**1.11-1.53**		**1.32**	**1.13-1.56**	
1665-2386				0.97	0.84-1.13		0.98	0.84-1.13					**1.20**	**1.04-1.38**		**1.20**	**1.04-1.38**	
1188-1664				0.91	0.78-1.05		0.89	0.77-1.04					1.12	0.98-1.28		1.12	0.98-1.28	
751-1187				0.91	0.79-1.06		0.91	0.78-1.06					1.09	0.97-1.23		1.09	0.97-1.23	
<=750 (Ref.)				1.00			1.00						1.00			1.00		
Highest qualification																		
Degree				**0.64**	**0.54-0.77**		**0.66**	**0.56-0.79**					0.87	0.73-1.03		0.94	0.79-1.12	
Secondary				0.88	0.75-1.04		0.89	0.75-1.05					0.93	0.79-1.09		0.97	0.83-1.15	
None (Ref.)				1.00			1.00						1.00			1.00		
Health status																		
Limiting illness							0.91	0.84-1.001								**0.91**	**0.83-0.99**	
None (Ref.)							1.00									1.00		
Smoking status																		
Smoker or ex-smoker							**1.48**	**1.34-1.63**								**1.66**	**1.51-1.81**	
Never smoked (Ref.)							1.00									1.00		
Friendships																		
No							**0.60**	**0.49-0.74**								0.88	0.67-1.15	
Yes (Ref.)							1.00									1.00		
Population Density																		
Urban							**1.20**	**1.08-1.33**								**1.12**	**1.01-1.24**	
Rural (ref.)							1.00									1.00		
Level 3 Variance	**Estimate**	**Std.Error**	**Sig.**							**Estimate**	**Std.Error**	**Sig.**						
GOR (random intercept)	0.046	0.023	0.50	0.043	0.022	0.53	**0.052**	**0.026**	**0.47**	0.014	0.009	0.128	0.014	0.009	0.126	0.016	0.010	0.113
Level 1 Wave Variance	0.534	0.014		0.538	0.014		0.548	0.014		0.581	0.015		0.582	0.015		0.595	0.015	
Covariance	0.465	0.018		0.460	0.018		0.448	0.018		0.420	0.018		0.419	0.018		0.405	0.018	
-2 log-likelihood	38626			38720			38865			39832			39878			40079		

5.3.3 Consistent Binge Drinking Across Waves and Associations with Transitions in Predictor Variables (RQ3)

A multilevel logistic regression model (controlling for GOR clustering) for associations with binge drinking in both waves is shown in Table 5.5. This model differs from the full sample model in Table 5.4 as only drinkers who reported any drinking in both wave 2 and 5 were included. Table 5.5 also considers a transition model (model 2) with this population of binge drinkers by analysing how changes in the predictors included in model 1 are associated with the risk of maintaining binge drinking in both waves.

Model 1 showed mostly similarities to the full sample model in Table 5.4. Similar to the full sample model, there was a statistically significant decline in binge drinking with age in both sexes and a negative association with binge drinking for having no friendships or having degree-level education in men. There was a positive association with cohabiting and divorce in men, having no children in the household for women, no religious belonging in both sexes, higher income in women only, smoking and living in an urban area in both sexes. The same statistically significant variance by GOR residence in men was also found. In general, the OR for this consistent binge drinking model were stronger than the full sample model with particularly strong associations comparatively for smoking in both sexes (OR Men 1.84, Women 2.23), living in an urban area (OR Men 1.43, Women 1.26), degree qualifications in men (OR 0.48[0.36-0.62]) and divorce in men (OR 1.42[1.08-1.87]). Predictors that were borderline significant in the full sample model were no longer statistically significant in the consistent binge drinking model including ethnicity, marital status, and health status in women. There were two novel outcomes in the consistent binge model compared to the full sample model which were a positive association with the highest income quintile in men (OR 1.30[1.03-1.65]) and a negative association with retirement in women (OR 0.80[0.65-0.98]).

Transitions Model: The transitions model (model 2) in Table 5.5, showed that changes in some of these predictor factors were associated with maintaining binge drinking in both waves when their status changed between wave 2 and 5. Moving into or out of a relationship in men was associated with an increased risk of maintaining binge drinking, with a stronger risk for entering a relationship (OR 2.05[1.35-3.12]). This matches the associations found for marital status in men in the previous consistent binge drinking model. No statistically significant associations were found for a relationship change in women. Other transition factors that agree with the consistent binge drinking model include a negative association with maintaining binge drinking in men

when changing to no reported friends (OR 0.53[0.37-0.75]), moving from an urban to a rural area in both sexes (OR men 0.49, women 0.53) and becoming an ex-smoker in women (OR 0.72[0.54-0.95]). A novel outcome was found for a negative association with entering employment in women (OR 0.69[0.48-0.98]) but not in men. Contrasting outcomes for the consistent binge drinking model and the transitions model were found for becoming religious in women (OR 1.55 [1.18-2.03]) and taking up smoking in men (OR 0.70[0.51-0.97]). This contrasting result for religious belonging may have been impacted by the use of backcoding as this variable was found to be more time-variant than expected (Table 5.3). Changes in other socioeconomic status factors other than employment in women were not statistically significant. The number of individuals who both changed status for some factors and were consistent binge drinkers were small and possibly underpowered, including (both sexes) entering employment (n=49), gaining a child (n=42), gaining a qualification (n=55), started smoking (n=82) urban or rural change (n=43) and any change in friendship (n=83).

Table 5.5 Multilevel logistic regression for binge drinking in both waves and transition predictors associated with maintaining binge drinking in both waves, by sex.

Consistent Bingers: Binge drinking both waves vs. No Binge drinking both waves								
	Factors (Model 1)					**Transitions in Status (Model 2)**		
	Men (8+ units)		**Women (6+ units)**			**Men (8+ units)**		**Women (6+ units)**
Level 1 Fixed Effects	**OR**	**95% CI**	**OR**	**95% CI**	**Level 1 Fixed Effects**	**OR**	**95% CI**	**OR**	**95% CI**
Intercept	1.20	0.79-1.82	0.73	0.52-1.04	**Adjusted for wave, age (linear), ethnicity**				
Wave 5 (Ref. Wave 2)	**1.16**	**1.02-1.32**	**1.15**	**1.01-1.31**					
Age									
65-69	**0.40**	**0.30-0.53**	**0.42**	**0.31-0.57**	**Marital status**				
60-64	**0.55**	**0.44-0.69**	**0.57**	**0.45-0.73**	Single to other	**2.05**	**1.35-3.12**	1.40	0.95-2.08
55-59	**0.77**	**0.62-0.96**	**0.69**	**0.56-0.86**	Relationship to other	**1.58**	**1.07-2.35**	1.27	0.90-1.78
50-54	1.06	0.86-1.31	0.88	0.72-1.08	Stable (Ref.)	1.00		1.00	
45-49 (Ref.)	1.00		1.00		**Number of children**				
Ethnicity					1+ to none	0.84	0.67-1.05	0.88	0.71-1.10
Other	**0.73**	**0.56-0.94**	0.87	0.67-1.12	None to 1+	0.65	0.41-1.01	1.61	0.97-2.70
White British (Ref.)	1.00		1.00		Stable (Ref.)	1.00		1.00	
Marital Status					**Belong to religion**				
Single	1.02	0.81-1.29	0.97	0.78-1.22	Became religious	1.09	0.86-1.38	**1.55**	**1.18-2.03**
Living as a couple	**1.31**	**1.06-1.62**	1.08	0.86-1.34	Became non-religious	0.96	0.73-1.25	1.25	0.94-1.66
Divorced	**1.42**	**1.08-1.87**	1.07	0.88-1.31	Stable (Ref.)	1.00		1.00	
Married (ref.)	1.00		1.00		**Employment status**				
Number of children					To Retirement	0.99	0.81-1.21	0.95	0.77-1.17
None	1.07	0.92-1.25	**1.21**	**1.04-1.41**	To Employment	1.00	0.61-1.62	**0.69**	**0.48-0.98**
1+ (Ref.)	1.00		1.00		Stable (Ref.)	1.00		1.00	
Belong to religion					**Net Income**				
No	**1.24**	**1.09-1.41**	**1.17**	**1.03-1.33**	Gained income	0.86	0.74-1.003	1.06	0.89-1.25
Yes (Ref.)	1.00		1.00		Lost income	0.84	0.69-1.02	1.17	0.97-1.40
Employment status					Stable (Ref.)	1.00		1.00	
Other	0.82	0.59-1.14	0.80	0.62-1.03	**Highest qualification**				
Retired	1.12	0.93-1.36	**0.80**	**0.65-0.98**	Gained qualification	1.50	0.97-2.34	0.76	0.49-1.19
Employed (Ref.)	1.00		1.00		Stable (Ref.)	1.00		1.00	

Consistent Bingers: Binge drinking both waves vs. No Binge drinking both waves

	Factors (Model 1)						Transitions in Status (Model 2)					
	Men (8+ units)			Women (6+ units)			Men (8+ units)			Women (6+ units)		
(Continued from previous page)												
Net income (month)							**Health status**					
>£2386	**1.30**	**1.03-1.65**		**1.35**	**1.06-1.71**		Gained health problem	1.18	0.97-1.43		1.08	0.88-1.32
1665-2386	1.07	0.84-1.34		**1.31**	**1.04-1.63**		Lost health problem	**1.22**	**1.004-1.48**		1.15	0.94-1.40
1188-1664	0.94	0.75-1.19		1.10	0.90-1.34		Stable (Ref.)	1.00			1.00	
751-1187	1.11	0.86-1.42		1.18	0.98-1.42		**Smoking status**					
<=750 (Ref.)							Non-smoker to smoker	**0.70**	**0.51-0.97**		1.30	0.91-1.85
Highest qualification							Smoker to non-smoker	0.87	0.68-1.13		**0.72**	**0.54-0.95**
Degree	**0.48**	**0.36-0.62**		0.87	0.67-1.13		Stable (Ref.)	1.00			1.00	
Secondary	0.82	0.64-1.07		0.93	0.72-1.20		**Friendships**					
None (Ref.)	1.00			1.00			Friends to no friends	**0.53**	**0.37-0.75**		0.98	0.61-1.57
Health status							No friends to friends	0.99	0.61-1.61		0.73	0.42-1.28
Limiting illness	0.88	0.77-1.01		0.94	0.82-1.07		Stable (Ref.)	1.00			1.00	
None (Ref.)	1.00			1.00			**Population density**					
Smoking status							Rural to Urban	0.95	0.51-1.78		1.14	0.56-2.32
Smoker or ex-smoker	**1.84**	**1.61-2.10**		**2.23**	**1.96-2.53**		Urban to Rural	**0.49**	**0.28-0.86**		**0.53**	**0.28-0.99**
Never smoked (Ref.)	1.00			1.00			Stable (Ref.)	1.00			1.00	
Friendships												
No	**0.55**	**0.39-0.76**		0.97	0.64-1.45							
Yes (Ref.)	1.00			1.00								
Population Density												
Urban	**1.43**	**1.24-1.64**		**1.26**	**1.10-1.45**							
Rural (Ref.)	1.00			1.00								
Level 2 Variance	**Estimate**	**Std. Error**	**Sig.**					**Estimate**	**Std. Error**	**Sig.**			
GOR (random intercept)	**0.111**	**0.055**	**0.043**	0.028	0.019	0.130	GOR	**0.092**	**0.047**	**0.047**	0.020	0.015	0.166
-2 log-likelihood	19463			18396			-2 log-likelihood	19235			18191		

***p* <0.05** OR: Odds Ratio

5.3.4 Binge Drinking at Wave 5 only or Wave 2 only and Association with Transitions in Predictor Variables (RQ4)

Table 5.6 shows the multilevel logistic regression model for binge drinking in wave 5 only, compared to non-binge drinkers in both waves, controlling for GOR. The outcomes of this model suggest which individual factors may be associated with initiating binge drinking as these drinkers did not binge drink in wave 2. Similar to other models described so far, initiating binge drinking was negatively associated with age in both sexes (Age 65-69 years OR Men 0.47, Women 0.58), having no children in the household for women only (OR 1.25[1.03-1.52]) and a borderline negative association with degree education in men (OR 0.70[0.48-0.99]). Being a smoker or ex-smoker was positively associated with initiation in women (OR 1.45[1.23-1.71]) but borderline significant in men. Whilst not being religious was positively associated with initiating binge drinking in men (OR 1.21[1.02-1.43]), there was no association found in women despite associations found for women and religious association in all previous models. A novel association was found for employment status with initiating binge drinking associated with retirement status in men (OR 1.36[1.05-1.77]) despite there being no association with employment status in men in all former models.

Table 5.6 also shows the multilevel logistic regression model showing the opposite outcome to the wave 5 binge drinking initiation model. Model 2 suggests which factors are associated with binge drinking in wave 2 only, and therefore not wave 5 (cessation), compared to those who continued to binge drink in both wave 2 and 5. Factors associated with a cessation in binge drinking agree with results from former models including a negative association with smoking in both sexes (OR Men 0.78, Women 0.81), the highest income quintile in both sexes (OR Men 0.66, Women 0.63) (a result found in the consistent binge drinking model), and a positive association with no friends in men (OR 1.73[1.13-2.63]). Differences in outcomes by sex were found for urban residence in men but not women (OR 0.61[0.51-0.73]), oldest age in women but not men (OR 1.55[1.05-2.30]), and non-religious association in women but not men (OR 0.75[0.64-0.90]) despite a relationship with being non-religious found in men in the wave 5 initiation model.

Table 5.6 Multilevel logistic regression for factors associated with initiation of binge drinking in wave 5 or cessation of binge drinking in wave 5, by sex.

Binge Drinking Direction	**Binge drinking in Wave 5 only vs. No Binge drinking (Initiation of Binge Drinking) Model 1**				**Binge drinking in wave 2 only vs. Binge drinking in both waves (Cessation of Binge Drinking) Model 2**			
	Men (8+ units)		**Women (6+ units)**		**Men (8+ units)**		**Women (6+ units)**	
Level 1 Fixed Effects	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Intercept	**0.46**	**0.28-0.77**	**0.52**	**0.35-0.79**	0.63	0.39-1.01	**0.41**	**0.26-0.64**
Wave 5 (Ref. Wave 2)	**1.07**	**1.01-1.13**	1.09	0.93-1.29	0.95	0.80-1.13	0.90	0.76-1.07
Age								
65-69	**0.47**	**0.32-0.68**	**0.58**	**0.39-0.85**	1.39	0.96-2.02	**1.55**	**1.05-2.30**
60-64	**0.57**	**0.42-0.78**	**0.64**	**0.46-0.87**	0.90	0.67-1.22	1.27	0.92-1.75
55-59	**0.73**	**0.55-0.97**	**0.72**	**0.55-0.94**	0.88	0.67-1.16	1.32	0.995-1.74
50-54	1.01	0.77-1.33	0.90	0.70-1.16	0.87	0.67-1.12	1.21	0.94-1.58
45-49 (Ref.)	1.00		1.00		1.00		1.00	
Ethnicity								
Other	0.72	0.51-1.004	0.72	0.51-1.01	1.10	0.77-1.56	1.11	0.78-1.57
White British (Ref.)	1.00		1.00		1.00		1.00	
Marital Status								
Single	1.25	0.93-1.69	0.76	0.56-1.03	1.33	0.997-1.78	0.95	0.70-1.28
Living as a couple	1.10	0.82-1.47	1.04	0.79-1.38	1.22	0.95-1.58	1.25	0.96-1.63
Divorced	1.31	0.91-1.90	0.89	0.69-1.16	1.02	0.73-1.43	1.01	0.78-1.31
Married (Ref.)	1.00		1.00		1.00		1.00	
Number of children								
None	1.11	0.90-1.36	**1.25**	**1.03-1.52**	1.04	0.85-1.27	1.13	0.93-1.37
1+ (Ref.)	1.00		1.00		1.00		1.00	
Belong to religion								
No	**1.21**	**1.02-1.43**	1.05	0.89-1.24	0.98	0.82-1.16	**0.75**	**0.64-0.90**
Yes (Ref.)	1.00		1.00		1.00		1.00	
Employment status								
Other	1.00	0.64-1.56	**0.66**	**0.47-0.93**	1.16	0.77-1.74	1.17	0.85-1.61
Retired	**1.36**	**1.05-1.77**	0.83	0.63-1.07	0.97	0.74-1.26	1.28	0.98-1.67
Employed (Ref.)	1.00		1.00		1.00		1.00	

Binge Drinking Direction	**Binge drinking in Wave 5 only vs. No Binge drinking (Initiation of Binge Drinking) Model 1**						**Binge drinking in wave 2 only vs. Binge drinking in both waves (Cessation of Binge Drinking) Model 2**					
	Men (8+ units)			**Women (6+ units)**			**Men (8+ units)**			**Women (6+ units)**		
Level 1 Fixed Effects	**OR**	**95% CI**		**OR**	**95% CI**		**OR**	**95% CI**		**OR**	**95% CI**	
(Continued from previous page)												
Net income (monthly)												
>£2386	1.27	0.93-1.75		1.06	0.78-1.44		**0.66**	**0.49-0.90**		**0.63**	**0.46-0.87**	
1665-2386	0.98	0.71-1.34		1.13	0.85-1.49		0.80	0.60-1.08		0.84	0.63-1.11	
1188-1664	1.09	0.79-1.49		1.02	0.79-1.31		0.86	0.64-1.15		0.86	0.67-1.12	
751-1187	1.09	0.78-1.53		1.00	0.79-1.26		0.84	0.62-1.15		**0.71**	**0.56-0.91**	
<=750 (Ref.)	1.00			1.00			1.00			1.00		
Highest qualification												
Degree	**0.70**	**0.48-0.999**		0.75	0.54-1.04		1.05	0.76-1.44		0.98	0.69-1.38	
Secondary	0.81	0.57-1.15		0.86	0.63-1.18		0.80	0.59-1.08		1.11	0.81-1.53	
None (Ref.)	1.00			1.00			1.00			1.00		
Health status												
Limiting illness	0.90	0.75-1.08		0.96	0.81-1.14		1.02	0.86-1.23		0.95	0.79-1.13	
None (Ref.)	1.00			1.00			1.00			1.00		
Smoking status												
Smoker or ex-smoker	1.19	1.000-1.41		**1.45**	**1.23-1.71**		**0.78**	**0.65-0.93**		**0.81**	**0.68-0.96**	
Never smoked (Ref.)	1.00			1.00			1.00			1.00		
Friendships												
No	0.96	0.64-1.44		0.62	0.34-1.13		**1.73**	**1.13-2.63**		0.92	0.54-1.58	
Yes (Ref.)	1.00			1.00			1.00			1.00		
Population Density												
Urban	1.18	0.98-1.41		1.17	0.99-1.39		**0.61**	**0.51-0.73**		0.92	0.77-1.11	
Rural (Ref.)	1.00			1.00				1.00				
Level 2 Variance	**Estimate**	**Std Error**	**Sig.**				**Estimate**	**Std Error**	**Sig.**			
GOR (Random intercept)	0.014	0.013	0.298	No estimate	-	-	0.039	0.029	0.181	0.038	0.024	0.113
-2 log-likelihood	11964			12899			15452			13846		

***p* <0.05** OR: Odds Ratio

The final set of models in Table 5.7 examines the association of a change in binge drinking status and a change in predictor variable status between waves 2 and 5. The outcomes of this model suggest how changes in factors across waves may be associated with the initiation or cessation of binge drinking at follow-up. The causality cannot be proven as it is unknown if the change in status led to a change in drinking or a change in drinking led to a change in status. The sample size for changes in both binge drinking and changes in individual-level factors was small and possibly underpowered particularly for marital status change (n=94), entering employment (n=37), gaining a child (n=30), gaining qualification (n=37), any friendship change (n=54), any urban change (n=43) and starting smoking (n=54).

Entering a relationship was associated with the initiation of binge drinking in men (OR 1.89[1.03-3.46]) with a wide confidence interval but this relationship was also found in the transition model for consistent binge drinkers. Unlike any former models, a change in child status in both directions was negatively associated with the initiation of binge drinking in men (changing to no children in household OR 0.67, gaining children 0.47). This relationship was also found in women but only for a change to no children in the household (OR 0.68[0.50-0.92]), which contrasts with former models showing no children in the household being associated with binge drinking in women. When considering the cessation of binge drinking in the second model of Table 5.7, both gaining (OR 1.83[1.05-3.21] and changing to no children in the household (OR 1.41[1.05-1.88]) were associated with cessation in men only.

The cessation of binge drinking (binge drinking in wave 2) was associated with becoming a non-smoker in women (OR 1.89[1.34-3.67]) and a change to no reported friends in men (OR 1.73[1.09-2.74]) which are relationships observed in the consistent binge drinking transitions model. Novel socioeconomic changes were found in this model for women with a change to retirement associated with cessation (OR 1.38[1.06-1.79]), which was also observed in the consistent binge drinking model. An increase in income in women was positively associated with a cessation in binge drinking (Highest quintile OR 1.25[1.01-1.56]) which contrasts with the positive relationship of higher income and binge drinking in women in former models.

Table 5.7 Multilevel logistic regression for transitions in factors associated with the initiation of binge drinking in wave 5 or cessation of binge drinking in wave 5, by sex.

	Binge Drinking Direction Transitions							
	Binge drinking in Wave 5 only vs. No Binge drinking (Initiation of Binge Drinking) Model 1				**Binge drinking in wave 2 only vs. Binge drinking in both waves (Cessation of Binge Drinking) Model 2**			
	Men (8+ units)		**Women (6+ units)**		**Men (8+ units)**		**Women (6+ units)**	
Level 1 Fixed Effects	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Adjusted for age, wave, and ethnicity								
Marital status								
Single to other	**1.89**	**1.03-3.46**	0.91	0.51-1.61	0.68	0.41-1.14	0.97	0.60-1.56
Relationship to other	1.33	0.78-2.30	0.88	0.55-1.40	0.65	0.38-1.10	1.16	0.77-1.74
Stable (Ref.)	1.00		1.00		1.00		1.00	
Number of children								
1+ to none	**0.67**	**0.48-0.93**	**0.68**	**0.50-0.92**	**1.41**	**1.05-1.88**	1.11	0.83-1.48
None to 1+	**0.47**	**0.23-0.95**	1.20	0.61-2.35	**1.83**	**1.05-3.21**	1.10	0.61-2.00
Stable (Ref.)	1.00		1.00		1.00		1.00	
Belong to religion								
Became religious	0.82	0.58-1.15	1.19	0.82-1.73	0.77	0.55-1.07	0.93	0.66-1.31
Became non-religious	1.28	0.91-1.79	1.35	0.95-1.90	0.84	0.57-1.24	0.98	0.68-1.42
Stable (Ref.)	1.00		1.00		1.00		1.00	
Employment status								
To Retirement	1.24	0.96-1.62	1.07	0.82-1.40	0.87	0.66-1.16	**1.38**	**1.06-1.79**
To Employment	1.52	0.85-2.70	0.81	0.52-1.26	0.58	0.24-1.39	0.83	0.48-1.44
Stable (Ref.)	1.00		1.00		1.00		1.00	
Net Income (month)								
Gained income	0.86	0.70-1.06	1.10	0.88-1.37	0.94	0.76-1.17	**1.25**	**1.01-1.56**
Lost income	0.80	0.61-1.04	0.98	0.77-1.25	1.16	0.89-1.49	0.98	0.77-1.25
Stable (Ref.)	1.00		1.00		1.00		1.00	

	Binge Drinking Direction Transitions											
	Binge drinking in Wave 5 only vs. No Binge drinking (Initiation of Binge Drinking) Model 1						Binge drinking in wave 2 only vs. Binge drinking in both waves (Cessation of Binge Drinking) Model 2					
	Men (8+ units)			Women (6+ units)			Men (8+ units)			Women (6+ units)		
Level 1 Fixed Effects	**OR**	**95% CI**		**OR**	**95% CI**		**OR**	**95% CI**		**OR**	**95% CI**	
(Continued from previous page)												
Highest qualification												
Gained qualification	1.36	0.75-2.48		1.03	0.61-1.75		0.74	0.41-1.33		1.42	0.82-2.49	
Stable (Ref.)	1.00			1.00			1.00			1.00		
Health status												
Gained health problem	1.10	0.85-1.44		0.98	0.75-1.28		1.06	0.82-1.37		1.16	0.89-1.50	
Lost health problem	0.94	0.71-1.24		1.20	0.93-1.54		0.91	0.70-1.18		1.29	1.000-1.65	
Stable (Ref.)	1.00			1.00			1.00			1.00		
Smoking status												
Non-smoker to smoker	0.90	0.59-1.39		1.11	0.68-1.79		0.97	0.60-1.58		1.06	0.68-1.66	
Smoker to non-smoker	1.19	0.85-1.67		0.98	0.70-1.37		1.05	0.74-1.49		**1.89**	**1.34-2.67**	
Stable (Ref.)	1.00			1.00			1.00			1.00		
Friendships												
Friends to no friends	0.67	0.42-1.07		0.53	0.24-1.16		**1.73**	**1.09-2.74**		0.90	0.48-1.69	
No friends to friends	0.91	0.48-1.72		0.49	0.20-1.20		0.46	0.19-1.09		1.00	0.44-2.26	
Stable (Ref.)	1.00			1.00			1.00			1.00		
Population density												
Rural to Urban	**0.19**	**0.04-0.84**		0.64	0.21-1.97		1.13	0.50-2.55		**0.23**	**0.05-0.98**	
Urban to Rural	0.70	0.35-1.39		**2.09**	**1.22-3.58**		1.76	0.86-3.62		**3.20**	**1.57-6.51**	
Stable (Ref.)	1.00			1.00			1.00			1.00		
Level 2 Variance	**Estimate**	**Std. Error**	**Sig.**				**Estimate**	**Std. Error**	**Sig.**			
GOR (Random intercept)	0.015	0.014	0.268	No est.	-	-	0.022	0.020	0.274	0.033	0.022	0.125
-2 log-likelihood	11949			12863			15350			13817		

***p* <0.05** OR: Odds Ratio

5.4 Discussion

This study considered how demographic, socioeconomic and co-risk factors, and changes in such factors, across two waves of a longitudinal panel survey, were associated with binge drinking patterns in middle-aged men and women in the UK. This study was novel in that it showed how individual binge drinking patterns can be inconsistent across waves compared to what can be revealed through cross-sectional data and accounted for the clustering of individuals within GOR and repeated measures (99). It showed that associations with transitions may occur when no relationship is found for a stable status. For example, entering employment in women was negatively associated with maintaining binge drinking but there was no association with employment status in the main model. A relationship with a change in status in one direction is not necessarily associated with a change in the opposite direction. For example, only moving to a rural area was negatively associated with binge drinking but no association was found with moving to an urban area despite associations with stable urban status. However, most statistically significant associations with transitions were in the expected direction for binge drinking associated with their stable characteristic.

For individuals with two waves of data, 40% were binge drinkers in both waves whilst 27% of this sample engaged in binge drinking in only one wave. This study provided further evidence for the association of individual-level factors with binge drinking in middle-age across two waves of panel data (RQ1) that were selected to be comparable with the binge drinking outcomes in the cross-sectional analysis of study 1 (RQ2). The availability of repeated measures extended study 1 by considering associations and transitions in predictor variables with maintaining binge drinking across two waves (RQ3) and associations and transitions of variables with binge drinking in only one of these waves (RQ4). Due to the interlinked nature of these research questions on the associations tested, this discussion will consider these questions for each variable in turn to improve overall interpretation.

For the main outcome, binge drinking, men were more likely to be binge drinkers and binge drink in both waves compared to women, which is consistent with study 1 and the literature (94, 96). Cross-sectionally, the percentage of binge drinkers by survey wave was higher than the outcomes reported for the same years in study 1 (28.5% vs 51.9% for men, 20.0% vs 46.5% in women, 2011 HSE data compared to wave 2). The potential reasons for this are considered in the limitations section of this discussion as this may be the result of factors such as attrition bias, sampling frame or questionnaire administration.

Binge drinking declined with age in both sexes, as found in study 1, and increasing age was negatively associated with initiating binge drinking in both sexes. Adults aged 65-69 years were half as likely to be binge drinkers compared to those age 45-49 years, as has been described in the literature (93, 124). However, there was no difference by age for the cessation of binge drinking in men. Although ethnic minorities were less likely to binge drink in both sexes in the full sample, as found in study 1 and the literature (218), there was no statistically significant difference by ethnicity in most two wave models, except consistent binge drinking men, but this may be a result of attrition bias.

A divorced or cohabiting marital status were both associated with binge drinking risk in men but not women. This was despite an association with both marital statuses found in women for binge drinking in study 1, but only divorce in men. However, there was no association of marital status with the initiation or cessation of binge drinking in both sexes. Marital status is one of the few factors that was not consistent across study 1 and 2 for binge drinking. The lack of consistency does not appear to be due to measurement differences as the same categories were available in both surveys and combined in the same way, except for a lack of civil partnerships before 2004 but these numbers were small. Change in marital status in both relationship directions across waves increased the risk of maintaining binge drinking in men but not women. Entering a relationship was also associated with the initiation of binge drinking in men but not women. In the literature entering a relationship was associated with higher units consumed in the past week in the ELSA cohort but only in men (101). This suggests the relationship between marital status and binge drinking remains complex by direction but may have a stronger association in men.

Having no children in the household was associated with an increased risk of binge drinking in the main model and initiation of binge drinking but only in women. A change in child status was not associated with maintaining binge drinking in either sex. Problem drinking in ELSA was negatively associated with having children in the household, but this outcome was also found only in women (256). However, changes in child status were negatively associated with initiation and positively associated with cessation of binge drinking in men. This suggests that fathers may be more likely to have short term reductions in binge drinking following changes in family structure compared to a long-term care role of traditional mothers (288, 505). However, a relationship with binge drinking and children in the household was not found in study 1. Having no religious association was found to increase the risk of binge drinking in both sexes, an initiation of binge drinking in men and negatively associated with cessation in women. This is a novel outcome for this study as an indicator of both personal attitudes and wider community

norms on drinking (311), although no association with considering religion important was found for problem drinking in ELSA (256).

Moving onto socioeconomic factors, there was no association of binge drinking with employment status in both sexes which is also consistent with study 1. However, in the consistent binge drinking model there was a negative association with retirement in women. A transition to retirement was also associated with a cessation in binge drinking in women but not men. In the literature, a transition to retirement was associated with a reduction in units consumed in ELSA for both sexes (101). However, retirement was associated with the initiation of binge drinking in men only. This outcome was also found in the Irish Longitudinal Study of Ageing (TILDA) cohort (478). In the opposite direction, a transition to employment was negatively associated with maintaining binge drinking in women but not men. In the literature, this transition was associated with a reduction in units consumed in women in the NCDS cohort in the short term (283). This suggests that women may be more sensitive to employment factors with binge drinking compared to men.

In the full sample model, a higher net income gradient was associated with binge drinking in women only. However, the highest income quintile was associated with consistent binge drinking in both sexes. The highest income quintile was also negatively associated with a cessation of binge drinking in both sexes. However, a change in income amount was not associated with maintaining binge drinking. These results are similar to study 1 in which women may have a stronger association with income than men for binge drinking in this age group. For education and as in study 1, binge drinking and initiation of binge drinking were negatively associated with degree education in men but no association with education was found for women across all models. There was no association of maintaining binge drinking with gaining a qualification, although this may have been underpowered from a small sample size. There may be no immediate effect from educational gain if this better reflects lifecourse socioeconomic outcomes (506).

Smoking was strongly associated with binge drinking and included consistent binge drinking in both sexes, an initiation of binge drinking in women and negatively associated with cessation in both sexes. Becoming a non-smoker was also negatively associated with maintaining binge drinking in women and positively associated with cessation of binge drinking in women but not men. These outcomes suggest that smoking has a role in both maintaining binge drinking and reducing the likelihood of not binge drinking. Transitions in smoker status with drinking

behaviours have not been previously analysed in middle-aged cohorts from UK studies, although the association between the two behaviours is recognised (258, 260).

For community factors, reporting having friends was associated with increased binge drinking risk in men only. A change to no reported friendships was negatively associated with maintaining binge drinking and both having no friends and a change to having no friends were positively associated with cessation in men only (but no relationship with initiation). These outcomes reaffirm the sensitivity of men to relationship changes as found for marital status, with friendships involved in both maintenance and change in binge drinking behaviours. This is a novel outcome for this study that agrees with the qualitative literature that men use drinking as a social tool (117, 118). Heavier drinking occasions have been reported when friends are present and fewer friends seen as protective in men (100, 130), whilst women may be more likely to drink for relaxation and self-care purposes in midlife (119, 120). Living in an urban area, compared to rural, was associated with binge drinking in both men and women and negatively associated with cessation in men. Moving to a rural area was negatively associated with maintaining binge drinking in both sexes although there was no association with maintenance and moving to an urban area. This is a novel outcome for this study and has not been investigated in the literature for middle-aged adults but suggests that urban areas may have different resources, such as transport links (507), or social attributes associated with binge drinking behaviours in the long term (see Chapter 2.4.3). Urban is not indicative of residential quality and is a broad measure of population density (508).

There was small but statistically significant variance across GOR residence found for male binge drinkers in the full sample and consistent binge drinking models. This suggested that aspects of North East and West England as regions are associated with binge drinking behaviour in this age group for men independently of their individual-level characteristics, agreeing with previous literature using all adult ages (296-298). However, an independent association with GOR was not found in study 1. The higher levels of binge drinking in Scotland and Northern Ireland, indicated in the descriptive statistics, may have contributed to the association found in this study as study 1 only used an English population.

5.4.1 Strengths, Limitations and Further Research

This study extended study 1 and addressed the gap in the research for understanding how individual-level factors, including novel community indicators, and transitions in such factors over time may be associated with patterns of binge drinking engagement in men and women

aged 45-69 years. This study used two waves of a repeated measures panel survey, with a random stratified sampling design in wave 1, which allowed for the analysis of change within the same individuals at three years follow up. Few studies of binge drinking have utilised panel data, which has an advantage over birth cohort data for analysing behaviour changes due to its more regular survey frequency (93). The outcome was a measure of binge drinking using the same reference period as study 1 (drinkers of the previous week) and threshold that is consistent with other current health surveys to enable comparisons (190). Except for the measure of income, variables in this dataset were measured similarly to study 1 which allowed for the creation of similar categories for comparisons in outcomes across both studies. USoc contains data from across the UK to provide further insights compared to the English focus of study 1.

Multilevel modelling was used to consider the independence of GOR to individual characteristics but also used to account for the clustering of repeated measures in individuals and the correlation of such measures in the full sample model (Table 5.4) (500). This allowed for the inclusion of participants with only one wave of data into this model and therefore test associations with binge drinking using a much larger and consistent sample size across waves (n 12,737) and therefore statistical power (447). This model was not able to consider moving to a new GOR residence between waves at level 3 (see 6.4.1 for more information) but this involved only a small number of individuals in this sample.

Only 5,989 individuals responded with drinking in both waves which limited sample size when considering changes in binge drinking behaviours with sex stratification. This also applied to models considering transitions in status which may have been underpowered for factors such as re-entering employment or gaining a qualification for this age group. To increase sample size, transitions were combined into broader categories that inhibited analysis of more specific status changes. The difference in associations with consistent binge drinking compared to the full sample model may be due to lower statistical power or sample bias towards those with responses in both waves as regular drinkers. This study treated a change in binge drinking between the two waves as a potential change in the decision to engage in the behaviour, however the intra-person stability of drinking behaviours can be irregular (99). Therefore, the consideration of drinkers who binged in both waves or one wave may be coincidental as the frequency of binge drinking is not measured in this dataset that would give a better indication of the regularity of binge drinking. It is therefore unclear if there is a difference between the characteristics of regular and less frequent binge drinkers (509).

The association of a change in status between waves was assessed with binge drinking within the same follow-up wave and therefore it is unclear which behaviour may have initiated the change within the three years. The limitations in maintaining a sample of drinking responders across waves (as the intakes of less than weekly drinkers were not reported) prevented the application of a wave-lagged model that is more suitable at observing the order of events and follow up changes in behaviour (510). However, the appropriate follow-up times required for binge drinking behaviours in response to a change in the variables tested are unknown and may occur within the same wave, for example with a relationship change (287), or may take several years to develop as part of long-term socioeconomic trajectories (511, 512). Therefore, a lagged model may not infer an advantage to detect such changes (513).

The percentage of binge drinkers in this sample was higher than found in study 1, although there are no other cohort studies of middle-aged adults using the 8/6+ threshold to compare with. This is despite using the same binge drinking threshold and sampling frame as used for the HSE (45-69 aged drinkers of the previous week of the survey). Outcomes from other cross-sectional health surveys in the UK do not indicate that the inclusion of participants from Northern Ireland, Scotland or Wales would create such an increase (96, 150), although binge drinking in these countries was descriptively higher than most English GOR in this study. Comparing the sample characteristic percentages of this study to those of the HSE in study 1 (period 2 2011-2015), most predictors were within 10%. Exceptions were for having no qualifications (22% in HSE period 2 vs 11% in USoc wave 5) and never smokers (47% in HSE period 2 vs 35% in wave 5), with education and smoking found to have statistically significant binge drinking associations in both studies. As both studies analysed data without using weights for population representation, measurement of the percentage of binge drinkers in the two cohorts may not be as comparable (443, 514).

A possible cause for the high percentage of binge drinkers may be due to study attrition and the drinking sampling frame of the previous week creating, a sample biased towards more regular drinkers. Frequent drinkers have been shown to also be more likely to be binge drinkers (515). Single wave responders were more likely to be ethnic minorities or those of low income which are associated with a lower risk of binge drinking in study 1 and 2 of this thesis, non-drinking in the literature (213, 218) and known characteristics of non-response attrition in USoc reports (403). Therefore, the increase in binge drinking from wave 2 to 5 may be due to this attrition bias as binge drinking was comparably stable for the same period in study 1. A high percentage of abstainers were also found in the non-responding sample of a Netherlands drinking survey (516).

Another issue is that USoc does not include an option for serving sizes in its questions on drink types and therefore an average serving size is assumed, which may have caused an overestimation of units in this sample. The use of a self-completion booklet instead of an in-person interview may have led to misinterpretation of the question "on the day you drank the most" as it does not make it clear if this is for all drinks in total or for each specific drink type requested. This could lead to multiple drink types being drunk on different days as being reported as consumed on the same day and therefore over-reporting. The self-completion section was slightly more prone to non-response compared to the interview component in USoc reports (517). Alternatively, in-person interviewing in the HSE may have led to under-reporting in study 1 due to social desirability bias which is more likely to occur with riskier drinking patterns such as binge drinking (431).

Binge drinking was found to be driven more by social processes in men than for women in this study. Only men had associations with binge drinking in response to transitions in personal relationships, entering retirement and long-term marital status and friendships. It is unclear if this was due to factors such as differences in resulting financial circumstances, changes in social groups, responsibilities, or different subjective coping responses which could be explored in further research (116, 518-520). Such explorations would also help explain why retirement may be a sensitive period for exceeding the guidelines in both sexes in study 1, rather than simply due to changes in income source (135, 278). For example, a temporary relationship between risk drinking (>24/16 units) and retirement was found in Finland only when there was workplace stress or forced retirement (281). Subjective relationships with drinking could be explored using the DMQ-R[22], which covers topics of enhancement, coping, conformity and social motivations using Likert scales that were not available in the surveys used in this thesis (521).

This study contributes to the research into understanding middle-aged risk alcohol consumption by discovering further novel associations, including transitions, with binge drinking patterns over time. This study supported the outcomes of study 1 by finding a statistically significant association of higher net income quintiles with binge drinking in middle-aged women. Men and women in the highest gross income quintile were also more likely to exceed the weekly alcohol guidelines in study 1, suggesting that higher purchasing power may be a risk factor for higher alcohol consumption. However, the association with income and actual expenditure on alcohol in middle-age is unknown. Additionally, study 1 indicated that the association of income with

[22] Drinking Motives Questionnaire (revised), 20 item survey validated for older adults (521).

weekly alcohol risk may be decreasing which may have a relationship with the known rising affordability of alcohol over time. These issues are explored in the next chapter that presents study 3 using alcohol expenditure from seven waves of panel data in middle-aged headed households.

Chapter 6 Study 3: The association of income and household composition on middle-aged alcohol expenditure: multilevel longitudinal analysis of UK panel data

This chapter describes the third and final study of this thesis using seven waves of longitudinal panel data from the Understanding Society (USoc) cohort. This study aims to address the research gap posed by the fifth and final objective identified by the literature review in Chapter 2.6.1: To explore how household-level income and composition in middle-age are associated with alcohol expenditure and whether alcohol affordability has increased in this population over time. It does this by considering associations with household-level expenditure on alcohol in households headed by middle-aged individuals (45-69 years) over survey waves. The outcomes of this study also support research objective 2 by providing further contextual evidence for the role of income on the availability of alcohol over time.

6.1 Background

The financial ability of the household to purchase alcohol (purchasing power) increases its availability which provides greater opportunity for consumption. Therefore, a higher income has been associated with a greater household expenditure on alcohol in a UK analysis using all ages (437). An analysis of the Expenditure and Food Survey (EFS) 2006/08 using all ages, for which both expenditure and alcohol volume were available, found that the highest income quintile purchased the most number of units on average (360). This suggests that higher purchasing power may be a risk factor for greater alcohol consumption, supporting the outcomes of study 1 that found men and women in higher gross income quintiles were more likely to exceed the former weekly alcohol guidelines (21/14 units) and engage in binge drinking. Greater purchasing power may also increase access to situations that encourage alcohol use, such as social events and vacations (144). Descriptive trends from the Living Cost and Food Survey (LCFS) suggested that until 2013, households with an HRP (household representative person) aged 50-64 years were the highest spenders on alcohol, which has been taken over by rising expenditures in those aged 65-74 years (see Chapter 2.5.3) (352). However, no empirical analysis has been performed to understand the relationship between income and expenditure on alcohol specifically in

middle-age. This would provide an alternative aspect to understanding the characteristics of alcohol demand in this age group.

These outcomes also support research into the application of pricing and taxation policies that rely on a reduction of affordability (as a function of price and income) to reduce population levels of alcohol intake (320, 348). Such policies may only function if a reduction in affordability is maintained in response to macro-level changes in economic conditions (479, 522). Recent freezes on alcohol duty (since 2017) and the removal of the duty escalator (2% above inflation) in 2013 have contributed to the debate that alcohol has become too affordable over time in the UK (105, 174). Study 1 suggested that the association of higher income with exceeding the weekly guidelines had reduced between the early 2000s and early 2010s. This reduced association may relate to the rise in household disposable incomes exceeding the stable inflation-adjusted alcohol prices since the 2008 recession, and therefore reducing the relevance of income to alcohol availability (98, 343). However, as affordability is constructed using population-level statistics, it is unclear how the proportion of household income spent on alcohol in middle-aged drinkers has changed since the recession (341).

Price elasticity studies suggest that different drinking contexts can change how much individuals are willing to spend on alcohol, including the type of beverage, place of purchase (on-or off-trade) (354, 523) and desired volume, including for binge alcohol use (356-358). Women may be more price responsive than men, possibly due to greater biological sensitivity to alcohol and therefore lower demand (350). A United States study suggested that health, employment status, education and income may be important factors in determining alcohol demand in adults over 50 years (524, 525). There has been no analysis to understand how household composition is associated with alcohol expenditure in middle-age and how this might modify the relationship with income in the UK. This limits our understanding of the demand for alcohol in different subgroups of this age group (321).

Data from the LCFS suggested that descriptively, past week household expenditure on alcohol varies by Government Office Region (GOR) with the highest three-year average spend for all ages found in the North West of England and lowest in London (2015/17 data) (352). However, this difference has not been tested empirically considering just the middle-aged population and adjusted for household composition factors. Such outcomes may support insights into regional contexts for expenditure in this age group that cannot be obtained from retail data (234). Price differences for alcohol across GOR are not expected to vary more than 3% from the UK average (526).

The observed change in the association of income quintile with exceeding the weekly guidelines between survey periods in study 1, suggested that changes in the association of factors with household alcohol expenditure over survey waves should be tested. This would indicate any period change in associations with expenditure in middle-aged households to population-level events such as the post-recession observed increase in household disposable incomes over time (343) or a regional impact of the Scottish Alcohol Act in 2011 (340).

Therefore, research gaps identified a lack of age-specific research into understanding alcohol expenditure, an issue related to alcohol accessibility, in the middle-aged population. This includes a lack of investigation into the relationship of income and affordability trends over time, and the associated household and regional characteristics with expenditure. The following study-specific research questions (RQ) were developed to address such research gaps:

1) How is household income associated with alcohol expenditure in middle-aged adults?
2) How has household expenditure on alcohol changed over time? What is the relationship to income over time?
3) What household composition factors are associated with more or less expenditure on alcohol?
4) Is household expenditure on alcohol associated with residing in a particular GOR in the UK?
5) Has the association of household composition factors or GOR residence with expenditure changed over time?

The third study of this thesis addressed these research gaps by exploring alcohol expenditure in middle-aged headed households over seven waves of longitudinal data from USoc for the years 2009/10 to 2015/16. It considered how alcohol expenditure varied by income groups descriptively and linearly within a multilevel model that accounted for the correlation of repeated measures of the same individuals (RQ1). The change in alcohol expenditure over the seven waves was similarly considered descriptively and within a multilevel model including household income (RQ2). The association of various household level composition factors that considered demographics and sources of income with expenditure on alcohol were considered within the same multilevel model (RQ3). The association with GOR residence was considered as a fixed effect in this model (RQ4). The interaction of household variables with survey wave, including GOR residence, was used to assess if the association of such factors had changed over the study period (RQ5).

6.2 Methods

6.2.1 Study Population and Design

This study uses data from waves 1 (year 2009/10) to 7 (2015/16) of USoc, also known as the UK Household Longitudinal Study, for households headed by adults aged between 45-69 years. The 2009-2015 period covered by these seven waves had relevant macro-level contexts to the study's RQs into expenditure trends from being post-recession and a time of changing alcohol duty policies, as explored in Chapter 2.5.2 (343). USoc is a longitudinal panel survey using a random stratified sample of adults living across all nations of the UK, with annual re-surveying of sample members every year, as explored in Chapter 3.5.1 (399). This dataset was chosen for being the only available UK source of data with longitudinal measures of annual household alcohol expenditure whilst also providing a large sample size and coverage of the target age range. A longitudinal analysis provides an advantage over a repeated cross-sectional design for this study by following the same households over time, reducing the random variability of different households and unobserved heterogeneity across waves that may reduce statistical power and outcome validity (481, 527). A household-level analysis has the advantage of taking into account shared accumulation of income, responsibilities and spending contexts which may be imbalanced at an individual level e.g. one member may be the main earner and another the main purchaser of groceries.

6.2.2 Outcome – Expenditure on Alcohol

Previous month alcohol expenditure was available at the household level for every wave currently published. Therefore, this study was restricted to household level associations with the outcome. Alcohol expenditure was surveyed via the question of "*About how much have you and other members of your household spent in total on alcohol in the last four weeks? Please include alcohol purchased from a supermarket or off licence and from pubs, restaurants or other venues."* Unlike alcohol consumption in wave 2 and 5 which is part of a self-completion component, alcohol expenditure is captured as part of the in-person household interview section with the HRP. Households reporting more than £1000 per month were asked a second time by the interviewer as triggered as unusual in the CAPI[23] software (referenced as "soft check" in USoc). Alcohol expenditure was not available for on and off-trade separately.

[23] Computer Assisted Personal Interviewing

6.2.3 Predictor Variables

Predictor variables were considered based on availability at the household level (rather than individual) and relationship to alcohol consumption in the previous two studies and literature review. As not all members of a household are surveyed, it was not possible to aggregate variables at the individual level to the household level. The HRP was used for age and ethnicity where it was assumed that other adult members (>16 years) of the household might share similar characteristics. 90% of the sample were defined as being single person, coupled households or couples with adult sharers who may be related. Variables used in the final model are shown in Table 6.1.

Table 6.1 Description of variables included in the main regression model for study 3.

Outcome	
Alcohol expenditure	Previous month household expenditure on alcohol in £ and pence
Level 1 – Repeated Measures	
Time	Wave number from 1 to 7
Level 2 – Fixed Effects	
Age of the HRP	5 age groups of years for 45-69 years e.g. 45-49
Ethnicity of the HRP	White British (England, Wales, Scotland, Northern Ireland), all other responses.
Number of adults in the household	1 adult per household versus 2+ person households, excluding children.
Children present in the household	1+, None (from count of) aged 15 years and below.
Employed adults in the household	1+, None (from count of) derived from a question on paid employment status. None is a proxy for retirement or unemployment for other reasons (73% of non-employed household HRP are over 60 years).
Largest source of income	Derived from identifying the largest value of income category for each household. Investment income [private pension, rent] including private benefit [accident insurance, alimony etc.], Social Benefit [state pension, disability, child, tax etc.], Labour [including self-employment].
Net household income (linear)	Total of all sources of income (described above) less tax (excluding council tax) in £. Imputation is provided by USoc for individual non-response in this variable resulting in a percentage of imputation at the household level. The mean imputation per household is 20% but can be 100%.
Housing tenure	Owned outright, Mortgage, Rental or other (rent-free, 'other')
Population density	Urban (>10k persons/hectare) or Rural
Government Office Region (GOR)	Nine England Regions + Scotland, Wales, Northern Ireland

6.2.4 Included Cases Across Waves

Households were selected for this study if they responded to at least one wave, starting at any wave of the survey, and the HRP was aged between 45-69 years old. The HRP was defined as the owner or renter of where the household lived and the oldest aged member if multiple owners (442). This resulted in an initial sample of 23,091 households. The main reason for household exclusion was due to non-expenditure on alcohol (n=5,028 households), as shown in Figure 6.1. The loss to Complete Case Analysis (CCA) was low in this study (n=41 households) likely as the HRP interview is the first requirement of household response.

Cases are defined as a single year response of a household and therefore households can have up to seven cases. The number of cases per household in the study depended on whether the household responded for a particular year, whether they included a positive alcohol expenditure response and whether the HRP matched the age criteria in that year (45-69 years) as described below. Due to the ability of multilevel modelling to handle missing wave data, problematic cases rather than entire households were excluded from the dataset.

Alcohol expenditure: Cases with £0 or missing outcomes for alcohol expenditure were excluded as the study focus was on the relationship between income and expenditure rather than spenders and non-spenders (437). The justification for this is similar to the exclusion of abstainers in study 1 and 2 (Chapter 3.8.2), in that the decision not to buy alcohol is motivated by different circumstances than purchases and would need to be accounted for using more complex econometric techniques, which are described in the discussion section of this study (437). Cases for which the household alcohol expenditure exceeded the household income reported were excluded due to unclear circumstances regarding income. The average income of these excluded households was £83.88 for the month yet their mean alcohol expenditure was £176.55 (n=18 households)

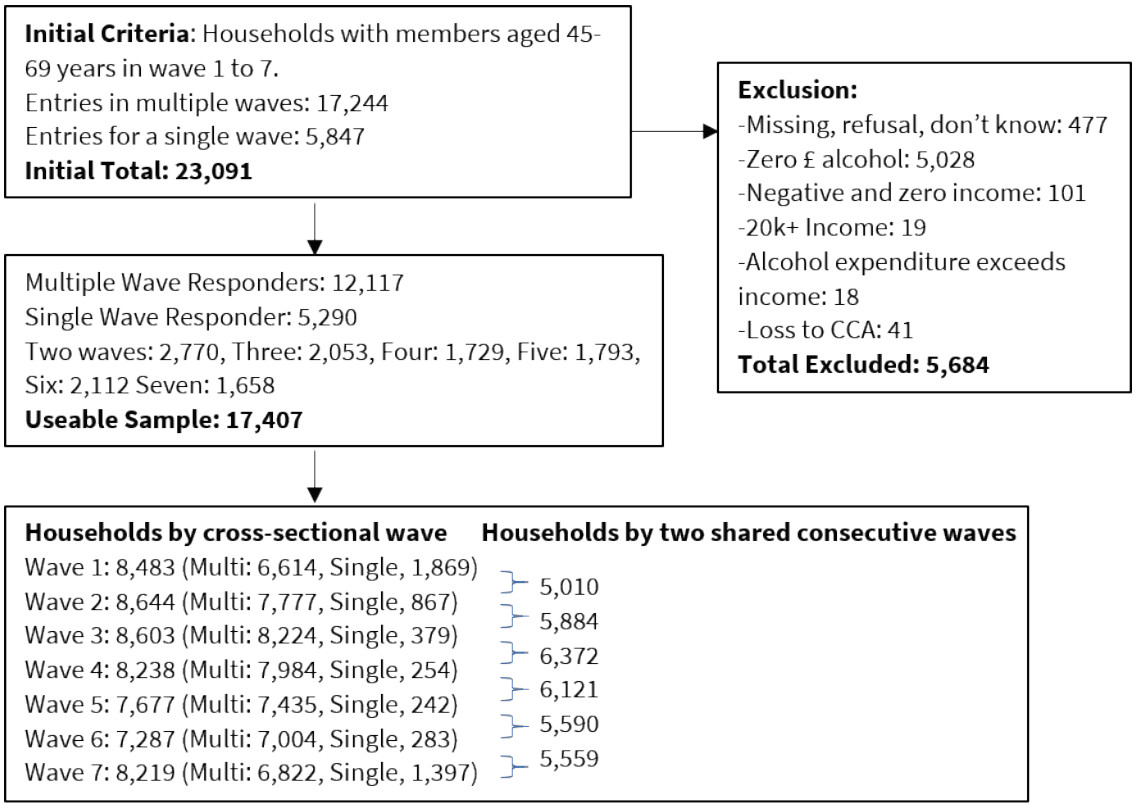
Income: The net household income for the previous month in USoc includes cut-off values at £20,000 and -£20,000 for non-disclosure of households. Cases with these values were excluded as the true income values were unknown for modelling (n=19 households). Negative and £0 incomes were reported as part of negative self-employment, for which income is irregular or seasonal. These cases were excluded due to unclear sources of income to afford alcohol (n=101 households).

Attrition: There were 5,290 households that responded in only one wave compared to multiple waves. These households were more likely to be from wave 1, have an HRP with a minority

ethnicity or HRP in the youngest age group (45-49 years), more likely to live in London, more likely to be renters, of the lowest income group, and have social benefit as the main source of income (chi-square analysis). Therefore attrition was more likely in low-income families of minority background which has been noted in previous attrition reports of the former British Household Panel Study (BHPS) and USoc (403).

The flow of how the final sample was achieved is displayed in Figure 6.1. The final sample size was 17,407 households across seven waves with 1,658 households responding in all seven waves. The increase in households responding to wave 2 relates to the households added from the former BHPS (405). The increase at wave 7 relates to the addition of households from the minority boost sample refreshment and a campaign by USoc to encourage former responders to return to the survey (442). The number of households with responses for more than one wave decreased with the number of waves suggesting an increase in non-response over time. The number of households that responded to two consecutive waves was on average 5,756 households over the seven waves as shown in Figure 6.1.

Figure 6.1 Flow chart for progression to final sample size for study 3. N= Households.



6.2.5 Statistical Analysis

Descriptive statistics were performed to explore the distribution of alcohol expenditure and income groups. Variable proportions at wave 2 and 7 were compared using paired z-test with Bonferroni correction for multiple comparisons (471). Wave 2 was chosen, instead of wave 1, as this wave better represents the sample characteristics over time with the addition of the BHPS at wave 2 and without the attrition loss that occurred in wave 1. Independent variables were checked for multicollinearity using Variance Inflation Factor (VIF), with the final models VIF below 2 as part of regression model assumptions (472). IBM SPSS Statistics version 26.0 was used for all analyses (447). Data were used unweighted to maximise the sample size of the specific target group (Chapter 3.8.3).

Multilevel linear (mixed) regression models were used to explore repeated measures of alcohol expenditure. Alcohol expenditure does not display properties of true continuous data in that it is not feasible for negative expenditure or denominations below one pence. The distribution of the expenditure data was found to be skewed with tails of very high expenditures (Skewness *p*: 0.010). A linear model was chosen to explore the relationship between expenditure and income using expenditure untransformed for the non-normal distribution. This was chosen to provide a model with a more interpretable and useable outcome than would be obtained from using a logarithmic transformation or a more complex analysis method (528). The non-normal distribution of the resulting residuals of the model was then explored to determine the characteristics of cases that poorly matched the model predictions. Model residuals were assessed for normality and Pearson residuals above 3.0 (n cases=902) were assessed for characteristics against the rest of the sample using χ^2 (cross tabs chi-square).

A multilevel Poisson (generalized linear mixed model using log link) analysis with income offset was also considered in Appendix Table 7.3. A Poisson model has some suitability over a linear model for handling the skewed semi-continuous data with discrete values starting from £1. However, this model is limited in its interpretation with an outcome that uses expenditure as a component of income rather than the intended analysis of the direct relationship between income and expenditure and was therefore not explored further in this study.

Models were conducted using multilevel modelling (mixed models) to account for the non-independence of waves in individuals from the longitudinal data format, as described in Chapter 3.9. Wave data were matched to the household representative person id (hrpid). Survey wave was included as a fixed effect to observe if expenditure changed over time compared to wave 1. Each

variable in the fully adjusted model was tested for interaction effects with survey wave as a two-way fixed effect, with only statistically significant results reported (model 5).

A Toeplitz covariance structure was applied at level 1 to account for correlation between responses from repeated measures of the same household (covariance structures were described in the previous study Chapter 5.2.7) (529). Figure 6.2 shows the Toeplitz structure has constant variance (σ^2) and correlation ($\sigma^2\rho$) between adjacent measures that reduces with distance between repeated measures (502). This structure was chosen as the within household variance in spending by year was similar (homogenous) however adjacent years displayed some covariance whilst further apart waves showed less correlation (501, 530). The suitability of this structure was tested against other covariance structures, using the lowest log-likelihood values to assess model fit.

Figure 6.2 Covariance matrix illustrating the Toeplitz structure used to account for wave correlation.

$$\begin{pmatrix} \sigma^2 & \sigma^2\rho_1 & \sigma^2\rho_2 & \sigma^2\rho_3 \\ \sigma^2\rho_1 & \sigma^2 & \sigma^2\rho_1 & \sigma^2\rho_2 \\ \sigma^2\rho_2 & \sigma^2\rho_1 & \sigma^2 & \sigma^2\rho_1 \\ \sigma^2\rho_3 & \sigma^2\rho_2 & \sigma^2\rho_1 & \sigma^2 \end{pmatrix}$$

GOR was not used as a grouping factor in this study (multilevel model level 3) as household movement between GOR over the period of the study would create a time-variant factor that does not create a nested hierarchy. Such households would require classification of at least two GOR in the model, a more complicated modelling process described in the discussion (458), therefore GOR was included as a fixed effect.

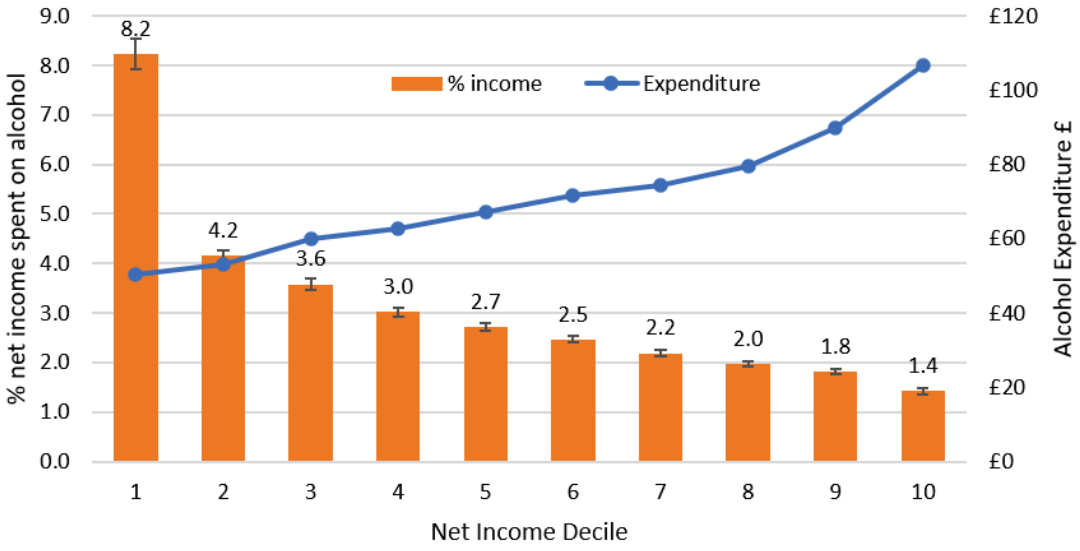
Variables were added in a stepped process to determine the impact of adjustment, building five incremental models considering: 1. demographics, such as age and ethnicity, 2. the addition of proxy indicators of income such as housing tenure, 3. the addition of GOR and urban level as contextual factors, 4. the addition of linear net income in the final adjusted model and 5. wave interactions as previously described. Income was added as the final factor of the fully adjusted model assuming it would have the largest impact on expenditure.

6.3 Results

6.3.1 Descriptive Statistics

Alcohol Expenditure and Income (RQ1): Households within higher income quintiles had higher actual spending on alcohol compared to lower-income quintiles. This ranged from an average of £52 in the lowest quintile to £100 in the highest quintile (Table 6.3) However, higher-income quintiles spent a lower percentage of their income on alcohol with the opposite trend for lower-income households as shown in Figure 6.3. The percentage of net income spent on alcohol within the lowest income decile (8.2%) was double the percentage of the next bottom income decile (4.2%). There were 1,307 cases (23%) within the bottom decile that spent at least 10% of their income on alcohol compared to 516 cases (9%) in the second decile and only 26 cases in the top decile.

Figure 6.3 Mean percentage of disposable income spent on alcohol (95%CI) and alcohol expenditure by household net income decile (previous month of survey).



1=lowest income, average 1-7 waves of USoc.

Alcohol expenditure over time (RQ2): Table 6.2 shows how the average household expenditure on alcohol (for the previous 4 weeks of the survey) increased from an average of £67.57 to £74.86 over waves 1 to 7, corresponding to the years 2009 to 2015. The larger standard deviations in wave 4 and 7 relate to the very high expenditure cases compared to the mean expenditure observed in these years. Whilst there were 16 cases reporting alcohol expenditures above £1000, 83% of cases reported £100 or less for the previous month expenditure. Interviews performed in January reported the highest average expenditure at £81.06 compared to £66.41 in February,

suggesting seasonal patterns (Christmas, New Year). The average net household income increased from £2846.21 to £3528.61 over 7 waves. When calculated as a percentage of net household income, average alcohol expenditure decreased from 3.51% to 2.81% of income over 7 waves. This suggests the increases in net income over survey waves were greater than the small increases in alcohol expenditure observed.

Table 6.2 Descriptive trends for household alcohol expenditure and household net income over 7 waves of USoc.

Year	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Wave	1	2	3	4	5	6	7
Household alcohol expenditure previous month							
Mean £	67.57	68.16	71.06	72.59	74.36	73.11	74.86
Std D.	78.60	80.57	87.20	118.71	86.82	81.75	99.84
Median £	40.00	40.00	50.00	50.00	50.00	50.00	50.00
IQR	60.00	60.00	80.00	80.00	80.00	80.00	80.00
Range £	1 to 1220	1 to 1200	1 to 3000	1 to 7000	1 to 1500	1 to 2000	1 to 5000
Net household income previous month							
Mean £	2846.21	2750.15	3115.61	3170.39	3265.71	3415.09	3528.61
Std D.	2137.23	2075.52	2104.77	2106.87	2115.84	2241.99	2234.09
Median £	2347.79	2282.72	2669.24	2727.42	2846.12	2996.64	3080.98
IQR	2201.16	2022.44	2272.37	2298.01	2377.19	2457.38	2536.88
Range £	9.33 to 19953.20	21.65 to 19980.32	25.00 to 19941.80	8.53 to 19275.93	51.62 to 19151.97	21.08 to 19860.08	20.83 to 19607.71
Household alcohol expenditure as a percentage of income							
Mean %	3.51	3.59	3.11	3.05	3.04	2.94	2.81
Std D.	5.86	6.02	4.71	4.80	4.71	4.86	4.29

Std D: Standard Deviation. IQR: Interquartile range

Household Composition (RQ3): Table 6.3 explores how the sample composition changed between wave 2 and 7 for factors included in a multilevel linear model of alcohol expenditure (Table 6.4). The largest change in variable sample size from wave 2 to 7 was a 5.0% increase in labour income with a 4.3% reduction in social benefit income as the main source. Increases in sample composition over time were also observed for the presence of children (+4.1%) and employed adults (+2.8%). This improvement in the percentage in employment and receiving labour incomes as their largest source likely contributes to the observed increases in income over time, possibly as a recovery from the 2008 recession, but may also be due to sample attrition as considered in this study's discussion section. The small increase in ethnic minorities can be attributed to the refreshment of the ethnic minority boost in wave 7. The most common household characteristics were living in an urban area (71%), having employed persons (74%), multi-adult (77%) and without children (84%) (Table 6.3). The lowest income tertile households (£<2003 previous month) had a higher percentage of single-person, non-employed, social benefit as the main income source, and rental characteristics compared to the two higher tertiles. Income was not found to vary by ethnicity in this study sample.

GOR (RQ4): The North East England region had both the highest average alcohol expenditure at £81.90 (Table 6.3) and the highest percentage of income spent on alcohol at 4.1% on average. When plotted over quintiles of household net income, mean alcohol expenditure for the North East was highest compared to other GOR for the first three quintiles only (lower income). The South East region showed a comparatively high alcohol expenditure (average £77.25) despite the percentage of income spent at 2.9%, likely reflecting the higher incomes of this region compared to the North of England.

Change with factors over time (RQ5): Large increases in average alcohol expenditure between waves 2 and 7 were observed for investment (+£23.84) and private pension (+£11.07) as main sources of incomes in Table 6.3. By GOR, large increases in average expenditure were observed for the West Midlands (+£23.91), South East (+£10.65) and Wales (+£12.83) between waves 2 and 7. Northern Ireland was the only region to show a large decrease in expenditure between wave 2 and 7 (-£12.95).

Table 6.3 Descriptives for categorical predictor variables and alcohol expenditure by wave 2 or 7 of USoc.

	Household Sample Composition				Average Alcohol Expenditure			
		Wave 2	Wave 7	Change	Wave 2		Wave 7	
	Average cases	%	%	%	£	± SD	£	± SD
Alcohol Expenditure Quintile								
£<= 20	15740	29.3	26.4	-2.7 *				
21 -40	11970	22.4	19.9	-2.3 *				
41 -60	9317	15.6	16.2	0.5				
61 -100	10237	16.5	19.3	2.7 *				
101+	9696	16.2	18.1	1.9 *				
Age of HRP								
45-49 years	13823	24.2	24.4	0.1	72.01	±81.44	75.38	±80.33
50-54	12436	20.8	21.7	0.8	74.94	±87.90	80.53	±143.44
55-59	11075	19.0	19.5	0.4	69.60	±84.61	79.83	±99.58
60-64	10317	19.8	16.7	-2.9 *	65.12	±76.75	71.24	±74.06
65-69	9545	16.1	17.7	1.7	55.79	±66.78	65.06	±77.17
Ethnicity of HRP								
Other ethnicities	6367	10.7	13.4	2.7 *	58.57	±80.31	60.44	±164.19
White British	50792	89.3	86.6	-2.7 *	69.32	±80.59	77.04	±85.65
Single Person in Household								
Yes	12481	23.1	19.5	-3.6 *	53.08	±67.35	55.66	±65.72
No -Multi	44715	76.9	80.5	3.6 *	72.79	±83.73	79.41	±105.86
Children Present								
1+	9996	15.7	19.8	4.1 *	68.00	±76.83	69.97	±86.14
None	47880	84.3	80.2	-4.1 *	68.22	±81.32	76.05	±102.91
Employed Adults in Household								
1+	43285	74.0	76.8	2.8 *	72.64	±83.50	78.50	±107.07
None	13911	26.0	23.2	-2.8 *	55.70	±70.50	62.69	±69.37
Largest source of Income								
Investment income	2111	5.3	4.2	-1.1 *	84.61	±104.89	108.45	±154.21

(Continued from previous page)

Pension or private benefit	6661	11.7	12.0	0.3	65.03	±69.37	76.10	±83.74
Social Benefit	10680	21.7	17.4	-4.3 *	50.08	±62.21	54.54	±63.54
Labour	37744	61.3	66.3	5.0 *	73.89	±85.22	78.04	±105.40
Housing Tenure								
Rental or other	10542	18.7	18.1	-0.3	55.50	±70.24	59.36	±69.87
Mortgage	22911	38.8	39.9	0.8	75.50	±85.07	82.09	±93.63
Owned outright	23570	42.5	42.0	-0.5	67.06	±79.98	74.63	±114.70
Population Density								
Rural	16308	29.1	28.3	-0.8	69.03	±84.74	74.73	±89.16
Urban	40860	70.9	71.7	0.8	67.84	±78.91	74.89	±103.75
Government Office Region								
North East	2388	4.0	4.2	0.3	78.08	±86.21	81.51	±79.90
North West	5874	10.4	9.5	-1.0	71.92	±75.34	81.39	±84.05
Yorkshire & the Humber	4333	7.2	7.9	0.8	72.02	±85.99	76.23	±83.27
East Midlands	4450	7.6	7.5	0.0	73.57	±82.99	77.09	±77.36
West Midlands	4444	7.6	7.7	0.1	59.95	±61.35	83.86	±212.45
East England	4823	8.8	8.3	-0.4	61.36	±67.67	65.06	±74.46
London	4987	8.2	10.0	1.8 *	63.88	±80.07	64.76	±70.54
South East	7410	12.6	13.0	0.4	73.00	±97.13	83.65	±109.11
South West	5158	8.8	9.1	0.3	69.00	±84.53	76.64	±89.93
Wales	4085	7.9	6.6	-1.2 *	61.62	±67.89	74.45	±81.12
Scotland	5638	10.3	9.7	-0.6	64.36	±68.93	70.79	±77.21
Northern Ireland	3578	6.7	6.5	-0.5	73.28	±97.88	60.33	±63.40
Net Income Quintile £								
Q1 <= 1492.36	11398	26.8	13.9	-12.9 *	51.83	±62.28	52.56	±58.30
Q2 1492.37 -2270.50	11387	22.8	17.6	-5.2*	60.50	±70.33	60.04	±66.74
Q3 2270.51 -3149.23	11389	20.1	20.0	0.1	69.06	±75.74	68.82	±74.76
Q4 3149.24 -4417.42	11391	16.4	22.2	5.8*	78.39	±86.12	75.92	±75.61
Q5 4417.43+	11395	13.8	26.4	12.6*	100.16	±111.45	100.11	±151.47

Represents cases rather than households. * z-test p <0.05 for wave. ±SD: Standard deviation.

6.3.2 Multilevel Linear Regression Models (RQ4)

The stepped adjustment for the multilevel linear regression models is shown in Table 6.4. Model fit by log-likelihood improved with the addition of variables to each model.

Change in expenditure over time (RQ2): In the initial model only adjusted for demographics, alcohol expenditure increased with survey wave by an estimate of 1.13[95%CI 0.78 to 1.49], however this association decreased as the model was adjusted for further predictors. This suggests that the previously observed increases in income over time better explain some of the increase in expenditure over time rather than a period effect. In the final adjusted model (Model 4), survey wave was associated with an estimate of 0.63[0.28 to 0.99], suggesting that for every wave (adjusted for other variables included in the model), expenditure increased by £0.63 (£4.47 over 7 waves).

Level 1 of the models shows how the measurement of expenditure at the household level tended to have a higher correlation with neighbouring waves, suggesting that behaviours at the previous

wave have some influence on the next wave. However, this correlation decreases with the distance between waves, suggesting that the influence is more wave on wave than in the long term. This pattern is accounted for by the Toeplitz correlation structure previously described in section 6.2.5.

Association with Household Composition (RQ3): The initial model adjusted for demographics showed that expenditure declined with age of the HRP (Model 1, 45-59 years B: 12.6 compared to 60-64 years B: 3.01). However, the addition of socioeconomic indicators in model 2 removed the statistically significant difference of ages 55-64 years compared to 65-69 years, suggesting a greater role of income sources, particularly as receiving a pension increased with age. In the final model, there was no statistically significant difference between the 60-64 and 65-69 year age groups suggesting pre-retirement age was associated with higher alcohol expenditures. Having at least two adults in the household compared to a single adult household was associated with greater expenditure (Model 4 B: 11.3[8.8 to 13.8]). This association also declined with further adjustment, suggesting that some of the association of household members with expenditure was related to greater income availability rather than spending by more individuals. No children in the household (aged up to 16 years) was associated with a greater expenditure and this association remained stable with adjustment (Model 4 B: 8.4[5.8 to 11.0]).

In model 2, the addition of proxy indicators of income found there was no statistically significant association with having at least one adult in the household in employment. Although this was statistically significant when GOR was added to the model, the association was lost when income was added to the final model, suggesting income better accounted for the association with expenditure rather than the employment itself. This would support why there was no statistically significant difference in the expenditures of employee pension income and employment income. However social benefit income was associated with lower alcohol expenditure, although this association weakened when taking into account actual income in the final model (Model 4 B: -8.1[-11.1 to -5.1]). Rental tenure was associated with lower alcohol expenditure compared to home-ownership (including mortgage) (Model 4 B: -5.1[-8.1 to -2.1]). This association did not greatly change from the addition of income, suggesting rental tenure may not be a reflection of lower-income, particularly for those living in high-value areas. There was no association found for expenditure with an urban or rural residence.

Association with GOR (RQ4): When GOR was added to Model 3 (Table 6.4), alcohol expenditure was lower in most GOR compared to the North East region, except for the North West, East Midlands and South East regions. The addition of income to the final model removed a

statistically significant difference between Yorkshire and the North East but created a statistically significant difference for the South East (Model 4 B: -7.6[-13.6 to -1.5]). Alcohol expenditure was comparatively lowest in East England compared to the North East (Model 4 B: -13.5[-19.9 to -7.1]). The addition of GOR to model 3 did not greatly change the association of other variables with expenditure.

Association with income (RQ1): In the final model (Table 6.4, Model 4), a small statistically significant association was found for linear income with expenditure (Model 4 B: 0.004[0.004 to 0.005]). This implies that for every £100 increase in income, alcohol expenditure increased by £0.40 (adjusted for other variables in the model).

Interaction with wave (RQ5): When added as a linear interaction with each variable of the final model (Table 6.4, Model 5), survey wave was found to have a statistically significant interaction only with GOR. The West Midlands showed an increased association with expenditure over time (B: 2.58[0.48 to 4.67]) and Northern Ireland a decreased association over time (B: -2.28[-4.53 to -0.03]). These effects were observed in the descriptive statistics. No other statistically significant interactions with wave were found.

Table 6.4 Multilevel linear regression model of previous month alcohol expenditure of waves 1-7 of USoc, stepped adjustment for predictors with wave interaction.

	Model 1	**Demographics**	**Model 2**	**+Socioeconomic**	**Model 3**	**+Living Area**	**Model 4**	**+Income**	**Model 5**	***wave (sig.)**
Level 2 Fixed Effects	**B**	**95% CI**	**B**	**95% CI**	**B**	**95% CI**	**B**	**95% CI**	**B**	**95% CI**
Intercept	20.45	15.34 to 25.57	31.96	26.32 to 37.59	41.12	32.86 to 49.38	31.96	23.75 to 40.18		
Wave (linear)	**1.132**	**0.776 to 1.488**	**1.093**	**0.738 to 1.449**	**1.102**	**0.746 to 1.457**	**0.633**	**0.276 to 0.990**		
Age of HRP										
45-49	**12.61**	**9.56 to 15.65**	**7.54**	**4.10 to 10.98**	**7.57**	**4.13 to 11.01**	**8.09**	**4.67 to 11.51**		
50-54	**11.87**	**8.98 to 14.75**	**6.84**	**3.60 to 10.09**	**6.82**	**3.57 to 10.06**	**7.36**	**4.13 to 10.58**		
55-59	**7.48**	**4.66 to 10.31**	2.83	-0.25 to 5.90	2.81	-0.26 to 5.88	**3.56**	**0.50 to 6.61**		
60-64	**3.01**	**0.47 to 5.56**	0.00	-2.63 to 2.63	-0.01	-2.64 to 2.62	0.77	-1.85 to 3.39		
65-69 (Ref.)	1.00		1.00		1.00		1.00			
Ethnicity of HRP										
White British	**15.88**	**12.60 to 19.16**	**14.70**	**11.42 to 17.98**	**14.15**	**10.55 to 17.75**	**13.74**	**10.19 to 17.29**		
Other ethnicities (Ref.)	1.00		1.00		1.00		1.00			
N. of Adults in Household										
2+	**20.40**	**17.98 to 22.82**	**16.95**	**14.46 to 19.44**	**16.95**	**14.47 to 19.44**	**11.29**	**8.76 to 13.81**		
1 (Ref.)	1.00		1.00		1.00		1.00			
Children Present										
None	**7.17**	**4.58 to 9.76**	**7.26**	**4.67 to 9.86**	**7.26**	**4.66 to 9.86**	**8.38**	**5.80 to 10.96**		
1+ (Ref.)	1.00		1.00		1.00		1.00			
Employed Adults in Household										
None			-2.80	-5.65 to 0.06	**-2.90**	**-5.76 to -0.05**	-0.34	-3.20 to 2.52		
1+ (Ref.)			1.00		1.00		1.00			
Largest source of income										
Investment income			**9.74**	**5.47 to 14.01**	**9.66**	**5.39 to 13.93**	**7.88**	**3.62 to 12.14**		
Pension or private benefit			-2.62	-5.91 to 0.68	-2.62	-5.92 to 0.68	-2.19	-5.47 to 1.09		
Social Benefit			**-11.42**	**-14.42 to -8.42**	**-11.48**	**-14.49 to -8.48**	**-8.10**	**-11.11 to -5.09**		
Labour (Ref.)			1.00		1.00		1.00			
Housing Tenure										
Rental or other			**-6.81**	**-9.80 to -3.82**	**-6.71**	**-9.71 to -3.71**	**-5.11**	**-8.08 to -2.14**		
Mortgage			1.19	-1.17 to 3.55	1.15	-1.21 to 3.51	0.15	-2.20 to 2.49		
Owned outright (Ref.)			1.00		1.00		1.00			

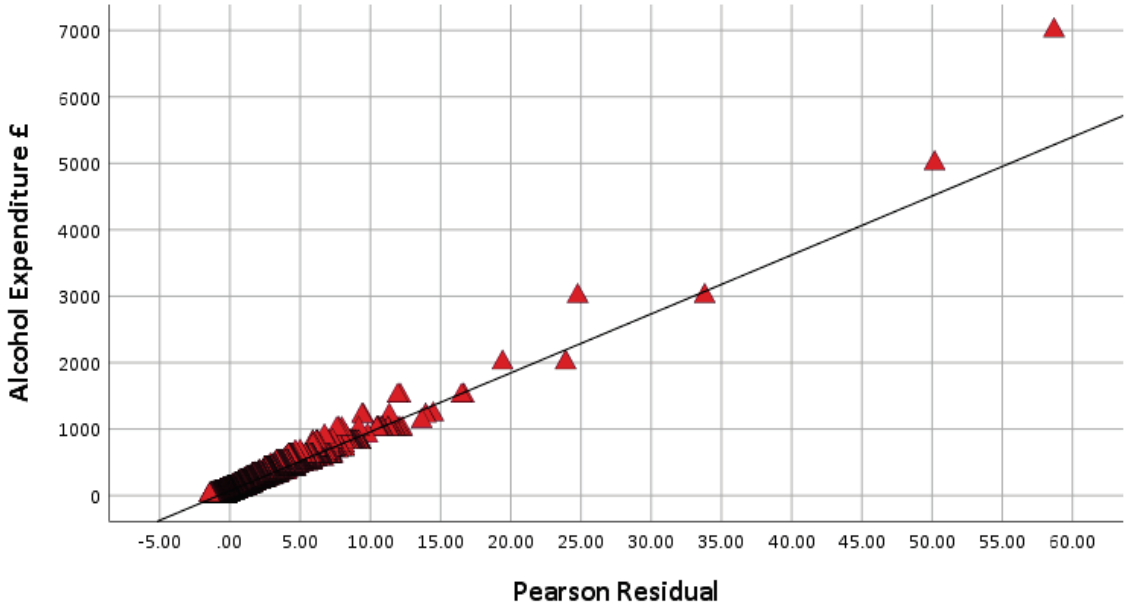
	Model 1	Demographics	Model 2	+Socioeconomic	Model 3	+Living Area	Model 4	+Income	Model 5	*wave (sig.)
Level 2 Fixed Effects	**B**	**95% CI**	**B**	**95% CI**	**B**	**95% CI**	**B**	**95% CI**	**B**	**95% CI**
(Continued from previous page)										
Population Density										
Urban					-0.78	-3.23 to 1.67	0.25	-2.17 to 2.67		
Rural (Ref.)					1.00		1.00			
GOR										
Northern Ireland					**-9.06**	**-15.96 to -2.16**	**-8.82**	**-15.62 to -2.02**	**-2.28**	**-4.53 to -0.03**
Scotland					**-12.16**	**-18.48 to -5.83**	**-13.13**	**-19.37 to -6.89**		
Wales					**-13.91**	**-20.55 to -7.26**	**-13.66**	**-20.21 to -7.10**		
South West					**-10.64**	**-17.10 to -4.18**	**-11.30**	**-17.67 to -4.93**		
South East					-5.05	-11.18 to 1.07	**-7.57**	**-13.61 to -1.52**		
London					**-9.12**	**-15.72 to -2.51**	**-12.27**	**-18.79 to -5.74**		
East England					**-12.26**	**-18.75 to -5.76**	**-13.51**	**-19.92 to -7.10**		
West Midlands					**-9.72**	**-16.30 to -3.15**	**-10.68**	**-17.16 to -4.19**	**2.58**	**0.48 to 4.67**
East Midlands					-3.52	-10.11 to 3.08	-3.85	-10.35 to 2.66		
Yorkshire & the Humber					**-6.62**	**-13.21 to -0.02**	-6.47	-12.97 to 0.04		
North West					-3.03	-9.34 to 3.27	-3.90	-10.12 to 2.32		
North East (Ref.)					1.00		1.00			
Net Income										
Linear							**0.004**	**0.004 to 0.005**		
Level 1 Wave Variance Toeplitz	**Estimate**	**Std. Error**	**Estimate**	**Std. Error**	**Estimate**	**Std. Error**	**Estimate**	**Std. Error**		
Within household variance	8249.94	59.44	8190.48	58.85	8178.56	58.75	8046.89	57.45		
Wave correlation distance 1	0.457	0.005	0.453	0.005	0.452	0.005	0.441	0.005		
2	0.365	0.006	0.361	0.006	0.360	0.006	0.350	0.006		
3	0.372	0.007	0.368	0.007	0.367	0.007	0.356	0.007		
4	0.354	0.008	0.350	0.008	0.349	0.008	0.338	0.008		
5	0.334	0.009	0.330	0.009	0.329	0.009	0.318	0.009		
6	0.286	0.011	0.282	0.011	0.281	0.011	0.270	0.011		
-2 log-likelihood	664,398		664,169		664,081		663,705			

Bolded *p* <0.05 (*wave sig.statistically significant results only)

6.3.3 Analysis of Residual Outliers

Model Pearson residuals were found to have a mean of 0.001 but a tail of positive residuals up to 58.7. Negative residuals did not occur below -1.45. Residuals were highly correlated with alcohol expenditure (r^2=0.938) as shown in Figure 6.4, but there was no correlation with net income. Residual cases above 3.0 reported an average alcohol expenditure of at least £270 for the previous month (n=902 cases, 668 unique households, 1.6% of all cases).

Figure 6.4 Pearson residuals of linear multilevel model (Table 6.4) against linear household alcohol expenditure.



Using cases from waves 2 and 5 for which heaviest day alcohol consumed was measured, the average unit intake on the heaviest day for the HRP was 12 units in residual cases above 3.0 compared to 6 units for the rest of the sample. Household net incomes were on average higher in the residual cases above 3.0 compared to the rest of the sample, (£4142 compared to £3130 for the previous month). Alcohol expenditure as a percentage of household income was very high in cases with residuals above 3.0, with an average of 17.4% of previous month income spent on alcohol, ranging up to 98.8%. In comparison, cases with residuals below 3.0 averaged at 2.9% of income spent on alcohol, a value similar to that found in the LCFS at 2.6% (369). The differences in the average level of household imputation for net income was not statistically significant between cases above or below 3.0 by chi-square (around 20%) suggesting this was not a measurement error. Residual cases above 3.0 were more likely to include cases who were employed, with a higher number of persons in the household and no children, but less likely to include cases with rental tenure or social benefit incomes. This suggests the high residual cases

are related to high alcohol expenditures but imbalances with reported incomes, although not necessarily low incomes, which may relate to larger household size.

An analysis of the households spending over £1000 in at least one wave (n=30) found this occurred more than once in only three households, suggesting a high expenditure for a one-off event in most of these households. However, 19 of these households spent between £100-£999 for the previous month in all other waves and seven households spent less than £100 in all other waves. The average units reported on the heaviest day for the HRP in wave 2 and 5 for these households was 10 units, above binge drinking thresholds. No changes from single to multi-adult households were found and all reported employment or retirement. All households reported between 1 and 5 members and higher expenditure years were not related to changes in household size. Spending over £1000 was not associated with any particular month of interview.

6.4 Discussion

This study investigated how income, household composition and GOR residence are associated with alcohol expenditure in middle-aged headed households in a longitudinal panel survey from the UK, between 2009/10 and 2015/16, accounting for repeated measures of the same households over time.

Considering the first question of this study (RQ1), it was found that increasing household net income was associated with higher alcohol expenditure on average, accounting for other household composition factors. This supports the evidence that income is a factor of purchasing power and the affordability of alcohol plays a role in purchasing decisions (349, 353). This relationship with income has been found in other UK modelling studies that also suggest higher income groups purchase a higher number of units on average in cross-sectional analyses where both units and expenditure were available (360, 437). The lowest income group was found to have the lowest expenditure on alcohol but also spent the largest proportion of their income on this alcohol spending. This result was found in a recent analysis of the LCFS that found that the bottom 10% of households by income use about 1% more of their disposable income on alcohol compared to the rest of the population (369). This outcome has been discussed as contributing to the potential of alcohol taxation to be regressive by placing a greater financial burden on those of the lowest income (531, 532).

In response to RQ2, both average household alcohol expenditure and net household income increased over the 7 waves. However, average alcohol expenditure as a percentage of household income decreased. Between 2009 and 2015, alcohol prices increased by 76.9% but decreased by

1.6% when adjusted for inflation (166). Therefore although expenditure increased on average, it is unclear if this was in response to inflation to maintain consumption, particularly as the duty escalator was in place between wave 1 and 3 of this study (174), or an actual increase in purchases (or higher-priced products). Household income adjusted for inflation increased by 13.7% over this period, despite the impact of the 2008 Recession on incomes initially, reflecting the increases in household income observed in this study (166). The contribution of income on expenditure over time was observed by the decreased association of wave when income was added to the final model. These outcomes support the discussion that alcohol has become more affordable for middle-aged adults over time, as increases in disposable incomes outpace rises in alcohol price and taxation in the UK (105).

For RQ3, household composition analysis suggested some factors were associated with more or less spending on alcohol when accounting for income. Similar to actual consumption in study 1 and 2, expenditure on alcohol declined with the age of the HRP with no statistically significant difference in spending above 60 years of age (197). It is unclear if this decrease is related to the natural decline in alcohol consumption with ageing or declines in overall spending that are observed in retirement (533). These outcomes are in contrast to the descriptive data from the LCFS that suggests that alcohol expenditure has been historically highest in adults aged 50-64 years and rising in older ages (352) (see Chapter 2.5.2). Also similar to actual consumption in the previous two studies, ethnic minority status was negatively associated with expenditure (218). Having more than one adult in the household was associated with greater expenditure, possibly as a reflection of more alcohol servings required. However, this assumes that other household members are drinkers and it is unclear if the increase in expenditure is also related to having more household social interactions whether positive or negative (285, 534). Having no children in the household was associated with higher expenditure, reflecting a similar trend found for exceeding the weekly guidelines in study 1 and binge drinking in study 2 for women (102). Data from the LCFS using all ages suggests that households with children spend less money on alcohol compared to the equivalent sized adult household without children (352). However, it is unknown if the reduced expenditure with children reflects reduced consumption or changes in spending distribution to account for an additional family member (491).

Considering socioeconomic factors, the presence of at least one employed adult, (without being a proxy for household retirement or other unemployment), was associated with greater expenditure until income was added to the model when significance was lost. This suggests higher income from any source is more important than the social implications of being in employment for expenditure on alcohol in middle-age (116, 278). This is supported by there being

no statistically significant difference between private pension income source and labour income sources on expenditure. Although an association for retirement was found for exceeding the weekly guidelines in study 1, accounting for income, other studies from the literature have found no association with employment status and problem drinking in adults over 50 years (256, 276). When accounting for income, social benefit income remained negatively associated with expenditure compared to labour income. This is despite a lower social class being associated with a greater risk for problem drinking in middle-aged cohort studies (275, 276). Similarly, rental tenure, with tenure often considered a product of income (268), was associated with lower expenditure on alcohol compared to outright home-ownership. Yet rental tenure was associated with exceeding the weekly guidelines and problem drinking in two midlife cohort studies (275, 276). These outcomes may be reflective of the discrepancies between actual alcohol consumed and price paid which is further explored later in the discussion (360).

For RQ4, this study found that regional living area was associated with statistically significant differences in alcohol expenditure, although the independence of this association to the characteristics of the residents was not tested, as explained later in this discussion. Descriptively, average alcohol expenditure for all waves was highest in the North East and West, East Midlands and South East which was also found when accounting for household characteristics. However, when also accounting for income, the North East and West, Yorkshire and East Midlands were found to have higher expenditures compared to all other regions, suggesting that the higher household incomes of the South East compared to the North were able to account for the differences in regional spending (294). Data from the LCFS, using all ages, suggested that descriptively the highest expenditures for the previous week (year 2009/10) were found in the North East and West but also Northern Ireland and Scotland, suggesting possible age differences in spending outside of England (352).

For the final RQ5, there was a statistically significant increase in expenditure found for the East Midlands and a decrease in expenditure for Northern Ireland over time, as found in the descriptive statistics. No large changes in sample composition for these GOR were observed that might explain these changes. Data from the LCFS for all adult ages suggested trends in alcohol expenditure were decreasing in Northern Ireland, and increasing in the East and West Midlands, North West and East England (352). It is unclear if this is related to changes in alcohol consumption or changes in economic development in those regions. No statistically significant interactions with wave were found with other household variables, including income, suggesting there were no other large changes in subgroup alcohol expenditure over this study.

6.4.1 Strengths, Limitations and Further Research

This study addressed an absence in the research for understanding trends in household alcohol expenditure and the household level factors associated with spending in households headed by adults aged 45-69 years from across the UK. This study used seven waves of repeated measures panel data, with a random stratified sampling design in wave 1, resulting in 1,658 households responding to all seven waves. It therefore had a longitudinal advantage over the commonly used cross-sectional LCFS by the greater statistical power provided by the reduced variability in outcomes from analysing individual level rather than population-level change (481). A longitudinal analysis is better at controlling for unobserved heterogeneity (unmeasured confounding) as this is assumed to be constant across the repeated measures of the individual (527). Expenditure was measured using an in-person interview using a question that considered the alcohol spending of other household members and therefore accounted for the potential sharing of household budgets.

The linear outcome was analysed untransformed to enable practical interpretation of how a variable was associated with expenditure rather than using log adjusted or more complex modelling that may be a further source of bias (528). Due to surveying performed throughout the calendar year for households, outcomes were less likely to be affected by observed seasonal changes in alcohol spending (380, 381). The loss of households to 'missing' responses and CCA (not non-response) was small compared to loss found at the individual level in the previous two studies, possibly as the HRP interview is a required component before further individual level interviews take place.

The non-independence of repeated measures within households was accounted for using multilevel modelling, allowing for the inclusion of households with irregular responses or waves without expenditure on alcohol (452). Including non-spenders would have required the consideration of a tobit or double hurdle model which are more appropriate at handling zero expenditure as an outcome (437). However, these models have been criticised for making the underlying characteristics of the two groups (non-spenders and spenders) appear distinct when such behaviour choices overlap in reality (535). The associations of non-spenders were not deemed relevant to the aims of this study.

Although sample size was maintained within 1,300 households cross-sectionally, it was difficult to determine the impact of wave attrition from non-response due to the exclusion of non-drinkers on a wave basis. As single wave households were more likely to be from lower-income or ethnic minority HRP, who are less likely to consume risk alcohol from studies 1 and 2, the increase in

expenditure over survey waves could also be a product of the attrition of such households. It is difficult to determine if the household composition improvement in income and employment status over time were due to attrition bias or period effects of recession recovery. Although reports of USoc suggest a general maintenance of sample representation over the seven waves despite initial attrition loss (404), it is unclear if this applies to the middle-aged sample of drinkers in this study. As with alcohol consumption surveys, expenditure surveys are prone to recall error, particularly if a survey respondent is assuming other members spending (536, 537). Participating in longitudinal surveys may lead to more accurate reporting over repeated measurements but may also change reported alcohol behaviours due to social desirability bias (panel conditioning) (432, 538, 539).

A limitation of this study was the lack of matched data on actual alcohol consumption with expenditure on alcohol. USoc does not measure typical weekly alcohol consumption and is limited to binge drinking data of drinkers in the previous week for only two waves. Therefore this study cannot determine if higher expenditures relate to higher volumes or higher quality (cost per unit) alcohol (349). The availability of low-cost per unit alcohol means that high volumes of alcohol can be purchased at low prices per unit producing a market where expenditure and volumes are not clearly correlated. Higher unit intake drinkers are more likely to spend the lowest price per drink, in all age studies (355, 540) and respond to price increases through lower quality substitutions (356, 541) regardless of the type of drink (e.g. spirits, wine, beer) (106). In contrast, the highest income drinkers tend to be the least likely to purchase low-cost per unit options (360). However, the high spending required by problem drinkers to meet their demand tends to limit the purchasing power of higher incomes as the demand for units exceeds the quality of the product (359). Problem drinkers are also more likely to occur in low-income groups which additionally increases the demand for low-cost products (236). However, low income, low-risk drinkers do not necessarily prefer low-cost options if choosing quality over quantity (103, 360). Thus the association of expenditure with income is complex when considering the demand for alcohol volume and should be considered in further research if such data becomes available longitudinally (349).

A linear model that assumes a normal distribution of the data was applied to skewed semi-continuous data in this study. However, due to the large sample size available, the non-normally distributed residuals may not necessarily bias results (528, 542). The correlation between expenditure and positive residuals suggested the model is unable to correctly determine the characteristics of higher spenders beyond a normal distribution. Data from the LCFS with both expenditure and unit data suggested that problem drinkers spend on average £240 per month

(359), which is similar to the spending of at least £270 for residuals above 3.0 in this study. Such cases had high proportions of their income being spent on alcohol, suggesting possible issues of problematic spending on alcohol, spending beyond the needs of the household alone, such as for an event, or incorrect reporting of household income. Further contexts are needed to explain these cases.

Although USoc uses imputation to deal with missing responses to income, irregular and self-employment income may be associated with income under-reporting (485). Data on household savings and assets were unavailable that may have been an unrecognised source of spending power. Household income may be incorrectly reported if other household members incomes were unknown or the question was misinterpreted as only shared spending (423). The association of state pension with expenditure (a benefit available to most who are applicable) could not be separated from other state benefits in this study, which limited the exploration of retirement income.

The question used to determine household alcohol expenditure was simple and did not measure spending on specific drink types or the frequency of purchases that would allow for more detailed reporting (543). The spending of other household members is estimated by the HRP and there are no prompts to account for atypical spending months, such as bulk purchases, stockpiling or cross border purchases with different pricing systems (544).

The inclusion of factors related to the HRP was limited to those that had potential clustering with other household members. It was assumed for age and ethnicity that these variables crossed over to other members of the household in this study. This prevented the investigation into the impact of sex on expenditure that was found to have contrasting associations with alcohol consumption in study 1 and 2 (350). This also includes tobacco use, which is strongly associated with risk drinking in this thesis and is associated with greater expenditure on alcohol in cross-sectional studies (261, 545, 546).

For this study, GOR was not included as a random intercept as it would be difficult to account for self-selection of those who moved between GOR over the seven waves and exclusion would introduce another source of sample bias. Moving residence may imply unmeasured economic or lifecourse functions that may lead to follow on effects on drinking, as shown in study 2 (547, 548). A multiple-membership random effects model can account for longitudinal changes by recognising that individuals can be grouped in more than one region and could be considered in future studies (458). This would support further research into the regional variations in expenditure found in this study.

There has been a lack of research into understanding the choices of and differences by expenditure for purchasing locations in middle-aged adults from the UK (541, 549). Such data would advance research into the influence of alcohol-related outlets, a related aspect of alcohol availability, where influence is currently assumed by shortest distance to access or shared spatial location (80, 333, 550). For example, no association with urban residence and alcohol expenditure was found in this study which might be expected if urban environments provided better access to outlets (507, 508). Yet alcohol-related harm is higher in urban compared to rural areas (using all ages, adjusted for deprivation quintile) (226).

This study contributes to research gaps for understanding middle-aged alcohol consumption by discovering that alcohol affordability is rising in this age group but household purchasing power, and potentially regional residence, remain important determinants of alcohol expenditure. This is the final study of this thesis and therefore the next chapter moves onto the overall discussion of the outcomes of this work by considering an interpretation of the findings from all previous chapters. This includes an overview of its strengths and limitations, further studies to consider and the practical implications of these outcomes.

Chapter 7 Overall Discussion

The last chapter of this thesis integrates the outcomes of all three studies and supporting evidence from the published literature. After an initial summary of the outcomes in relation to the five thesis objectives (Chapter 2.6.1), an interpretation of the results with reference to the literature is considered, with a summary of further research topics to support these outcomes. An overview of the strengths and limitations of the data and methods used to measure these outcomes are evaluated with recommendations for improvements. Before the conclusion, this chapter considers the outcomes that may have public health strategy implications for the middle-aged drinking population.

7.1 Summary of Thesis Objectives and Outcomes

This thesis aims to understand the characteristics of middle-aged risk drinkers aged 45 to 69 years from the UK due to their high levels of alcohol-related harm (6, 166). Reducing alcohol-related harm is one of the seven priorities set out by Public Health England in 2014 as part of its Five Year Forward View (551). This age group has the highest percentage of drinkers exceeding the low-risk guidelines, rising levels of binge drinking and high household levels of alcohol expenditure, which were the target outcomes for investigation in this thesis (11, 12, 352). Such outcomes represent different sources of harm from chronic intake, short-term intoxication and alcohol availability (23, 41, 479). The promoters of alcohol consumption are recognised as acting within a social-ecological framework where individual characteristics interact with community availability, drinking contexts and lifecourse sensitivity (68, 93, 552, 553). However, research into understanding the specific individual and contextual characteristics of risk drinking in middle-age in the UK has been limited. Available studies lack age and sex-specific analyses and use inconsistent measures of alcohol consumption related to health risks (92, 190, 464, 554). This limits the application of such evidence to alcohol reduction strategies targeting multiple levels of influence that are considered more effective in the long term (14, 34, 320, 555).

This thesis addressed these issues by investigating five research gaps of risk drinking in middle-age, identified by a literature review in Chapter 2.6.1, that have not been previously investigated in other studies. Each objective was designed to be considered in steps of increasing complexity and movement up a multilevel social-ecological framework designed in Chapter 1.3.1. Multilevel analyses were conducted in middle-aged survey samples from the UK with sex-stratification for risk alcohol thresholds used by other UK surveys and alcohol expenditure, incorporating

temporal and contextual aspects. Drinking outcomes were found to vary by sex, age, socioeconomic status, social groups, and co-risk behaviours. The main outcomes of the five thesis objectives are summarised in Table 7.1 and as follows:

1. *To explore how the percentage of drinkers aged 45-69 years exceeding the weekly low-risk alcohol guidelines and binge drinking has changed over time:* Between 1998-2015 in England, exceeding the former weekly guidelines in men converged with women's rates at around 30% of drinkers (21/14+ units). Binge drinking (8/6+ units) increased over time, particularly in women, but men still binge drink at a higher rate at 29% compared to 22% of women drinkers. Whilst both behaviours were increasing between 1998-2002, only excess weekly drinking fell and continued to decline between 2011-2015 in both sexes.
2. *To explore how individual, social characteristics and co-risk behaviours are associated with these two risk alcohol outcomes, and whether these relationships have changed over time:* Exceeding the weekly guidelines was positively associated with smoking, higher income, higher education, in retirement, cohabiting marital status and having no children in the household for both sexes. Binge drinking was positively associated with smoking, higher body-mass index (BMI), higher income, divorced marital status, no religious belonging and urban residence in both sexes. However, associations with having friendships or no qualifications with binge drinking were found in men only. There was a statistically significant increase in the negative association of degree-level education and binge drinking in men, the positive association of smoking with both drinking behaviours in women and a decreased association of income with weekly drinking risk in both sexes between the early 2000s and early 2010s.
3. *To explore how transitions in individual life circumstances in middle-age are associated with changes in binge drinking behaviours*: Entering or leaving a relationship were both associated with an increased risk of maintaining binge drinking over survey waves in men, compared to a stable relationship status, but this association was not found in women. Moving to a rural area in both sexes, changing to no reported friends in men only, becoming a non-smoker and entering employment in women only, were negatively associated with maintaining binge drinking. Younger age was associated with an initiation of binge drinking in both sexes whilst retirement, no religious association and entering a relationship were associated with the initiation of binge drinking in men only. Smoking and having no children in the household were associated with initiation in women only.

4. *To explore the relevance of government office region (GOR) to place effects on risk alcohol behaviours in middle-age*: Living in a particular GOR, accounting for individual characteristics, was not associated with exceeding the weekly guidelines or binge drinking in cross-sectional data. There may be statistically significant variance across GOR in men in a panel sample with a high percentage of binge drinkers, indicating higher levels of binge drinking in the North East and West of England. When added as a fixed effect, expenditure of alcohol was found to be higher in the North of England compared to other regions of the UK.
5. *To explore how household-level incomes and composition in middle-age are associated with alcohol expenditure and whether alcohol affordability has increased in this population:* Alcohol expenditure as a percentage of income decreased over survey waves with rising levels of household net income, suggesting an increase in affordability in middle-aged headed households. Household alcohol expenditure was found to increase by household factors of income, home ownership, younger age, number of household residents but no relationship was found for employed adults or urban residence. The directions of outcomes for the main models in the three studies are summarised in Table 7.1.

Table 7.1 Summary of associations with drinking behaviours for middle-aged adults from studies 1, 2 and 3.

Drinking Behaviour	**>Weekly Guidelines**		**Binge Drinking**				**Expenditure**
	Study 1		**Study 1**		**Study 2**		**Study 3**
Demographic and Social	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Household**
Age group (years)	↑ <60-64	↑ <55-59	↑ <60-64	↑ <60-64	↓ >55-59	↓ >50-54	↑ <55-59
Ethnicity: Other (Ref. White British)	↓	↓	↓	↓	↓	↓	↓
Marital Status: Single	-	-	↑	-	-	↓	↑ Multi-
Divorced	↑	-	↑	↑	↑	-	person
Living as a couple (Ref. Married)	↑	↑	-	↑	↑	-	
Number of children: None (Ref. 1+)	↑	↑	-	-	-	↑	↑
Belong to religion: No (Ref. Yes)					↑	↑	
Friendships: No (Ref. Yes)					↓	-	
Employment status: Other	-	-	-	-	-	-	
Retired (Ref. Employed)	↑	↑	-	-	-	-	-
Income: Higher (Ref. Lower)	↑>30k	↑>20k	↑>50k	↑>50k	-	↑*	↑Linear
Highest qualification: Degree	↑	↑	↓	-	↓	-	
Secondary (Ref. None)	↑	↑	-	-	-	-	
Health: Limiting illness (Ref. none)	-	↓	-	↓	-	↓	
Smoking status: Smoker (Ref. Non)	↑	↑	↑	↑	↑	↑	
BMI: Obese	-	↓	↑	↑			
Overweight (Ref. Normal)	-	-	↑	↑			
Population Density: Urban (Ref.Rural)					↑	↑	-
GOR (Fixed effect in study 3)	-	-	-	-	↑North	-	↑North

Legend: ↑ Significantly increased association, ↓ Significantly decreased association, -No significant association ☐ Not tested in this study (Multi: multi-person household), *Net income above £1600/month

7.2 Interpretation of Findings

Due to the interlinked nature of the research objectives, this section considers the relationships between outcomes with reference to the wider literature. As there are few studies available that considered a similar age population using sex stratification with the same risk thresholds for outcome comparisons, most findings are novel to the UK literature.

7.2.1 Exceeding the Weekly Guidelines and Alcohol Expenditure

In adults aged 45-69 years, it was found that the percentage of drinkers exceeding the former weekly guidelines, between 1998 and 2015 in England, had reduced by 10% in men and 3% in women. This resulted in a convergence of both sexes to around 30% of drinkers exceeding the former guidelines. This convergence has been noted in other countries, although whether this is driven by male declines or female increases may depend on the period and age group studied (38, 474, 556). Women's drinking has become more prevalent over birth cohorts (76, 142), related to rising gender equality (64, 557), however trends suggest there has not been a recent period increase in excess weekly drinking in middle-aged women that has been observed in the United States (US) (558).

Average alcohol expenditure as a percentage of household income decreased between 2009 and 2015 with rising average household net incomes. This suggests an increase in the affordability of alcohol in middle-aged headed households, agreeing with population-level statistics (98, 343). Despite this, exceeding the weekly guidelines has continued to decline which has been referred to as a 'saturation' of the market (144). Higher incomes were associated with exceeding the weekly guidelines in both sexes, with a stronger association in women, as found in an all-age but not sex-stratified analysis of the Health Survey for England (HSE) (236). This association with income and weekly drinking risk was found to decline over survey years in both sexes. Household alcohol expenditure, accounting for other household composition factors, was linearly associated with income, as found in a population-level analysis (437), whilst rental tenure and social benefit income as the main source, were associated with lower expenditures on alcohol. In the literature, greater alcohol expenditures may be associated with higher unit consumption per week, but less so when consuming over the weekly guidelines (359, 360). However, as household wealth and incomes generally peak in middle-age compared to other age groups, this may be an important contributor to overall alcohol intake (559).

Higher education was associated with exceeding the former weekly guidelines in both sexes, possibly as a function of higher socioeconomic status (268), which was also found in a study of

the HSE using all ages (236). Individuals with higher education were less likely to reduce their alcohol intake over time in the 1958 Birth cohort (NCDS) (208). The addition of co-risk factors increased the association of weekly drinking risk with higher education in both sexes. Smoking was strongly associated with risk drinking and this association increased in women over survey years. However, no statistically significant interaction between education and smoking on weekly drinking risk was found. In the literature, young and middle-aged adults with higher education who were smokers were more likely to exceed the former weekly guidelines than smokers without tertiary education despite finding opposing socioeconomic associations with smoking independently (487, 560, 561).

Although income was found to outweigh having employed adults in the household for the relationship with alcohol expenditure, there was an increased association of exceeding the weekly guidelines in both sexes for individuals in retirement compared to being in employment. As the associations of both household alcohol expenditure and the risk of exceeding the guidelines were found to decline with age, this suggests there may be something specific about retirement that is not related to purchasing power. For example, reduced employment responsibility has been cited as a reason for restraining alcohol intake in middle-age (116, 130, 278). Having children under the age of 16 years in the household was negatively associated with both household alcohol expenditures and weekly drinking risk in both sexes, which may implicate responsibility roles and spending changes in younger middle-age (102, 480, 491). Married couples were found to have a reduced risk of exceeding the weekly guidelines compared to cohabiting ones, particularly in men. This has been related to convergent drinking patterns by spouses and reduced influence of wider social networks (519, 562), although it has been suggested that heavier drinkers may simply be less likely to marry than lighter ones (285, 563). Overall, exceeding the weekly guidelines appears to be a product of demand and access in this age group.

7.2.2 Binge Drinking

Between 1998 and 2015 in England, there was a 4% increase in men and a 10% increase in women's binge drinking (8/6+ units on heaviest day) in adults aged 45-69 years. Whilst male binge drinking has stabilised at 29%, women's binge drinking has continued to rise to 22%, with similar trends in middle-aged women from studies in the US (38, 475, 564). Whilst associations for exceeding the weekly guidelines were mostly similar between men and women, associations for binge drinking were found to vary by sex.

The highest income quintile was associated with binge drinking cross-sectionally in both sexes, as found in an all adult ages study of the HSE (236), but a higher income association was only found in women for panel data. In the US, the greatest rise in women's binge drinking in early middle-age has been in the highest income groups (565). Binge drinkers may be less price elastic and therefore the impact of rising affordability of the off-trade sector on this behaviour is unclear (357, 566). In contrast to exceeding the weekly guidelines, having no qualifications was associated with male binge drinking whilst there was no association of education in women. This association in men increased over survey years as the percentage of individuals without any reported qualifications declined, possibly reflecting birth cohort improvements in education access (470). This outcome, found only in men, is novel as the negative association of higher education with binge drinking in middle-aged cohorts is only available for non-sex stratified outcomes (273, 274). Although the reason for this difference between men and women for the association of education has not been investigated in the literature for middle-aged adults, it has been theorised there may be residual stigma for binge drinking in women from a lower socioeconomic status (64, 119, 213, 288).

No association was found for employment status and binge drinking in both sexes, which is also in contrast to exceeding the weekly guidelines. However, retirement was associated with the initiation of binge drinking in men only, as found in the Irish Longitudinal Study of Ageing (TILDA) cohort (478). This reinforces the concept, described for weekly drinking risk, that retirement may be a sensitive transition period related to unmeasured contextual changes (279, 281), particularly as men have a greater percentage of binge drinkers in older age than women (94). Therefore, binge drinking appears to be less socioeconomically dependent than weekly excess volume and may be more driven by social contexts.

Smoking was strongly associated with binge drinking in both sexes cross-sectionally and in panel data. However, only women were found to be sensitive to transitions in smoking with those who reported not smoking at follow-up less likely to maintain binge drinking across repeated measures. An increased risk for binge drinking was also found in women smokers with higher education compared to those without educational qualifications. Although both high volume and episodic intake are associated with smoking, binge drinking has been implicated in maintaining smoking behaviours (259, 567), particularly when used in social contexts, which may be more common in women (568-570). Being classified as overweight or obese was associated with binge drinking, particularly in men, with episodic drinking known to contribute to calorie intake (571), but no interaction was found with socioeconomic status. As BMI was only available cross-sectionally, a longitudinal analysis is required to understand whether binge drinking

promotes weight gain or if higher weight individuals engage in more binge drinking. This is particularly as no association with BMI and exceeding the weekly guidelines was found in men and was negatively associated with obesity in women when weekly drinking would better indicate a volume to weight relationship.

Binge drinking declines more strongly with increasing age than for exceeding the guidelines and men and women were both less likely to initiate binge drinking with age, which is recognised in a population-level analysis (93). Reductions in binge drinking have been related to increased sensitivity to side effects and multimorbidity with age (115, 117, 208, 572). However, a US-based study has reported that the age of usual binge drinking peak in young adulthood may be increasing, particularly in women, resulting in a continuance of binge drinking into older ages (124, 486). The delay into family roles from the increasing participation of tertiary education and changing family structures over time may be contributing to this shift (285, 573). This also includes changing levels of religious association, related to moderating attitudes in the literature (311, 574), a lack of which was associated with increased binge drinking risk in men and women in panel data.

Although there was no association of binge drinking with having children in the household for both sexes in cross-sectional data, having no children in the household was associated with binge drinking and initiation of binge drinking in panel data for women only. However, transitions in child status in any direction were associated with a cessation in binge drinking in men but not women. Whilst parenthood is generally associated with reductions in binge drinking, particularly in women in US studies (469, 477), men may only be less likely to binge drink with young children (<5 years in studies) compared to women (102, 575).

Divorced marital status was associated with increased risk of binge drinking in both sexes cross-sectionally but only in men for panel data. Longitudinal research suggests that the moderating impacts of a partner's drinking, particularly women on men's drinking, are lost when a relationship ends, along with other family responsibilities, that may lead to a return to former drinking behaviours with wider social networks (286, 287). Discordant drinking behaviours between couples, rather than drinking volumes, may be associated with marital dissolution (576). Therefore, similar to retirement, transitions in relationships may be related to binge drinking through changing contexts that require further clarification (285). It then follows that an association of friendships with binge drinking was only found in men and not women, including a transition to no reported friendships negatively associated with maintaining binge drinking in men. The qualitative literature has indicated that socialising and maintenance of friendships was

a motivator and promoter for excess drinking in midlife men, associated with the use of on-trade venues (79, 115, 118), particularly if there was friendship approval of such drinking (519). In contrast, women may be more likely to use alcohol for self-care purposes facilitated by home drinking (119, 120, 132, 326).

Although no association was found in cross-sectional data, this outcome found only in men may be related to the multilevel regional variance found for male binge drinking in panel data, indicating higher risk in the North East and West of England, as found in an HSE study using all ages (298). Higher household alcohol expenditures, adjusted for household composition, were also associated with North and East Midlands regions, although not separated for the possible shared characteristics of households in those regions. The relationship between these findings is unclear but may relate to contextual drinking preferences, such as on-trade spending, which has maintained lower affordability and lower price elasticity compared to off-trade venues (343, 354, 523). On-trade spending for all ages in 2017/18 was highest in the North East and West in the Living Cost and Food Survey (LCFS) (352). However, urban residence was found to be associated with binge drinking in both sexes with moving to a rural area negatively associated with maintaining binge drinking. This could be related to multiple contexts such as changing social groups, outlet availability or transport connectivity (318, 507, 508). However, there was no association of household alcohol expenditure with urban residence suggesting that urban accessibility may not be important for purchasing in this age group.

7.2.3 Further Research to Support Outcomes

As previously considered in individual study discussions, further research could support these outcomes by providing more detail on the characteristics of specific higher-risk groups. This includes those drinking units above problem thresholds (50/35+), which may differ to hazardous drinkers (above 14 units but below problem) (236), co-consumers of tobacco and alcohol (239, 255), and identifying further middle-aged subgroups where risk drinking behaviours are rising, such as those identified for female binge drinking (577). Such outcomes would help public health to target those most in need and therefore distribute resources more efficiently. Further research would also support a better understanding of why factors, such as retirement or changes in relationship status, are associated with risk drinking behaviours. This may reveal the underlying contexts involved, such as economic, social or mental health resources, the targeting of which may provide longer-lasting outcomes on risk drinking behaviours (13, 248, 518). Although the qualitative literature has provided insight into understanding such contexts in relation to

changes in relationships or retirement (278), such associations would benefit from being quantified in the middle-aged drinking population.

One such context is the lack of research into understanding the locations where risk drinking and alcohol spending occur in middle-aged adults (78, 89, 100, 578). Individual characteristics are known to interact with community availability in different locations and social groups to impact risk alcohol consumption but this kind of data is limited for the UK context (534, 552, 579). Event level studies can consider promoters of risk drinking occasions, such as motivations, drinking groups and venues using designs such as ecological momentary assessment, diaries, or occasion recall (580). However, such research has not been performed specifically in middle-age with most studies performed in young adults or student populations, reducing generalisability (79, 100).

Understanding the contexts involved with both consumption and purchasing would help determine the most appropriate spatial scales to apply when considering place effects on alcohol consumption (69, 290, 581). Whilst shared household contexts are important, the spatial scales of alcohol purchasing are less likely to be influenced by only a small local context when considering the activity spaces involved with work, commuting, socialising and grocery purchases (78, 317). GOR is a relevant geographical measure if there are cultural or long term historical impacts from the region but smaller measures, such as local authority (LA), are still too broad to confer advantage (e.g. differences in Index of Multiple Deprivation (IMD) quintiles across LA) whilst small area measures in relation to home may not detect relationships with public alcohol activities (214, 582). This also relates to MAUP[24] in which different boundaries can lead to different observed relationships to the outcomes and may not be relevant to the social processes being investigated (301, 302).

7.3 Strengths and Limitations

This section provides a summary of the strengths and limitations of this thesis, including sources of bias (583), that should be considered when interpreting study outcomes. Improvements to survey and data quality are also suggested towards the end of this section.

Both the cross-sectional and longitudinal datasets used in this thesis, the HSE and Understanding Society (USoc), were chosen to apply a social-ecological framework considering both individual-level and contextual factors, including repeated surveying over time, specifically in middle-aged

[24] Modifiable Areal Unit Problem

adults, that would address the research objectives (68, 100). This includes the use of multilevel modelling that can account for the non-independence of repeated measures and regional residence to individual-level characteristics (450, 500). Both datasets provided good sample sizes and maintenance over repeated measures to provide statistical power in main models (387). All three studies contained a temporal aspect to consider changes in alcohol behaviours, sample composition and period effects (21). This included annual trends of harmonised unit conversions (151) and alcohol expenditure, within-person changes (208), and changes in risk factor associations over study periods (481).

The first two studies used thresholds of risk drinking that were relevant to the public health guidelines and comparable to other health surveys in the UK as alcohol is used within a harm reduction framework (175, 584). A linear unit change would not capture the characteristics related to risk alcohol consumption that was the target for investigation (162, 585). Both surveys used the recommended BSQF[25] method to capture alcohol consumption, although USoc did not offer drink serving sizes available in the HSE and therefore standard servings were assumed (190, 415). The third study used an untransformed measure of expenditure that has greater interpretability than a linear measure adjusted for non-normality (528). The study samples included drinkers only and excluded those reporting no alcohol intake or no alcohol expenditure in the survey. This was based on evidence that abstainers are not the same as low-risk drinkers by health and socioeconomic status which could bias the low-risk reference group, as explained in Chapter 3.8.2 (206, 434, 435). A sensitivity test of study 1 found that including abstainers created a greater association of health status that is likely related to the poorer health found in abstainers and ex-drinkers (586). Not including cases without alcohol-related measures also removed the statistical issues of dealing with zero as an outcome (437, 587).

The sex-specific stratification revealed differing characteristics with risk alcohol consumption that would not be observed with simple adjustment and reduced the need to account for household-level clustering (71, 457). Most predictor variables were measured with the same categories in both surveys allowing a degree of harmonisation, however the lack of weighting may have reduced comparability of the different study samples in descriptive statistics (443, 514). There are likely to be further measures not controlled for that contribute to the relationship with alcohol consumption, as sources of unmeasured confounding, particularly in repeated cross-sectional analysis (527, 583). For example, cohort studies suggest a role of early lifecourse

[25] BSQF: Beverage specific, quantity, frequency.

socioeconomic position with drinking in midlife (275, 588), however these measures were not available in the HSE and were not matched across waves in USoc and therefore not included.

7.3.1 Sources of Bias and Estimation Error

The use of survey data and self-reported alcohol consumption measures introduced sources of both selection and information bias that may have produced a study sample with characteristics less representative of the target population group of middle-aged drinkers (583). Both surveys used sampling designs to achieve representation, but the response rates were moderate at around 60% for the HSE and 57% for USoc wave 1. Both surveys are known to have minor under-representation of men and Londoners (of all ages) (378, 403). Non-response for specific variables led to the use of complete case analysis which created a sample with some bias towards a drinking population who were in younger middle-age, employed and with qualifications in both study 1 and 2, that may have contributed to the higher socioeconomic associations for drinking measures in this thesis. Survivorship bias may have caused the percentage of risk drinkers to appear to decline with age when some long-term risk drinkers may have been non-responders due to failing health, particularly for cross-sectional HSE analysis (438).

Mixed models allowed for the inclusion of households with missing waves which reduced the amount of non-response in studies 2 and 3 (452). However, attrition bias may have reduced the representation for ethnic minorities and low income or low education responders over survey waves in USoc analysis, again contributing to a higher socioeconomic sample (403). The oversampling of ethnic minorities in sampling designs and the large sample size achieved for the main models in this thesis may have been able to buffer loss to non-response and attrition bias by providing sufficient sample sizes of under-represented groups, which was chosen as a management strategy over the use of weighting, as discussed in Chapter 3.8.3 (377, 399, 583). Changes in sample representation over survey years may have falsely led to the appearance of changes in sample composition, such as the increase in employed adults in study 3, or the high percentage of binge drinking in study 2 if low-level drinkers were more likely to leave the study. This may have been further exaggerated by the availability of binge drinking measures only in those who drank in the previous week and therefore the exclusion of less frequent drinkers (515), which also restricted the sample size for transition analysis in study 2.

Self-reported alcohol measures are prone to underestimation due to poor recall (411). This has been found to occur more for occasional and mixed drinking patterns and therefore may be less of an issue for the binge drinking measure, with a one week reference period, than average

weekly drinking with a one year reference period (376, 386, 433). However, binge drinking behaviours may be more prone to social desirability bias where participants may adjust their responses, intentionally or not, to be in line with perceived social norms, particularly in individuals of higher socioeconomic status (429, 431, 433). Adjusting for such under-reporting requires further research into the population distribution of this bias (375, 376). Although slightly more prone to non-response, social desirability bias may have been reduced by the use of a self-completion booklet for USoc alcohol measures compared to an interview in the HSE (384, 517).

7.3.2 Data Limitations and Survey Recommendations

There is a need for a longitudinal measure of chronic alcohol consumption to measure against exceeding the weekly guidelines. The lack of this measure limited further longitudinal research into outcomes found cross-sectionally that were found to differ to binge drinking, such as retirement. A typical weekly measure is a better indicator of overall alcohol-related harm (153, 163, 589) although binge drinking does contribute to increased mortality independently (590). The switch to using AUDIT-C[26] measures in USoc wave 7 limited the number of consecutive waves that could be analysed and is a poorer quality measure from its absence of specific beverage or serving sizes for the calculation of units (418). The lack of coherence in alcohol measures and for not measuring patterns of drinking across studies is a known criticism of the area (584).

The origins and justification of the UK binge drinking threshold and one-week reference period have not been clearly defined (191, 192). Whilst the weekly guidelines are based on evidence for exposure and harm, the binge drinking threshold appears to be based on the former daily guidelines (41, 186). Determining a threshold for binge drinking is considered more challenging due to its irregularity and individual differences in alcohol tolerance (188, 591), however there does not appear to be a review on consolidating the current use of the 8/6+ threshold in the UK (592, 593). Surveys should include a measure of the typical frequency of binge drinking, recognising that participants may not understand a definition using units, as the intensity of this behaviour is unknown and limits assessment of change longitudinally (99, 509, 594). The current use of a one-week reference period leads to a biased assessment of only recent drinkers, an issue found across British cohort studies for both typical weekly intake and binge drinking (Table 2.2) (515). A one-month reference may better capture less frequent engagement in binge drinking for this age group.

[26] Alcohol Use Disorders Identification Test – Condensed Version

USoc is one of the only resources to contain a longitudinal measure of alcohol expenditure which would be more interpretable in combination with a typical alcohol consumption measure, although recognising the limitation that not all household members are surveyed. This would allow for the exploration of how well alcohol expenditure may function as a proxy for volume consumed (349). Improvement needs to be made for questions measuring alcohol expenditure, without the participant burden of a diary (536), by asking more specific questions about expenditure on beverage types, similar to that for consumption. A Swedish study that enquired about specific beverage types, frequency and volume purchased found an 87% coverage compared to retail sales, possibly as expenditure data may be less prone to social desirability bias (543). Separate expenditure estimations for on-or off-trade purchasing locations would provide contextual data for spending analysis. Making assumptions for other household members likely contributes to misestimation, particularly as drinking outside of the home may not occur as a household unit (423).

7.4 Public Health Implications

These findings support discussion in the public health sector by highlighting trends, personal characteristics, contextual influencers, and sensitive periods associated with exceeding recognisable alcohol risk thresholds and alcohol spending. Exceeding the former weekly guidelines appears to be on the decline in middle-aged drinkers aged 45-69 years from England, however 30% still exceed this guideline (595). The convergence of genders for this risk and the slower decline in women suggests that targeting should no longer be biased towards men (577, 596, 597). The percentage of binge drinkers has increased, particularly in women although the greater burden of harm remains in men, as indicated by their higher percentage of hospitalisations by acute injury and intoxication in this age group compared to women (see Chapter 2.2.1) (166).

The alcohol harm paradox has highlighted the greater burden of alcohol-related harm in adults from deprived areas or of lower social class, as previously discussed in Chapter 2.2.5, although the relationship in middle-age is less clear (216, 236, 553). In this thesis, a lower individual socioeconomic status or IMD quintile were not indicated as sources of risk consumption in this age group, except for having no educational qualifications with male binge drinking. Except for binge drinking in tertiary-educated female smokers, there was also no interaction found for socioeconomic indicators (income, education, employment) with smoking or BMI on risk drinking in this age group, where co-risk factors have been theorised to increase alcohol-related harm in deprived individuals (237, 243). Socioeconomic inequality is smaller for partially

attributable chronic conditions, such as alcohol-related cancers, compared to wholly attributable conditions (222). As partially attributable conditions are the greatest source of alcohol-related harm in late middle-age, targeting risk alcohol consumption should not be restricted to deprived areas (6, 39). Higher socioeconomic status may be associated with better general health that may increase the maintenance of high alcohol intakes that require several years for such conditions to develop (23, 208, 217).

Co-consumers of alcohol and tobacco should be a target for intervention due to their strong association with both kinds of risk drinking and higher accumulation of harm (237, 239, 255). Use of both substances appears to reduce cessation of either behaviour, with social drinking identified as a source of smoking relapse (259, 567, 570). However, quit attempts for smoking may coincide with reductions in alcohol use, indicating an opportunity to target both behaviours (258, 260, 560).

The qualitative literature identified that middle-aged drinkers may downplay alcohol-related health risks in favour of social norms and enjoyment and may be unwilling to adhere to guidelines if preferring self-assessed limits (112, 117, 126, 598). Such social contexts of risk alcohol consumption were indicated in this thesis with drinking behaviours known to be shared between partners, friends and relatives (118, 128). These behaviours are strengthened by the approval of higher risk intake and normative misperceptions (118, 128, 519, 599). Providing normative information on other's drinking behaviours may help to reassess assumptions but the effects on consumption are considered small (600, 601). Alternative options for socialising and breaking routines that promote risk may be required (42). There may now be a greater acceptance and availability of drinking in retirement, which was identified as a risk factor for excess weekly drinking in both sexes (13, 278).

Male binge drinking was indicated with a regional effect in the North East and West of England which may contribute to the known inequalities of harm found in this region (165, 229), particularly as binge drinking has been indicated as contributing to the alcohol harm paradox (232). While public health is currently not a licensing objective in England, this may indicate further implication of local cumulative impact policies, particularly as alcohol expenditure for the on-trade is high in this region (337, 352, 602) and individuals in this region may be less price responsive, according to a regional survey (603). Currently, the effectiveness of community-level intervention appears to be small or unclear, potentially due to the absence of contextual studies on drinking occasions and venues as previously described (45, 48, 604).

The decline in exceeding the weekly guidelines has occurred despite the evidence for increasing affordability to purchase alcohol in middle-age (105, 350). Purchasing power still has an important role in this age group but pricing policies may be less impactful in the higher socioeconomic risk groups identified, particularly as they are less likely to purchase the low-cost alcohol targeted by minimum unit pricing (359, 360, 605). However, such policies may impact the very highest volume purchasers who still prefer low-cost options, as previously discussed in Chapter 2.5.3 (356, 370).

These findings could inform health professionals, research and advice groups, such as Drink Wise Age Well (463) and the Royal College of Psychiatrists (91) working to improve risk identification and lifecourse sensitive interventions for middle-aged drinkers (35, 43). Whilst evidence suggests education alone is unlikely to be impactful (89, 320, 555), personal engagement strategies such as the use of Alcohol Brief Intervention (ABI) have been found to reduce risk alcohol consumption in middle-aged adults (34, 606) and are recommended by the World Health Organisation, in combination with macro-level alcohol strategies (19). Such interventions are cost-effective, generally accepted by participants (26, 607) and may be implemented in community settings such as pharmacies (608, 609). However, a 2016 report suggested that less than 10% of heavy drinkers by AUDIT had received an ABI by their GP (30, 610).

7.5 Conclusion

The consumption of alcohol at levels posing a risk to health is high in UK men and women aged 45-69 years. This thesis determined that there are statistically significant individual-level characteristics, within a social-ecological framework, which increase the risk of drinking alcohol to excess, and household level factors associated with increased household expenditure on alcohol in middle-age. These characteristics, including family, socioeconomic and co-risk indicators, differed by sex, drinking pattern and survey period analysed. When accounting for such characteristics, there was no variation in exceeding the former weekly guidelines between GOR residence. Differences by sex were also found when considering within-person transitions in characteristics, between survey points, associated with binge drinking. Drinking patterns may be changing in this age group with a decline in exceeding the former weekly guidelines coinciding with a rise in binge drinking patterns despite increases in household alcohol affordability over time.

The novel contribution of this thesis is addressing research gaps with age-group and sex-specific analyses, using recognised risk alcohol thresholds, to determine trends and associations with

two risk drinking behaviours and longitudinal household alcohol expenditure over time. The use of multilevel modelling methods on repeated cross-sectional and longitudinal survey data accounted for regional living area and within-person changes in panel data that were absent in the literature for middle-aged risk drinking in the UK. The statistically significant characteristics found to be associated with risk drinking in this age group could be used to develop age and sex appropriate health targeting and policy to reduce such alcohol consumption in this population. Future research would help target the subpopulations at higher risk of these drinking behaviours by determining the underlying social mechanisms and place contexts where these occur.

Appendix A

Table 7.2 shows how changes to question responses in Understanding Society (USoc) waves 5 and 7 for 12-month drinking frequency would be poorly addressed through simple aggregation. It is impossible to know if the differences across waves reflect real changes in longitudinal frequency or a different interpretation of the responses by participants.

Table 7.2 Comparison of longitudinal responses to wave 5 and wave 7 frequency of alcohol consumption (aged 45-69 years) in USoc.

Original Question	**New Question: Alcohol frequency past 12 months (WAVE 7) →**				
↓How often drank alcohol last 12 months (WAVE 5)	**4+ times per week**	**2-3 times per week**	**2-4 times per month**	**Monthly or less**	**Total**
Almost every day	391	80	6	4	481
Five or six days a week	249	89	19	5	361
Three or four days a week	219	539	86	16	859
Once or twice a week	59	557	578	100	1295
Once or twice a month	7	56	290	227	580
Once every few months	5	12	75	269	360
Once or twice a year	5	3	24	221	254
Total	934	1337	1078	842	4190

Shaded areas indicate outcomes of similar responses in waves 5 versus wave 7.

Table 7.3 shows associations of household alcohol expenditure using a Poisson multilevel model that considers expenditure as whole integers rather than continuous data. An offset was created that represented alcohol expenditure as proportional to income and therefore income was not included as a fixed effect. A percentage of 3.16% was chosen based on the mean percentage of income spent on alcohol for the sample. This was transformed using a natural log function due to using a log link in the Poisson model. Using this offset allows the model to better account for household affordability with a higher outcome in the model representing a larger proportion of income spent on alcohol.

Proportional expenditure on alcohol was highest for single-person households (Risk Ratio (RR) 1.34 95%CI [1.30-1.39]), households without children (<16 years) (1.27 [1.23-1.32]), younger age household representative person (HRP) (1.21 [1.16-1.27]), without adults in employment (1.23 [1.18-1.28]) and social benefit as the main source of income (1.23 [1.18-1.29]). The lowest RR were found for London (RR 95%CI 0.70 [0.66-0.75]) and East England residence (0.76 [0.71-0.80]).

Table 7.3 Multilevel Poisson regression of household previous month alcohol expenditure with middle-aged HRP.

Level 2 Fixed Effects	RR	95% CI	*wave interaction (sig. only)
Wave (linear)	**0.98**	**0.98-0.99**	
Age			
45-49	**1.21**	**1.15-1.26**	
50-54	**1.20**	**1.15-1.25**	
55-59	**1.16**	**1.11-1.21**	
60-64	**1.12**	**1.08-1.16**	
65-69 (Ref.)	1.00		
Ethnicity of HRP			
British White	**1.21**	**1.16-1.25**	
Other ethnicities (Ref.)	1.00		
N of Adults in Household			
1	**1.34**	**1.30-1.39**	
2+ (Ref.)	1.00		
Children in Household			
No	**1.27**	**1.23-1.31**	
Yes (Ref.)	1.00		
Employed Adults in Household			
No	**1.23**	**1.18-1.28**	
Yes (Ref.)	1.00		
Largest source of income			
Investment income	0.99	0.94-1.05	
Pension or private benefit	**0.95**	**0.91-1.00**	
Social Benefit	**1.23**	**1.17-1.29**	
Labour (Ref.)	1.00		
Housing Tenure			
Rental or other	1.04	1.00-1.07	
Mortgage	**0.95**	**0.93-0.98**	
Owned outright (Ref.)	1.00		
Population Density			
Urban	**1.08**	**1.05-1.10**	
Rural (Ref.)	1.00		
Government Office Region			
Northern Ireland	**0.89**	**0.89-0.83**	
Scotland	**0.77**	**0.77-0.72**	
Wales	**0.83**	**0.83-0.78**	
South West	**0.82**	**0.82-0.77**	
South East	**0.78**	**0.78-0.74**	
London	**0.70**	**0.70-0.66**	
East England	**0.76**	**0.76-0.71**	
West Midlands	**0.81**	**0.81-0.76**	**1.04 [1.01-1.07]**
East Midlands	**0.92**	**0.92-0.87**	
Yorkshire & the Humber	**0.92**	**0.92-0.86**	
North West	**0.90**	**0.90-0.85**	
North East (Ref.)	1.00		
Level 1 Wave Variance	**Estimate**	**Std. Error**	
1	112.39	1.72	
2	123.42	1.88	
3	112.97	1.72	
4	156.41	2.44	
5	118.37	1.91	
6	106.29	1.76	
-2 log-likelihood	200,875		

***p* <0.05** RR: Risk Ratio

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