



Contents lists available at ScienceDirect

## Trends in Food Science &amp; Technology

journal homepage: [www.elsevier.com/locate/tifs](http://www.elsevier.com/locate/tifs)

## ICONIC: An international task force supporting collaboration in nutrition and cancer globally

Rachel E. Marklew<sup>a,\*</sup>, Alan A. Jackson<sup>a,b,d,e</sup>, Martin J. Wiseman<sup>a,b,c,d</sup>,  
Stephen A. Wootton<sup>a,b,d,e</sup>, on behalf of on behalf of the International Collaboration on Nutrition  
in relation to Cancer (ICONIC)

<sup>a</sup> International Collaboration on Nutrition in relation to Cancer, Task Force of the International Union of Nutritional Sciences (IUNS), London, United Kingdom

<sup>b</sup> Faculty of Medicine, School of Human Development and Health, University of Southampton, Southampton General Hospital, (Mailpoint 113), Southampton, SO16 6YD, United Kingdom

<sup>c</sup> World Cancer Research Fund International, 140 Pentonville Road, London, N1 9FW, United Kingdom

<sup>d</sup> National Institute of Health Research Cancer and Nutrition Collaboration, Southampton General Hospital, Tremona Road, Southampton, SO16 6YD, United Kingdom

<sup>e</sup> National Institute for Health Research Biomedical Research Centre, Southampton Centre for Biomedical Research, Southampton General Hospital, Tremona Road, SO16 6YD, United Kingdom

## ARTICLE INFO

**Keywords:**  
Nutrition  
Cancer  
Capacity building  
Prehabilitation  
LMIC  
Children

## ABSTRACT

**Background:** Cancer represents a major cause of mortality globally and by 2050 will be the major cause of ill health and death across the world, most particularly in low- and middle-income countries (LMIC). For forty years, there has been increasing recognition of the need to better understand how the modifiable factors related to diet, nutrition and physical activity can influence the risk of cancer, responses to treatment, and survival.

**Scope and approach:** The International Collaboration on Nutrition in relation to Cancer (ICONIC) - a task force of the International Union of Nutritional Sciences (IUNS) - was established in 2018, as a development from the UK NIHR Cancer and Nutrition Collaboration and as a mechanism to bring together wider international expressions of interest in nutrition and cancer.

**Key findings:** ICONIC has engaged in a range of activities, with a current focus of effort in three main areas: 1) building wider capability and stronger capacity for excellence in research and practice in Africa, with the longer-term ambition to develop a high quality, context-specific research programme in this region, 2) facilitating international collaboration and developing activities in the area of childhood cancers, and 3) developing an agenda for prehabilitation (personalised management of exercise, nutrition and psychological support before the start of definitive treatment) for cancer.

**Conclusions:** ICONIC's ambition is to build an international nutrition and cancer community - spanning research, education and training, in clinical and public health practice - to create coherence and common language across the two communities, and promote improved care and outcomes for those affected by cancer.

### 1. Overview of the last 40 years in nutrition and cancer

Nutritional factors have been implicated in determining risk of cancer for over 40 years (Doll & Peto, 1981) and in that time the nature of the relationships has been more clearly elucidated (WCRF/AICR, 1997, 2007, 2018) (Fig. 1). There has been a rapid increase in the amount of both observational and experimental evidence from humans, as well as in understanding the underlying mechanisms over recent years. Indeed, more recent analyses confirm that conclusions about the

broad pattern of diet, body composition and physical activity that reduces risk of the commonest adult cancers, remain largely unchanged over the last 15 years (WCRF/AICR, 2018). However, there remains further work to do in extending understanding to include populations not generally included in the existing evidence, and in exploring the role of nutrition in influencing progression of cancer after a diagnosis, or the response to treatment, or quality of life. There is now ample evidence that avoiding excess adiposity through regular physical activity and a diet rich in plant foods, moderate fresh red meat and dairy, and little if

\* Corresponding author.

E-mail address: [r.marklew@wcrf.org](mailto:r.marklew@wcrf.org) (R.E. Marklew).

<https://doi.org/10.1016/j.tifs.2022.08.019>

Received 11 July 2022; Received in revised form 17 August 2022; Accepted 28 August 2022

Available online 5 September 2022

0924-2244/© 2022 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

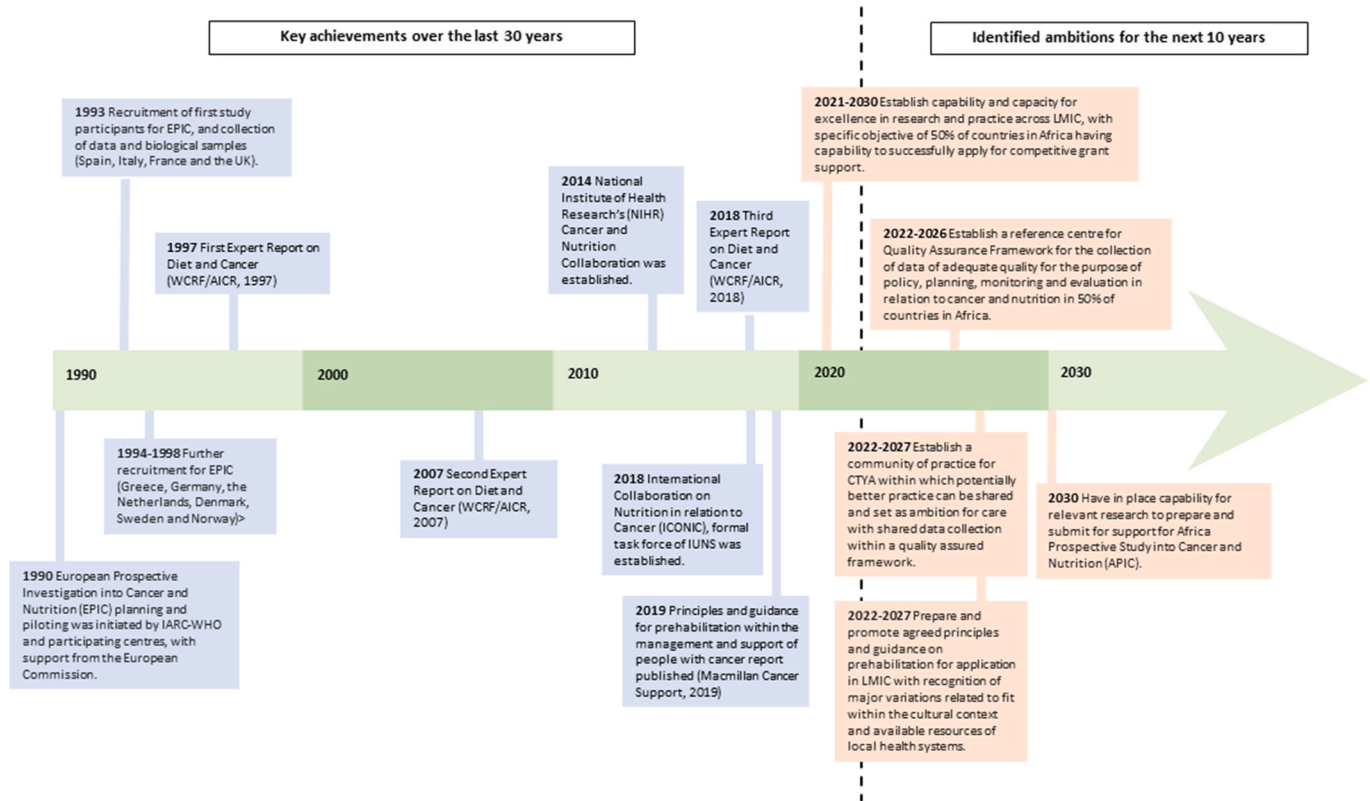
any added sugar, ‘fast foods’, alcohol or added salt, is the most important way of avoiding cancer after not smoking (WCRF/AICR, 2018). There is increasing interest in the role of so called “ultra-processed foods” in human health (Monterio et al., 2019). WCRF recommendations emphasise the avoidance of highly processed foods that are high in fat, salt or refined carbohydrates, as these are markers of a “Western” type dietary pattern associated with higher incidence of several types of cancer. However, any mechanisms underpinning such an association remain unclear. It remains to be established if the degree of processing *per se* is important, or whether it simply acts as a marker for other characteristics such as adiposity or consumption of processed meat, that themselves mediate an increase in risk. One study has directly linked higher consumption of ultra-processed foods to overall and breast cancer mortality, though it did not shed light on possible underpinning mechanisms (Fiolet et al., 2018).

The prevalence of cancer is increasing worldwide, with 19,292,789 reported cases in 2020 and accounting for nearly 10 million deaths (9,958,133 deaths) in the same year (Sung et al., 2021). In light of recent trends in incidence and global demographic projections, it is estimated there will be 28.4 million new cancer cases each year by 2040 and cancer will become the most common cause of mortality and morbidity. The changing pattern is attributed to the ageing population and increasing life expectancy, together with an increasing prevalence of the double burden of malnutrition (characterised by the World Health Organization as *the coexistence of undernutrition along with overweight and obesity, or diet-related noncommunicable diseases, within individuals, households and populations, and across the life-course* (World Health Organization, 2017)).

The particular pattern of cancers varies between countries, and within countries over time. It is likely these differences, and changes in populations that migrate between countries, are related to different or

changing patterns of exposure (Sung et al., 2021; WCRF/AICR, 2018). In many countries, there have been reductions in exposure to toxic and infective causative factors. This applies most particularly to the smoking of cigarettes, but also other environmental toxins such as aflatoxin or arsenic, or exposure to infection with viruses (e.g. human papillomavirus (HPV) or Hepatitis C), or bacteria, e.g. H Pylori). In contrast, there has been an increase in endogenous risk factors, often related to low grade inflammation such as physical inactivity, obesity, greater attained adult stature and other manifestations of the cardio-metabolic syndrome. Although higher cancer incidence rates occur in high-income countries (HIC), cancer mortality rates and total mortality are significantly higher in lower- and middle-income countries (LMIC), and these continue to rise (Torre et al., 2016). A substantial increase in prevalence is projected for all countries, but greatest rates of increase are expected for LMIC (Ferlay, Laversanne, et al., 2020), where resources for prevention and care are relatively limited.

The capability and capacity to prevent, treat and manage cancer are inadequate relative to the magnitude of the problem. Therefore, there is an imperative to improve prevention and increase effectiveness of treatment, which should include the better targeting and stratification of care. Progress in all these areas is constrained by inadequate understanding of the mechanisms that promote vulnerability, underlie risk, and constrain efficacy of current therapeutic options. The strong evidence from well-conducted epidemiological studies for likely causal relationships amongst diet, nutrition, physical activity and cancer indicate that the immediate nutritional microenvironment of the cancer is of importance, and this is probably determined by the wider metabolic state of the host (WCRF/AICR, 2018). There are many putative mechanisms that might explain these relationships, but the evidence is not sufficiently fine-grained to enable a secure nutritional diagnosis that can reliably inform appropriate evidence-based stratified care.



**Fig. 1.** Relevant key developments in nutrition and cancer over the last 30 years and identified key challenges for ICONIC ahead. The UK NIHR Cancer and Nutrition Collaboration was established in 2014 to address unmet needs identified within reports of the evidence and as a mechanism to apply recommendations in practice. ICONIC was established to mirror the UK activity but with an international focus, particularly in LMIC where the need is especially great. Main challenges relevant to ICONIC's current activities are identified for the next 10 years.

The cancer burden is of considerable size and has been compounded by the recent global Covid-19 pandemic, with significant disruption of cancer services across the globe as a result. This represents a major challenge and will come to dominate the delivery of healthcare to populations across the world, with the challenge to all health systems to provide effective care and support expected only to increase.

## 2. An international task force on nutrition and cancer

In 2014, the UK National Institute for Health Research (NIHR) Cancer and Nutrition Collaboration, coordinated by the NIHR Southampton Biomedical Research Centre (BRC), was initiated with the aim of engaging interdisciplinary stakeholders in the UK, to bring coherence to existing activities and provide a coordinated framework as a basis for future research into nutrition and cancer (NIHR Cancer and Nutrition Collaboration, 2015). To mirror the work of the UK Cancer and Nutrition Collaboration, in 2018 the International Union of Nutritional Sciences (IUNS) established an international nutrition and cancer task force to bring together wider international interests in this area. The International Collaboration on Nutrition in relation to Cancer (ICONIC) was specifically set up to promote and facilitate collaboration between the international scientific communities engaged in nutrition and cancer in research, education and training, in clinical and public health practice. ICONIC has drawn heavily on the experience of the UK NIHR Cancer and Nutrition Collaboration and comprises organisations with international commitment and responsibility in relation to nutrition or cancer (Fig. 2): the World Cancer Research Fund International (WCRF), the Union for International Cancer Control (UICC), the International Malnutrition Task Force (IMTF), the International Agency for Research on Cancer (IARC) and the International Atomic Energy Agency (IAEA). Specifically, ICONIC's ambition is to build capacity that will support practitioners in their training and practice, promote research leading to public policy focused on impactful intervention, and promote improved care and outcomes for those affected by cancer.

Most research on the relationship between nutrition and cancer risk derives from populations in HIC – including the USA, UK and mainland Europe – but the natural history of common cancers in LMIC, for instance breast cancer in Africa, differs from that in HIC, as do the patterns of nutritional exposures (Ssentongo et al., 2022). This makes it difficult to extrapolate with confidence the conclusions on nutritional determinants of cancer risk, and emphasises the need for locally relevant sources of evidence. Furthermore, current modes of treatment for cancer are resource intensive and may not be as accessible to lower-income communities, further highlighting the need for evidence on effective preventive measures.

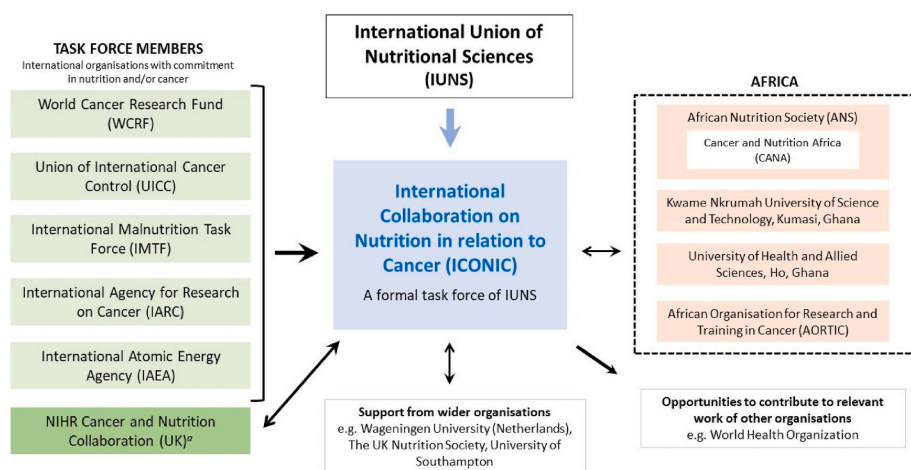
There are fewer data on the nutritional impact on people after a

diagnosis of cancer, and while nutrition is a major focus of policy and public health practice, it is less often an embedded feature of clinical care in cancer. There is a need to build bridges between the nutritional, public health and clinical care communities to improve research, training and practice relating to nutrition in cancer prevention and care. One key basic need is to ensure that nutritional measurements made in clinical practice and in research, conform to common standards - an agreed quality assurance framework for such measures (including anthropometric and physiologic measures as well as laboratory analyses) is a fundamental need to support an investigative framework (Wootton et al., 2014).

Key activities of ICONIC are currently focused around three important areas: 1) building stronger capability and wider capacity for excellence in research and practice in Africa, with the longer-term ambition to develop a high quality, relevant and context specific research programme in this region, 2) facilitating international collaboration and developing important activities in the area of childhood cancers, and 3) developing an agenda for prehabilitation (personalised management of exercise, nutrition and psychological support before the start of definitive treatment) within the management and support of those living with cancer. The following sections comment on the current state of knowledge and activity in each of these areas, and highlight some of the needs going forward.

## 3. Capacity building and developing a high-quality research programme for Africa

The predominant rates of increase in cancer incidence and prevalence are in LMIC (Sung et al., 2021), an accompaniment of the demographic, epidemiological, nutrition and development transitions. According to the Global Cancer Observatory (GCO) of the International Agency for Research on Cancer (IARC), 801,392 new cancer cases and 520,158 cancer deaths were estimated to have occurred in sub-Saharan Africa in 2020 (Bray & Parkin, 2022). Although this may seem relatively low compared with other countries, there are important issues to consider in relation to the impact and future of the disease in Africa. Cancer incidence is rapidly rising in Africa with an increase of over 45% since 2000, and cancer mortality is elevated in sub-Saharan Africa (Bray & Parkin, 2022; Ferlay, Ervik, et al., 2020). In the next 20 years, the burden is expected to double to nearly one million deaths as a result of population growth and ageing (Bray & Parkin, 2022; Ferlay, Laversanne, et al., 2020). It is projected that countries in Africa will come to carry a major part of the burden of cancer related ill-health, despite being poorly equipped to promote prevention or to cope with the costs of care. By 2030, an estimated 75% of all cancer deaths globally will occur in LMIC (Ferlay, Laversanne, et al., 2020).



**Fig. 2. International Collaboration on Nutrition in relation to Cancer (ICONIC).** Illustration to demonstrate the way in which ICONIC collaborates with and receives support from a variety of organisations (not intended to be exclusive and is based on current main activities).

\*ICONIC was established as a development from the UK NIHR Cancer and Nutrition Collaboration and as a mechanism to bring together wider international expressions of interest in nutrition and cancer. ICONIC sits as observer on the NIHR Cancer and Nutrition Collaboration Executive Committee.

There is considerable variability across Africa, with a wide range of social, economic, cultural and ecological niches. The continent is in the midst of the demographic, epidemiological, nutritional and developmental transitions and there are wide, dynamic differences within and between countries, at different rates of change. However, there is no formal attempt to capture either the current situation, nor to anticipate the pattern of change in a way that would be imperative for planning prevention and care services. The fast transition in dietary patterns and food production observed in LMIC, particularly among the poorest people and communities, is associated with more nutrition-related types of cancer. In Africa, there are limited studies that capture aspects of many of the factors that relate to cancer as an outcome, and only selective information on diet and dietary patterns (Aglago et al., 2019).

Most of the evidence which relates diet and physical activity exposures to various cancers has been generated from studies in the USA and Europe. The European Prospective Investigation into Cancer and Nutrition (EPIC) study, one of the largest cohort studies in the world with more than half a million participants recruited across 10 European countries, has provided major insights into how best to conduct studies of quality using validated methods across wide geographies - thereby generating evidence which is secure in identifying causality. There is little evidence from Africa that usefully informs on these relationships and which can be used to directly influence patterns of diet and physical activity. Given this lack of evidence, it was disappointing to see that a recent Lancet Oncology Commission on cancer in sub-Saharan Africa failed to emphasise adequately the importance of diet and physical activity as the major modifiable risk factors for cancer incidence and survival, together with smoking (Ngwa et al., 2022). There is an urgent need for investment in studies of quality in Africa with the potential to provide evidence that will be of substantial health and financial value to the people and countries of Africa themselves, but also confer benefit on the global drive to improve the health of all.

In fostering capacity building as a core ambition, ICONIC has been working towards building a more extensive capability and stronger capacity for excellence in research and practice across LMIC. Against many pressing demands and the desire to have a major prospective study across Africa that is similar in character to EPIC (Riboli et al., 2002; <https://epic.iarc.fr>), the development of capability and capacity in the first instance is considered paramount and fundamental to any progress. Having this securely in place would increase the likelihood of success for defined research projects, which would eventually build towards a major continent-wide collaboration to address the issues around the most common cancers in context.

As a first step and as part of building technical capability in the region, ICONIC has been working with Wageningen University and Cancer and Nutrition in Africa (CANA), a group of African scientists formed within the African Nutrition Society, to develop and implement training that will improve the preparation of grant proposals in the area of cancer and nutrition epidemiology. This learning experience has been based on similar courses offered by Wageningen University, but tailoring the new course to the African context. Following a successful pilot experience, the online course will be offered each year to African scientists who want to gain knowledge and experience with writing grant proposals in this specialist area.

Drawing on the EPIC experience, other important capabilities are recognised as critical to have in place in order to achieve this major research ambition for Africa. For rational cancer control and planning, there is the need for considerable capacity to be developed in all areas - especially data generation, analysis and interpretation, and the strengthening of capability for cancer registries (Bray & Parkin, 2022). For this to be carried out, with each country accepting responsibility, it will be necessary for a substantial increase in research activity and hence the need for those with the ability to compete successfully for grant support. Furthermore, if these data were to be collected using standardised methods within a quality assured framework, they would be available for geographical comparison and contribute directly to the

global experience. Of particular importance is the ability to collect data on diet (food and nutrient intake, dietary pattern and amounts), physical activity (a factor that sets the demand for food (energy and protein) and marks health potential) and anthropometry (height, weight, circumference, skinfold thickness, grip dynamometry) as markers of nutritional state, with validity and reproducibility across different centres, and within and between different countries (Wootton et al., 2014). There is some experience of collecting comparative data on some of these measures, but this is selective and limited in its scope (Pisa et al., 2018). Building on this experience to develop agreed and formally structured approaches to the collection of data, will greatly add value to the individual efforts within a collaborative enterprise. ICONIC is thus seeking to establish an appropriate Quality Assurance Framework (QAF) for the collection of data of adequate quality for the purpose of policy, planning, monitoring and evaluation in relation to cancer and nutrition. Having in place the security of quality assurance will facilitate research and service in cancer directly, but will also contribute to and add considerable value to other major efforts, such as the School Feeding Agenda (World Food Programme, 2020).

This is a major ambition and capability has to be developed sequentially. In order to bring together each of these capabilities, ICONIC and CANA are in the process of developing a series of studies in preferred locations across the continent, using standardised and validated methodologies, that will come together at some point in the future - using the example of EPIC as a model. This will undoubtedly be of direct benefit to Africa but will also provide value more widely. By adopting and replicating the secure approach developed within EPIC, these studies will validate the approach. Further, the data derived from this work will be directly comparable with the results from EPIC, thereby increasing its value by extending the variability in both the exposures and the range of outcomes across a much larger and more varied population. In time, the hope is that this will lead to deeper insights into the inter-relationships around causality and inform on patterns of change with time in different contexts.

#### 4. Nutrition and childhood cancers

Growth and development are defining features of health in childhood. Ensuring adequate and appropriate nutrition is essential for growth and development in children, teenagers and young adults (CTYA), but as with any ill-health, this is compromised in children with cancer. Comparatively little is known about the role of nutritional factors both in the development of childhood cancers and in survivors over time, but both overnutrition or undernutrition at diagnosis raises the risk of increased morbidity and mortality during therapy and beyond. Furthermore, all treatment modalities can jeopardise nutritional status with potentially adverse effects on clinical outcomes (Barr & Stevens, 2020).

There has been an ongoing interest on the relationship between nutritional state and childhood cancer for many years, with meetings for international exchange for at least 40 years drawing on the experience and enthusiasm of many different groups. Despite improvement in treatment and outcomes, these are much less efficacious in poorly nourished children and cancer remains an important cause of death in childhood (Barr & Stevens, 2020). Survivors carry significant risks to their long-term health in adult life, with acceleration of their vulnerability to ageing associated morbidity (Barr & Stevens, 2020).

A narrative review by Barr and Stevens, of the inter-relationships between nutrition and childhood cancer, identified experience that could be broadly categorised as deriving from HIC, or from LMIC (Barr & Stevens, 2020). The differences relate not only to the diagnostic and treatment options available in the different contexts, but also to the background nutritional status of the populations from which patients were derived. Children in places where undernutrition was prevalent were more likely to be poorly nourished at presentation, and this had an adverse effect on the response to treatment and outcome - the evidence

suggests that this adverse effect could be ameliorated with nutritional support in anticipation of treatment. A different pattern of problems was seen in children who were overweight, where responses to therapeutic interventions were uncertain and hence less secure. However, the data for these observations are limited and conclusions can only be drawn with caution. What was clear, was the need for a planned collaborative research agenda using standardised methodologies and well-defined outcome criteria. One of the major challenges for research is the relative infrequency of these conditions, making it difficult to achieve adequate statistical power for secure conclusions to be drawn in single studies in limited locations. Again, if measures of nutrition, nutritional status and the specifics of nutrition interventions were collected to an agreed standard, as a matter of course as a part of routine care, it would be more likely that adequate numbers could be achieved as part of a collaborative effort.

A number of groups with a stated interest in cancer and nutrition have come together to explore ways in which they might add value to each other's efforts. The International Society for Paediatric Oncology (SIOP) is the only global multidisciplinary society entirely devoted to CTYA related cancer, with a large international membership. SIOP has a focus both for HIC and LMIC, and its Nutrition Network aims to promote the translation of scientific nutritional understanding into clinical care, in order to improve outcomes for children. The International Initiative for Paediatrics and Nutrition (IIPAN) is a collaborative network of hospitals and clinicians and investigators conducting investigations in a number of centres in LMIC - its objective is to improve clinical care and hence success of cancer treatment throughout its network. The World Health Organization (WHO) also recently launched its Global Initiative for Childhood Cancer, with the aim of substantially increasing survival among children with cancer to at least 60% globally by 2030, and with an emphasis on LMIC – WHO has projected this would save an additional one million lives over the next decade ([World Health Organization, 2020](#)). The specialised agency of WHO, the International Agency for Research on Cancer (IARC), has extensive experience of global cancer surveillance and has established an initiative to promote and support a Biobank and Cohort Building network in LMIC. The International Atomic Energy Agency (IAEA) is one of the specialised agencies of the United Nations with a particular interest in human health and nutrition - it promotes the application of stable isotope methodologies to the characterisation of nutritional state for diagnosis, and to follow the response to interventions and assess the health effects of environmental factors. It has a five-year Coordinated Research Project into nutrition and childhood cancer. The World Cancer Research Fund International (WCRF) leads a network of cancer charities with global reach, and a relatively recent workstream of theirs is to provide clear guidance on food, nutrition and physical activity in childhood cancer, by better understanding the role of diet, body fatness and physical activity on survivors—the objective is to be able to develop evidence informed recommendations based upon a systematic and comprehensive review of the literature and to identify research gaps.

In the UK, the National Institute of Health Research Cancer and Nutrition collaboration has a workstream for CTYA which was developed closely with ICONIC. They have been able to bring together clinicians, allied health professionals and scientists to work together to promote nutrition research in CTYA cancer in the UK. Recently, they conducted a national survey of current practice around screening and assessment to inform the implementation of nutrition standards in routine care ([Henry et al., 2022](#)). Specifically, the survey gathered information on the availability and nature of dietetic support, and the extent and character of nutritional assessment from the principal clinical centres delivering care to CTYA in the UK. They identified major barriers to adequate nutritional assessment and treatment for all CTYA patients which included resource limitations (particularly for TYA), training for staff, and uncertainty about detailed assessment of nutritional status. There is every reason to move towards harmonisation of screening and assessment of nutritional status in CTYA in both HIC and LMIC settings,

although there may be context specific considerations that need to be taken into account. Most of those with responsibility for care recognise the importance of assessing every patient in relation to diet and nutrition. However, this is carried out inconsistently, and to a varied standard, with practices varying widely in different institutions. Agreement on how best to disseminate the results and generate recommendations for national practice is under way. Consideration is also being given to collecting similar data internationally, as baseline information for future activities and to inform ongoing studies being carried out by individual groups within the network.

In addition to the clinical and translational investigations, there is an urgent need for clarity around the mechanisms by which poor nutritional state influences the resilience to disease, response to treatment, and outcomes for children with cancer, so that ultimately this knowledge can be incorporated into clinical care and provide individuals and populations with evidence-informed guidance.

Given the widespread interest among the international community surrounding nutrition and childhood cancers, there was an early exploration of any need for a single grouping that might accept responsibility for drawing the experiences together and planning a coherent way forward, particularly for those operating in relative isolation in LMIC. Professor Michael Stevens, of Bristol University in the UK, accepted an invitation from ICONIC to explore how this might best be done. In order to facilitate collaboration and develop important activities in this area, in 2021 an ICONIC CTYA subgroup held an online Special Focus Dialogue hosted in collaboration with UICC (<https://www.uicc.org/events/special-focus-dialogue-nutrition-and-cancer-children-teens-and-young-adults-current-understanding>). There was extensive interest and recognition of the potential benefit of closer collaboration. Of particular note was the interest in HIC in being able to offer a consensus statement for current clinical practice, which would be pragmatic and experiential.

Overall, ICONIC supports the development of an agreed framework that will better enable collaboration to share understanding of what is already known, identify gaps in knowledge, and set research priorities that together will enhance opportunities for improved care.

## 5. Prehabilitation within the management and support of those living with cancer

Prehabilitation is the personalised management of exercise, nutrition and psychological support in patients before the start of definitive treatment for cancer. Poor diet and physical inactivity are established determinants of ill-health and have been shown to influence the development of several cancers, impact on its progression, response to treatment and the quality of life of those living with cancer ([Macmillan Cancer Support, 2019](#); [WCRF/AICR, 2018](#)). On receiving a diagnosis, people with cancer face many challenges. For some, the cancer may already have already affected their physical and nutritional state, as well as their psychological well-being. Surgery and anti-cancer therapies themselves may directly worsen nutritional state, decrease activity and increase psychological anxiety and distress. Individually and collectively, such changes can decrease resilience to the cancer, and affect response to cancer treatment with poorer outcomes.

Over the past decade, prehabilitation has developed as an extension of nutrition and other support during the perioperative and post-operative period, with initiation from the time at which a cancer diagnosis has been made and before any specific treatment modality has started. The European Society for Clinical Nutrition and Metabolism (ESPEN) has extensively reviewed the evidence available to inform the development of clinical guidelines on nutrition in cancer patients ([Arends et al., 2017](#)) and highlighted the poor quality of much of the evidence—many of the recommendations are restricted to a consensus of expert opinion. This guidance, like the subsequent practical comment ([Muscaritoli et al., 2021](#)), highlights the importance of addressing the nutritional needs of cancer patients before during and after treatment.

However, it does not consider how these recommendations might be best developed and applied in LMIC settings. There is the need to determine the extent to which guidelines that have been developed as applicable in HIC can be applied similarly in LMIC settings. Although it is to be expected that the principles might operate similarly, how best they might be implemented within different contexts, cultures and health systems in LMIC needs to be determined.

In 2019, the NIHR Cancer and Nutrition Collaboration, the Royal College of Anaesthetists and Macmillan Cancer Support worked together with other stakeholders and organisations to develop a collective view of what they saw as the principles and guidance for prehabilitation within the management and support of people with cancer (Macmillan Cancer Support, 2019). The underlying principle of prehabilitation is that patients need to be provided with structured support to address their nutritional needs, engage in supervised structured exercise therapy, and be offered psychological support to address their immediate concerns and promote their wellbeing (Macmillan Cancer Support, 2019). There is considerable evidence that nutritional interventions in those cancer patients who are undernourished prior to treatment, can improve nutritional state during treatment, reduce perioperative complications and reduce length of stay and health care costs. There is also accumulating evidence that structured exercise therapy in those who are inactive and unfit prior to treatment can improve functional capacity, accompanied by reduced perioperative complications. In the same way, psychological support can reduce and foster a sense of control and purpose, and can enable individuals to take steps that can improve their immediate ability to tolerate and respond to treatment, as well as help maintain long term health once treatment is completed. Combining these interventions together in a package of care before treatment starts is referred to as *multimodal prehabilitation*, which aims to prevent or ameliorate the decline in functional capacity associated with cancer treatment, improve the response to therapy, and enhance recovery. Although relatively new, the term prehabilitation is now accepted and the practice has become an important aspect of the care provided for patients with cancer, having been developed and adopted by a number of international organisations and with its own body, the International Prehabilitation Society and Evidence Based Perioperative Medicine (EBPM) (Gillis et al., 2021; <https://prehabsociety.com>).

Patients may have different degrees of risk for any given component of the intervention and so may require a different level of support for each element, within a framework of Universal, Targeted or Specialist prehabilitation interventions (Macmillan Cancer Support, 2019). The degree of need is dynamic and requires reassessment before, during and after treatment. The first step is to screen or triage the patients according to their level of risk in each of the three elements. For those with less advanced cancer, the advice and support is more generic so that it can be followed at home supported by virtual coaching, or offered in group sessions in community settings (universal prehabilitation). This does not require specialist equipment but does need trained and demonstrably competent staff (or trainers) who can support the patient, motivate them to exercise and direct them to resources that promote eating well, exercise, and behaviour change. Where the cancer is more advanced, or associated with rapid weight loss and feeding difficulties, severely constrained physical ability or associated with deep distress and anxiety, more targeted and specialist interventions may be offered by registered health professionals in association with conventional specialist hospital-based services. Simple schematics show how prehabilitation (before commencing treatment) and rehabilitation (after treatment) can affect the general health of patients with cancer over the timeframe from diagnosis of cancer, through treatment, recovery and living with and beyond cancer (Davis et al., 2022).

The NIHR Cancer and Nutrition Collaboration and ICONIC have continued to work with leading experts across the UK and internationally, to increase the evidence-base to support health and care services for people with a new cancer diagnosis, and better establish the role of prehabilitation in their treatment pathway by developing

implementation frameworks embracing screening, assessment and intervention (Bates et al., 2020; Davis et al., 2022). Much of the evidence has been generated in countries where the health care systems and resources are well developed. However, these same principles and guidance can be applied in all settings where access to resources may be limited as in LMIC. The principles are well-established but now need to be further refined and applied in ways that address the needs of the patients and fits within the cultural context of the local health system. Together with a sound understanding of the barriers and facilitators that determine the delivery, uptake and sustainability of care, alongside existing treatment pathways, these principles can be used to develop low-cost, high impact interventions. There is an interest in establishing prehabilitation activities more widely and ICONIC is exploring how it can work collaboratively, in the first instance across Africa where there is a demand (Fernandes et al., 2020), to determine how it might be possible to establish this in a way that is standardised and enables collection of reliable data.

## 6. Conclusions

It is now beyond debate that cancer will become a major cause of ill-health in the next 30 years, and as such, create a significant demand for services and a health budget that are beyond even more developed countries to cope. Without structured action as a matter of urgency, the situation in LMIC appears dire. ICONIC has accepted responsibility for exploring ways in which scattered efforts can be brought together for greater impact and has prioritised its activities, in the first instance, to areas that are underserved and where given adequate leverage, progress and impact might be demonstrable. For this reason, colleagues from Africa have been particularly receptive to potential for interventions related to diet, nutrition and physical activity, providing the traction needed for attracting support and going to scale. It is with this objective that CANA has been formed. Drawing on the wider experiences of other LMIC will help to determine how best to secure early progress. The African Organisation for Research and Training in Cancer (AORTIC) is dedicated to cancer control and palliation in Africa, and is actively connected to a global community who contribute to its activities. It has a primary focus in cancer, but some interest in nutrition related considerations and the opportunity to build an alliance with CANA offers the potential for reciprocal benefit for evident progress.

Given the importance of diet, nutrition and physical activity in relation to cancer and other non-communicable diseases (WCRF/AICR, 2018), the ability to collect high quality data in a standardised way is recognised by all the groups with which there is interaction. This emphasises the great importance of establishing a Quality Assurance Framework to consolidate the value and quality of effort in the area of nutrition.

As its immediate priorities, ICONIC will:

1. Establish a Quality Assurance Framework as a critical enabling capability for research, care delivery, monitoring and evaluation. It is of particular importance to collect quality data on anthropometry (height, weight, circumference, skinfold thickness, grip dynamometry); diet (food and nutrient intake, dietary pattern and amounts); physical activity (a factor that sets the demand for food (energy and protein) and marks health potential) as markers of different aspects of diet and nutritional state, to ensure validity and reproducibility across different centres, and within and between different countries.
2. Move towards the establishment of databases of quality assured data that will better enable the sharing of experiences.
3. Determine an approach that will enable a better understanding of the extent to which changing dietary patterns, novel methods of processing and novel foods, simply reflect wider social change or play a determinant role in cancer and possible relevance in relation to therapeutic foods.

These will be considered in relation to:

1. Building wider capability and stronger capacity for excellence in research and practice in Africa, with the longer-term ambition to develop a high quality, context-specific research programme in this region.
2. Facilitating international collaboration and developing activities in the area of childhood cancers.
3. Developing a framework for establishing prehabilitation (in terms of personalised management of exercise, nutrition and psychological support before the start of definitive treatment) in a formal way and in the context of quality implementation science i.e. capturing and sharing experience to move towards defining better care in a range of contexts.

It is against this, that the immediate priorities of ICONIC have been developed and its current focus on activities is helping drive forward the ambition to bring change. ICONIC anticipates being able to work with the growing enthusiasm to move towards better coordinated and more informative research activities in the future. In order to be successful, the ambition needs to be owned by all who can contribute, particularly a wider community of nutritionists and those with responsibility for the prevention and care of cancer. As ICONIC continues to identify opportunities for synergies and collaboration through meetings, coordinated actions, and purposeful research, the expectation is that this will bring leadership, coherence and focus to existing activities, as well as stimulate important new ambitions in related areas, many with particular relevance to LMIC. From its initial formation, the focus has been to establish an activity that is relevant and can command support across a wide range of interests. The challenge of the next period will be to attract support for activities which have relevance and impact, and build a community of like-minded academics, clinicians, public health practitioners, patients and members of civil society, committed to working towards sustainability.

#### Author contributions

Rachel Marklew: Conceptualisation, Writing – Original Draft, Project Administration. Alan Jackson: Conceptualisation, Writing – Original Draft, Supervision. Martin Wiseman: Conceptualisation, Writing – Review and Editing. Stephen Wootton: Conceptualisation, Writing – Original Draft.

#### Financial support

With thanks to IUNS for its financial contribution to support authors in preparing the review. The research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

#### Declarations of competing interest

None.

#### Data availability

No data was used for the research described in the article.

#### Acknowledgements

With thanks to those formally collaborating with ICONIC - the World Cancer Research Fund (WCRF), Union for International Cancer Control (UICC), International Malnutrition Task Force (IMTF), International Agency for Research on Cancer (IARC), International Atomic Energy Agency (IAEA), UK NIHR Cancer and Nutrition Collaboration, and Cancer and Nutrition in Africa (CANa).

#### References

- Aglago, E. K., Bray, F., Zotor, F., Slimani, N., Chajès, V., Huybrechts, I., Ferrari, P., & Gunter, M. J. (2019). Temporal trends in food group availability and cancer incidence in africa: An ecological analysis. *Public Health Nutrition*, 22(14), 2569–2580. <https://doi.org/10.1017/s1368980019000831>
- Arends, J., Bachmann, P., Baracos, V., Barthelemy, N., Bertz, H., Bozzetti, F., Fearon, K., Hütterer, E., Isenring, E., Kaasa, S., Krznaric, Z., Laird, B., Larsson, M., Laviano, A., Mühlbacher, S., Muscaritoli, M., Oldervoll, L., Ravasco, P., Solheim, T., ... Preiser, J. C. (2017). ESPEN guidelines on nutrition in cancer patients. *Clinical Nutrition*, 36(1), 11–48. <https://doi.org/10.1016/j.clnu.2016.07.015>
- Barr, R. D., & Stevens, M. C. G. (2020). The influence of nutrition on clinical outcomes in children with cancer. *Pediatric Blood and Cancer*, 67(Suppl 3), Article e28117. <https://doi.org/10.1002/pbc.28117>
- Bates, A., West, M. A., & Jack, S. (2020). Framework for prehabilitation services. *British Journal of Surgery*, 107(2), e11–e14. <https://doi.org/10.1002/bjs.11426>
- Bray, F., & Parkin, D. M. (2022). Cancer in sub-Saharan africa in 2020: A review of current estimates of the national burden, data gaps, and future needs. *The Lancet Oncology*, 23(6), 719–728. [https://doi.org/10.1016/s1470-2045\(22\)00270-4](https://doi.org/10.1016/s1470-2045(22)00270-4)
- Davis, J. F., van Rooijen, S. J., Grimmer, C., West, M. A., Campbell, A. M., Awasthi, R., Slooter, G. D., Grocott, M. P., Carli, F., & Jack, S. (2022). From theory to practice: An international approach to establishing prehabilitation programmes. *Curr Anesthesiol Rep*, 12(1), 129–137. <https://doi.org/10.1007/s40140-022-00516-2>
- Doll, R., & Peto, R. (1981). The causes of cancer: quantitative estimates of avoidable risks of cancer in the United States today. *Journal of the National Cancer Institute*, 66(6), 1191–1308.
- Ferlay, J., Ervik, M., Lam, F., Colombet, M., Mery, L., Piñeros, M., Znaor, A., Soerjomataram, I., & Bray, F. (2020). *Global Cancer Observatory: Cancer Today*. Lyon, France: International Agency for Research on Cancer. Retrieved 7 June from <https://gco.iarc.fr/today>.
- Ferlay, J., Laversanne, M., Ervik, M., Lam, F., Colombet, M., Mery, L., Piñeros, M., Znaor, A. S., & Bray, F. (2020). *Global Cancer Observatory: Cancer Tomorrow*. Lyon, France: International Agency for Research on Cancer. Retrieved 7 July from <https://gco.iarc.fr/tomorrow/home>.
- Fernandes, A. D. V., Moreira-Gonçalves, D., Come, J., Rosa, N. C., Costa, V., Lopes, L. V., ... Santos, L. L. (2020). Prehabilitation program for African sub-Saharan surgical patients is an unmet need. *Pan-African Medical Journal*, 36, 62. <https://doi.org/10.11604/pamj.2020.36.62.21203>
- Fiolet, T., Srour, B., Sellem, L., Kesse-Guyot, E., Allès, B., Méjean, C., Deschasaux, M., Fassier, P., Latino-Martel, P., Beslay, M., Hercberg, S., Lavalette, C., Monteiro, C. A., Julia, C., & Touvier, M. (2018). Consumption of ultra-processed foods and cancer risk: Results from NutriNet-santé prospective cohort. *Bmj*, 360, k322. <https://doi.org/10.1136/bmj.k322>
- Gillis, C., Davies, S. J., Carli, F., Wischmeyer, P. E., Wootton, S. A., Jackson, A. A., ... West, M. A. (2021). Current landscape of nutrition within prehabilitation oncology research: A scoping review. *Frontiers in Nutrition*, 8, Article 644723. <https://doi.org/10.3389/fnut.2021.644723>
- Henry, L., Aldiss, S., Gibson, F., Pugh, G., & Stevens, M. (2022). Nutritional assessment and dietetic resource for children and young people with cancer in the United Kingdom. *Pediatric Blood and Cancer*, 69(9), Article e29743. <https://doi.org/10.1002/pbc.29743>
- Macmillan Cancer Support, Royal College of Anaesthetists and the National Institute for Health Research (NIHR) Cancer and Nutrition Collaboration. (2019). Principles and guidance for prehabilitation within the management and support of people with cancer. <https://cdn.macmillan.org.uk/dfsmedia/1a6f23537f7f4519bb0cf14c45b2a629/1532-10061/prehabilitation-for-people-with-cancer-tcm9-353994>. (Accessed 4 May 2022).
- Monteiro, C., Cannon, G., Lawrence, M., Louzada, M. L., & Machado, P. (2019). *Ultra-processed foods, diet quality, and health using the NOVA classification system*. Rome: Food and Agricultural Organization of the United Nations. Retrieved from <http://www.fao.org/3/ca5644en/ca5644en.pdf>. (Accessed 4 July 2022).
- Muscaritoli, M., Arends, J., Bachmann, P., Baracos, V., Barthelemy, N., Bertz, H., ... Bischoff, S. C. (2021). ESPEN practical guideline: Clinical Nutrition in Cancer. *Clinical Nutrition*, 40(5), 2898–2913. <https://doi.org/10.1016/j.clnu.2021.02.005>
- Ngwa, W., Addai, B. W., Adewole, I., Ainsworth, V., Alaro, J., Alatise, O. I., ... Kerr, D. (2022). Cancer in sub-Saharan Africa: A Lancet Oncology commission. *The Lancet Oncology*, 23(6), e251–e312. [https://doi.org/10.1016/s1470-2045\(21\)00720-8](https://doi.org/10.1016/s1470-2045(21)00720-8)
- NIHR Cancer and Nutrition Collaboration. (2015). Report of phase one. [https://cancerandnutrition.nihr.ac.uk/wp-content/uploads/2016/06/Cancer-Nutrition-Full-Report-FINAL\\_03-06-16.pdf](https://cancerandnutrition.nihr.ac.uk/wp-content/uploads/2016/06/Cancer-Nutrition-Full-Report-FINAL_03-06-16.pdf). (Accessed 10 May 2022).
- Pisa, P. T., Landais, E., Margetts, B., Vorster, H. H., Friedenreich, C. M., Huybrechts, I., ... Slimani, N. (2018). Inventory on the dietary assessment tools available and needed in Africa: A prerequisite for setting up a common methodological research infrastructure for nutritional surveillance, research, and prevention of diet-related non-communicable diseases. *Critical Reviews in Food Science and Nutrition*, 58(1), 37–61. <https://doi.org/10.1080/10408398.2014.981630>
- Riboli, E., Hunt, K. J., Slimani, N., Ferrari, P., Norat, T., Fahey, M., ... Saracci, R. (2002). European Prospective Investigation into Cancer and Nutrition (EPIC): Study populations and data collection. *Public Health Nutrition*, 5(6b), 1113–1124. <https://doi.org/10.1079/phn2002394>
- Ssentongo, P., Oh, J. S., Amponsah-Manu, F., Wong, W., Candela, X., Acharya, Y., Ssentongo, A. E., & Dodge, D. G. (2022). Breast cancer survival in eastern region of Ghana. *Frontiers in Public Health*, 10, Article 880789. <https://doi.org/10.3389/fpubh.2022.880789>
- Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global cancer statistics 2020: GLOBOCAN estimates of incidence and

- mortality worldwide for 36 cancers in 185 countries. *CA: A Cancer Journal for Clinicians*, 71(3), 209–249. <https://doi.org/10.3322/caac.21660>
- Torre, L. A., Siegel, R. L., Ward, E. M., & Jemal, A. (2016). Global cancer incidence and mortality rates and trends—an update. *Cancer Epidemiology, Biomarkers & Prevention*, 25(1), 16–27. <https://doi.org/10.1158/1055-9965.Epi-15-0578>
- Wootton, S., Durkin, K., & Jackson, A. (2014). Quality control issues related to assessment of body composition. *Food and Nutrition Bulletin*, 35(2 Suppl), S79–S85. <https://doi.org/10.1177/15648265140352s112>
- World Cancer Research Fund/American Institute for Cancer Research. (1997). *Food, nutrition, physical activity and the prevention of cancer: A global perspective*. Washington DC: AICR.
- World Cancer Research Fund/American Institute for Cancer Research. (2007). *Food, nutrition, physical activity and the prevention of cancer: A global perspective*. Washington DC: AICR.
- World Cancer Research Fund/American Institute for Cancer Research. (2018). Diet, nutrition, physical activity and cancer: A global perspective: Continuous Update Project Expert Report. <https://www.wcrf.org/diet-activity-and-cancer/global-cancer-update-programme/resources-and-toolkits/>. (Accessed 4 May 2022).
- World Food Programme. (2020). *State of School feeding worldwide 2020*. Rome: World Food Programme. Retrieved from <https://www.wfp.org/publications/state-school-feeding-worldwide-2020>. (Accessed 7 June 2022) <https://www.wfp.org/publications/state-school-feeding-worldwide-2020>.
- World Health Organization. (2017). *The double burden of malnutrition: Policy brief*. Geneva: World Health Organization. Retrieved from <http://www.who.int/nutrition/publications/doubleburdenmalnutrition-policybrief/en/>. (Accessed 21 April 2022) Accessed.
- World Health Organization. (2020). *WHO report on cancer: Setting priorities, investing wisely and providing care for all*. Geneva: World Health Organization. Retrieved from <https://www.who.int/publications/i/item/9789240001299>. (Accessed 4 May 2022) Accessed.