

A Cross-Council vision for Food, Nutrition and Health research



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New and effective policies, therapies, products and interventions are urgently needed to mitigate the serious public health consequences of dietary excess and deficit. Developing them will require a deeper understanding of the complex relationships between food, nutrition and health. This insight can only be delivered through multidisciplinary and integrative research across the biological (basic and medical) and social sciences which considers the multiple, interrelated factors contributing to human health and behaviour.

Recognising that clearer cross-Council strategic direction and joint working across sectors is needed to support truly integrative research, this high level document aims to provide the academic and wider stakeholder communities with a clear joint (BBSRC, MRC and ESRC) vision for food, nutrition and health research. Its focus is on research from a human health and behaviour perspective, but it recognises the clear and crucial connections to issues of food security, sustainability and waste.



Vision and Key Goals

By approaching food, nutrition and health research from a joint strategic perspective, BBSRC, MRC and ESRC will support multidisciplinary across a broad range of disciplines to exploit those areas where integrative research is best placed to address important outstanding questions.

Where research problems are influenced by a variety of interacting biological, medical and social factors, approaches which consider these interdependencies will provide a more effective basis for new health policies, therapies, products and interventions.

This document seeks to

- clearly articulate the added value of a joint strategic approach
- set out a joint vision for food, nutrition and health research, with the aim of supporting health and well-being throughout the life-course
- highlight key opportunities for integrative research across Council remits
- identify key routes to impact for multidisciplinary and integrative research

Key goals of a cross-Council approach will be to

- foster better integration of research across molecular mechanisms, integrative physiology, experimental medicine, epidemiology, population health and social and economic sciences
- explore the social and biological determinants of food consumption behaviour, and how they influence long-term health
- support the generation of a robust evidence base which will drive development of healthy food products, inform interventions to support healthy eating and underpin public health policy
- encourage the development and wider adoption of multidisciplinary and integrative approaches, fostering the next generation of integrative researchers

The strategic importance of research and innovation in Food, Nutrition and Health

Global changes in diets and dietary habits are placing an unsustainable burden on healthcare systems, individuals, families and societies

Poor or inappropriate nutrition is associated with increased risk of many chronic conditions, making the widespread tendency towards consumption of foods with high energy and low nutrient density a pressing challenge for the developed and, increasingly, the developing world¹. As health care costs escalate, the need for products and interventions to prevent or manage these conditions is urgent.

UK diets have substantial adverse effects on the nation's health and finances: diet related chronic disease accounts for 9 % of all NHS spend², and more than 25 % of all cancers are attributable to dietary factors³. UK obesity rates (in children and adults) are amongst the world's highest, costing the wider economy more than £40bn per year (3 % GDP)⁴ and rising. Meanwhile, vitamin D and iron status remains a cause for concern across the UK population and particularly in vulnerable groups⁵.

When under-nourishment plays a part in more than half of all developing world child mortality⁶, the sustainable provision of adequate nutrition is a key global challenge⁷. However, changing lifestyles and patterns of consumption mean that, increasingly, countries with emerging economies are also facing the problems associated with obesity and excess consumption. They experience the majority of obesity-related chronic disease, making obesity responsible for around 5 % of all deaths and a \$2 trillion (2.8 % global GDP) loss to the world economy⁴.

Dietary decisions play a major role in influencing health, wellbeing and the risk of chronic diseases. Understanding what

drives and constrains these decisions – both individually and collectively – is a key challenge, and one which will be crucial in developing effective ways to modify the behaviours of diverse social, cultural and economic groups.

Many of the mechanisms underpinning the effects of food and nutrition on long-term health are under-investigated

The UK has a distinguished history of achievements in the field of nutrition and health. Over the last 100 years the Research Councils have supported landmark insights into the relationship of diet and health and the development of chronic disease.

Nevertheless, despite the clear influence of diet on health, many of the fundamental mechanisms which link nutritional intake to physiological consequences remain

undetermined. Epidemiological analysis is valuable in identifying correlations between foods or diets and health outcomes, but without a firm mechanistic basis such evidence may be incomplete or even misleading.

Multidisciplinary partnerships are increasingly needed to deliver the robust and authoritative evidence base which is crucial to development of healthier food products, optimisation and stratification of dietary guidelines, and determination of effective intervention strategies.

Effective nutritional advice requires accurate definition of varying nutritional needs between individuals, population groups and across the lifecourse

Appropriate nutritional advice and effective public health messaging depend upon reliable evidence to determine diets which will benefit health, but in many cases the absence of a robust underpinning evidence base leaves key questions unanswered. Guidance around what constitutes a “healthy diet” can therefore be inconsistent, leading to confusion and often cynicism towards dietary advice in general⁸.

Healthy nutrition is a complex subject. Nutritional requirements (both maximum and minimum) vary according to factors including age, sex, body weight, genotype, level of activity, physiological status (e.g. pregnancy and lactation) and concomitant disease, but these differences are largely unexplored. Development of stratified advice and policy to improve public health therefore depends upon a fuller understanding of inter-individual, inter-group and cross-life variation in the interactions between food, its consumption, and physiological and psychological wellbeing.



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Effective nutritional policy also requires an appreciation of the cultural and economic influences on individual and household diets, including the role of food in expressing religious and ethnic identities and the place of the food budget in low-income households. Increasing cultural diversity and increasing food poverty make these particularly urgent priorities for UK policy.

Innovation in the food industry depends upon underpinning research

Food and drink industries are of critical importance to the UK economy, contributing £87.9bn per annum (including £24.3bn

in manufacturing and £27.3bn in retail)⁹. They are also key players in addressing the challenges posed by modern diets¹⁰, with roles in both the choices available to, and exercised by, consumers.

Policy and consumer pressure to develop and promote healthier products is increasing, presenting significant opportunities for businesses able to innovate to deliver new or improved health-promoting products, or to reform existing products with improved health benefits and unimpaired palatability. However, significant gaps in our understanding of the mechanisms which link food components to health benefits make it difficult to substantiate health claims and

respond effectively to policy and regulatory requirements. Research focusing on the health implications of food retailing and food marketing will be crucial in understanding and influencing the interplay between consumer knowledge, attitudes and food-related behaviours.

Fully exploiting opportunities for innovation – and attracting multinational food companies to the UK – will require a strong body of research evidence around the relationships between food raw materials, processing methods, nutritional value and health benefits, retail and marketing, together with effective harnessing of industry expertise to inform academic research.

Cross-Council working in Food, Nutrition and Health

The need for a joined-up approach

Unpicking what is truly meant by healthy nutrition, and how we can best deliver it, is a multidisciplinary challenge. Insight will come from disciplines across crop science, food science, basic biology, health and clinical science, epidemiology, behavioural, social and political science, but the complex nature of key research questions means that they are not well served by interrogation from individual perspectives alone.



The production, purchasing and consumption of food are social and economic processes, whilst the digestion of foods and metabolism of nutrients is a biological process with diverse physiological influences and consequences for health and disease. Dietary practices are deeply embedded in family, society, religion and culture, requiring consideration at all levels from the individual to society. These interacting factors can be understood only through integrative research across the biological (basic and medical) and social sciences which considers the multiple, interrelated factors contributing to human health and behaviour.

Nutrition, consumer behaviour and food choice are key priorities for the Global Food Security programme, and early scoping work around the broader topic of sustainable nutrition has reinforced the need for a coordinated and multidisciplinary approach across a broad range of disciplines.

The benefits of working together

BBSRC, MRC and ESRC support vibrant and world-leading research communities in basic bioscience (plant, animal and human), health, medical and social sciences. By approaching the challenges of food, nutrition and health research from a joint perspective, the Councils will support their respective communities in identifying and investigating areas in which complementary expertise can address problems more effectively than individual disciplines.

Figure 1 illustrates the benefits of this approach for an exemplar research challenge (*understanding the determinants of food choice and energy intake*). Where research problems are influenced by a variety of interacting biological, medical, social

and environmental factors, integrative approaches which consider these interdependencies will result in a fuller understanding – and a more effective basis for new health policies, therapies, foods and other products and behavioural interventions.

The Research Councils will provide support to bring together diverse teams and increase awareness of interdisciplinary factors in research design. By supporting and fostering such integrative research, the Research Councils will maximise the complementarity of differing areas of expertise, guard against research gaps and overlaps, address interface issues through clearer articulation of their research priorities, and make more efficient use of overall resources.

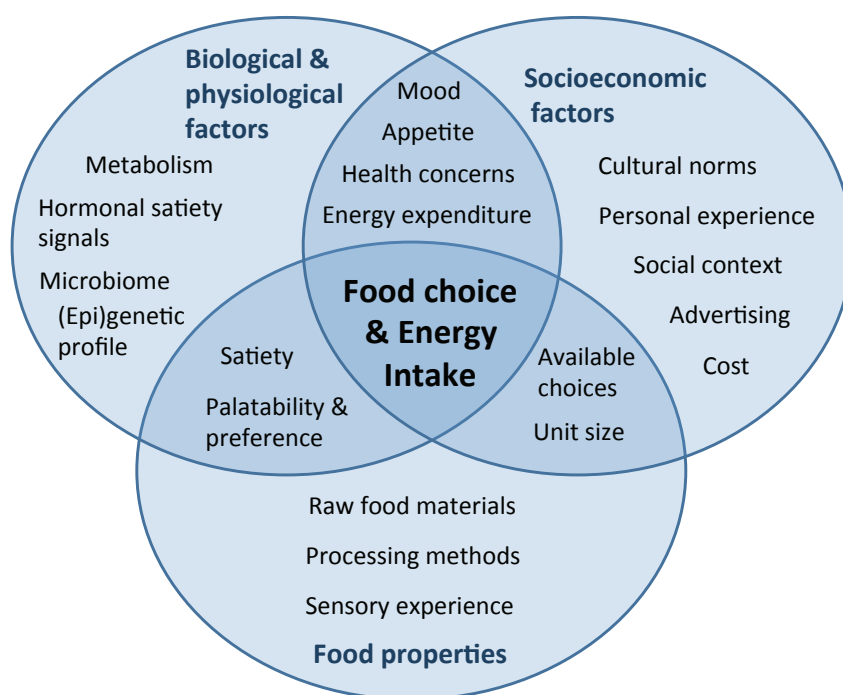


Figure 1: The benefits of a joint approach: Understanding the factors which influence food choice, and consequently energy intake (as one of many important aspects of nutritional intake), is crucial to devising strategies which will effectively promote healthier choices. Each decision is influenced by a variety of interacting social, biological and food-related factors (detail not intended to be exhaustive); research approaches which consider these interdependencies will result in a more complete understanding

Emerging opportunities for collaborative research

New capabilities in data-handling capacity, data-sharing and harmonisation are enabling the integration of information across disciplines in ever more powerful ways. The Councils will support researchers in making effective use of cutting-edge tools in collaborative research as well as developing a mutual understanding of research approaches, languages and methodologies.

A partnership approach will ensure that nutrition research is embedded in leading edge basic biology and medical research, benefitting from tools and techniques across disciplines and Council remits. It will encourage integration of mechanistic, clinical and behavioural science (including modelling approaches) to design more effective clinical and behavioural intervention studies, and facilitate effective use of the UK's world-leading capability in long-term cohort studies and clinical (notably NHS) databases.

Food, nutrition and health research across Council remits is likely to prove particularly fruitful in supporting integration between:

- basic biological and medical science; gaining a deep understanding of how nutrition influences states of health and disease (with particular reference to research in populations with subclinical phenotypes)
- fundamental, medical and clinical nutrition science; creating a translational pipeline from research to clinical application
- mechanistic and epidemiological approaches; ensuring they are mutually informing
- cultural studies, epidemiology and public health approaches
- human physiological and behavioural approaches; elucidating the interactions between physical, neurological and behavioural dietary decisions and responses

- human, plant and animal (livestock) biosciences; understanding the relationships between nutrient and bioactive content (including bioavailability and bioaccessibility) and health implications, informing agricultural research aims
- human and food microbiology; understanding their interactions in the GI tract in relation to health and disease

Multidisciplinary research challenges

Key high-level challenges and approaches for multidisciplinary research in food, nutrition and health are outlined in *Annex 1*. They have been identified as important in the context of this joint vision and do not in any way preclude support for other areas of interest to individual Councils.

The following areas may present particular opportunities for future cross-Council working:

- Understanding nutritional requirements at key life stages in different population groups, and variation in response to dietary interventions
- Understanding causal mechanisms linking foods, nutrients and disease
- Determinants of gut health and function (e.g. diet, age, nutritional status, microbiome and allergen exposure)
- Determinants of dietary decisions
- Targeting sustainable dietary behaviour change, across the lifecourse and particularly in children and young adults

In tackling key challenges, researchers from both academia and industry should make effective use of significant existing UK resources and research infrastructure. Some important examples are provided at *Annex 1*.



Working in partnership to derive impact

It is imperative that an increased understanding of the relationships between food, nutrition and health generates significant benefits for society and the economy.

The knowledge generated as a result of Research Council investment forms an essential part of the pipeline from research to impact, and strong partnerships with other stakeholders are critical to effective translation. The Councils will draw on wider stakeholders' understanding and consider their needs as end-users, proactively linking researchers and research users to ensure that new findings and deeper understanding result in effective and practical applications.

Impact through Industrial application

Food, nutrition and health research has relevance to a wide industrial base representing key components of the UK economy - including farming, manufacture and retail. The research challenges facing the sector are extensive, with stringent legislative and voluntary frameworks at national and European levels. However, industrial investment in R&D is relatively low, reflecting limited margins and the scale of the challenges to be addressed.

Food-related industries are therefore key users of the research that Councils support, and employers of the skilled practitioners which they train. For example, fundamental

research elucidating the mechanisms which link food components to physiological responses will underpin evidence for human health claims, whilst integration of bioscience and food science will facilitate formulation of healthier and more attractive foods. Better understanding of consumer behaviour and the retail environment will help to devise effective strategies for promoting healthier eating and more sustainable consumer behaviour.

Taking a lead from successful models of engagement¹², the Councils will seek to harness industry expertise in an appropriate way to inform academic research, and ensure that the outputs of academic research inform industry practices in ways which benefit health



Impact through evidence-based health policy

Food and nutrition are major determinants of health, and are socially patterned with marked inequalities at all life stages. An improved understanding of the nature of these relationships can directly inform health strategies, including regulation and consumer advice.

A more complete understanding of the physiological effects of foods and nutrients is likely to have implications for optimal nutritional care and disease prevention or management through diet. Partnership with stakeholders such as the *National Institute for Health Research*, the *UK Health Departments* and other relevant policy bodies will be crucial to support translation into clinical and public health practice where appropriate.

A mechanistic understanding of the relationships between diet and health will also underpin evidence for robust dietary guidelines, and a move towards better targeted advice which takes into account the biological and behavioural determinants of food intake. This is particularly important during critical phases of development and for groups whose dietary practices make them vulnerable to adverse health outcomes. Government bodies involved in food and nutrition policy, such as the *Food Standards Agency and Public Health England*¹³, as well as third sector organisations such as the *British Nutrition Foundation*, form a crucial

interface between the fundamental, clinical, population and social research supported by the Councils and its translation into public health practice and behaviour change.

Impact through engaging with researchers and the public

By working together, the Research Councils will aim to enhance individual and organisational research capability by supporting environments that develop researchers' skills and their access to research resources, including:

- supporting a new generation of researchers well positioned to undertake integrative research and form multi- and interdisciplinary partnerships
- considering where support might be required to bridge disciplines or address important skills gaps
- supporting collaboration and translation activities alongside high quality research
- promoting the effective use of national research infrastructure

Engagement and dialogue is a vital part of Research Council strategy, recognising that the full potential of UK research cannot be realised without meaningful interactions between researchers, funders and the public. This is particularly true for food and nutrition, where the innovative ideas of academia and industry must meet the (diverse) needs of society. In joint working, the Research Councils will promote the development of research agendas which reflect a broad range of interests, ensure that public engagement becomes more embedded in the day-to-day approach of researchers, and work to understand public perception, and acceptability, of new technologies in food production (both pre- and post-harvest).



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Annex 1

Key multidisciplinary research challenges

The examples below detail key high-level challenges and approaches for multidisciplinary research in food, nutrition and health. They have been identified as important in the context of this joint vision - and do not in any way preclude support for other areas of interest to individual Councils.

Health and Resilience:

- Characterisation of the healthy phenotype and short and long-term effects of nutrition
- Understanding how diet interacts with external (e.g. infections) and internal factors (e.g. microbiome) to modulate phenotypic responses that influence health
- Understanding the mechanisms by which nutrition and dietary components promote healthy development and function
- Understanding the trajectories of dysregulation (e.g. metabolic) and the tipping points between health and disease (e.g. Type 2 diabetes)
- Understanding the role of diet in determining chronic disease endpoints
- Improved understanding of the role of dietary components in maintaining gut health, mucosal immunology and the development of food allergy and intolerance

Dietary intake, nutrient status and bioavailability:

- Understanding the contribution of dietary patterns, individual nutrients, whole and processed foods and food structures to promoting and maintaining health
- Understanding the relationships between nutrient content, bioavailability, bioaccessibility and food processing methods
- Measuring and effectively relating nutrient status to physiological function

Nutritional requirements over the life course and relationship to health and disease:

- Understanding nutritional requirements at key stages across the life-course, including infant feeding, adolescent nutrition and nutritional needs of older people
- Understanding inter-individual and inter-group (population and social) differences in nutritional requirements and preferences
- Understanding nutritional requirements for healthy brain development, cognitive function and onset of neurological disorders

Behaviour and food choice:

- Understanding the gut-brain axis and the psychobiology of food choice, and satiety based on gut-mediated endocrinology
- Elucidating the interactions between physical, neurological and behavioural food responses (including plasticity)
- Understanding the role of the genome and epigenome in food choice predisposition
- Understanding the economic, social and cultural context of 'food choice', including the roles of public information, the retail environment, marketing and labelling
- Understanding how complex interventions that lead to sustained behavioural change and improved health can be developed and implemented
- Understanding food-related inequalities
- Understanding how behavioural economics - including the use of financial (dis)incentives - may impact on the consumption of specific foods and food groups

Key research approaches

Integrative research, with co-ordination and linkage across disciplines, may make use of:

- Mechanistic research and experimental medicine embedded in well-characterised population and cohort studies
- Informative model systems
- Iteration between basic & applied research, and between human & animal models
- Holistic consideration of dietary effects, given that interventions are likely to have multiple, and possibly diverse, outcomes on different biological systems
- High quality small-scale human studies in well-defined health, at risk or clinical groups
- Innovative approaches, for example using social media and crowd-sourced data

Partnerships:

- Collaboration with existing European¹⁴ and international research efforts to promote the sharing of resources and expertise where a transnational approach will add value.
- Partnership with food industries to enable rapid transfer of the best ideas into new products and/or interventions that will benefit the health of the public
- Partnerships with third-sector organisations, public sector bodies & consumer groups

Tools and techniques:

- Development and validation of appropriate measurement tools, techniques & technologies for studying:
 - o robust and accurate measurements of individual and population dietary intake, nutritional status and metabolic function
 - o body composition and fat distribution
 - o physical activity, energy expenditure and other relevant behaviours
 - o health-related aspects of the urban environment (e.g. food outlets)
- Development of unambiguous, objective health indicators and markers which link diet to health outcome
- Effective use of:
 - o new computational capacity for modelling and scenario building, use of big-data, and integration of models with experimental approaches
 - o new digital technologies for monitoring and self-monitoring
 - o new and existing cohorts

Interventions:

- Identification of critical points in life to allow intelligent targeting of interventions
- Dietary intervention studies (early and applied)
- Explanatory trials and proof of concept studies
- Early phase development of public health interventions, and tools for their evaluation at the population level



Key infrastructure and resources

UK Biobank

<http://www.ukbiobank.ac.uk/>

UK Population and Birth Cohorts

<http://www.mrc.ac.uk/news-events/publications/maximising-the-value-of-uk-population-cohorts/>

UK Dementia Research Platform

<http://www.mrc.ac.uk/research/facilities/dementias-platform-uk/>

The Farr Institute of Health Informatics Research

<http://www.farrinstitute.org/>

MRC-NIHR National Phenome Centre

<http://www1.imperial.ac.uk/phenomecentre/>

The Genome Analysis Centre

<http://www.tgac.ac.uk/>

MRC PHSRN Diet and Physical Activity Measurement Toolkit (DAPA)

[Reference/webpage no longer available – November 2018]

ELIXIR

<http://www.elixir-europe.org/>

Joint Programming Initiative *A healthy diet for a healthy life* (JPI HDHL)

<http://www.healthydietforhealthylife.eu/>

UK National Diet and Nutrition Survey Rolling Programme and related surveys

<http://discover.ukdataservice.ac.uk/catalogue?sn=6533>

The Nexus network

[Reference/webpage no longer available – September 2018]

Network for Integrated Behavioural Science (NIBS)

<http://www.behavioural-science.ac.uk/index.aspx>

Understanding Society - The UK Household Longitudinal Study

<https://www.understandingsociety.ac.uk/>

Lifestudy

<http://www.lifestudy.ac.uk>

Footnotes

¹ Overseas Development Institute: Future Diets (2014);

² DEFRA Food Statistics Pocketbook 2014

³ World Cancer Research Fund: Diet and Cancer Report (2009)

⁴ McKinsey Global Institute Report: Overcoming Obesity

⁵ National Diet and Nutrition Survey Summary Report (2014)

⁶ Black RE et.al. (2013): Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet* 382:427-451

⁷ WHO & FAO Rome Declaration on Nutrition (2014)

⁸ BBSRC public dialogue event: <http://www.bbsrc.ac.uk/web/FILES/Reviews/1404-food-nutrition-health-final-report.pdf>

⁹ DEFRA Food Statistics Pocketbook 2014

¹⁰ For an exemplar success in reducing salt see Wyness LA et al (2012): Reducing the population's sodium intake: the UK Food Standards Agency's salt reduction programme. *Public Health Nutr.* 15(2):254-61

¹¹ BBSRC, ESRC and MRC are all partners in the Global Food Security programme, which brings together the major UK public sector funder of food-related research: www.foodsecurity.ac.uk/programme/index.html.

¹² Notably the Diet and Health Research Industry Club (<http://www.bbsrc.ac.uk/drinc>) and Retail Sector Initiative

¹³ and equivalent public health agencies in the devolved administrations

¹⁴ Including the Horizon 2020 Programme and "A Healthy Diet for a Healthy Life" Joint Programming Initiative: <http://www.healthydietforhealthylife.eu/>