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NEWS AND VIEWS

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UK Nutrition Research Partnership (NRP) workshop: Improving our understanding of the metabolic interplay between nutrition and physical activity (IN-PACT)

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Abstract

This article describes a UK Nutrition Research Partnership (UK NRP)/Medical Research Council (MRC) 'Hot Topic' workshop that aimed to develop a better understanding of the interplay between nutrition and physical activity and their effects on human metabolism at the mechanistic level. The article provides a rationale for the workshop and a summary of the objectives. The report then presents an overview of the topics discussed at the workshop and the priority research areas identified that would enable the development of integrated evidence-based dietary guidelines with improved potential to transform long-term health.

KEYWORDS
nutrition, obesity, physical activity

BACKGROUND

Eating a nutritious, balanced diet and engaging in regular physical activity remain the cornerstones for weight maintenance and the prevention of metabolic diseases (NICE, 2006). A close interplay between nutrition and physical activity is generally accepted, but progress in understanding its precise nature is hindered by a lack of disciplinary integration and expertise gaps in the respective cognate disciplines. Nutritional scientists have contributed substantially to development of energy and nutrient needs for a variety of populations that inform public health guidelines for dietary intakes [e.g. recent Scientific Advisory Committee on Nutrition (SACN) reports on carbohydrates (SACN, 2015) and saturated fats (SACN, 2019)]. However, the influence of physical activity, the research domain of exercise scientists, on these guidelines is rarely considered. Physical activity can profoundly modulate physiological and behavioural responses to nutrition, and vice versa. Ignoring the metabolic interactions between nutrition and physical activity limits the utility and potential of dietary guidelines. In fact, the SACN Working Group on Energy Requirements highlighted improved understanding of the potential interaction of diet composition and physical activity in bodyweight regulation and the development and maintenance of obesity as a research recommendation (SACN, 2011). A concerted effort is required to act on the SACN recommendation and empower nutritional and exercise scientists to work together with other scientific disciplines and key stakeholders on the major public health concerns facing society. Hence, there is a need to bring nutritional and exercise scientists together to bridge the disciplinary gap and work collaboratively to define a research agenda that will enhance the nutrition field. The limited research that has considered the interconnections of nutrition and physical activity on metabolic processes

in humans is largely descriptive in nature. Greater understanding in the mechanisms of interplay between nutrition and physical activity on human metabolism is therefore imperative. With a burgeoning interest in the field of metabolism as a means to interrogate the biology of health and disease, an opportunity exists to integrate scientists working on cutting edge metabolic science to the nutrition field to enhance mechanistic understanding.

Funding from the Medical Research Council (MRC) as part of the UK Nutrition Research Partnership (UK NRP) awards supported a workshop to develop a better understanding of the interplay between nutrition and physical activity and their effects on human metabolism at the mechanistic level. Better understanding of the close metabolic interplay between nutrition and physical activity would enable the development of integrated evidence-based dietary guidelines with improved potential to transform long-term health.

MAIN AIMS OF THE WORKSHOP

The workshop, named 'Improving our understanding of the metabolic interplay between nutrition and physical activity (IN-PACT)' was held in January 2021. The IN-PACT workshop aimed to:

- bring world-leading nutritional and exercise scientists together to bridge the disciplinary gap and work collaboratively to define a research agenda that will enhance the nutrition field;
- facilitate the integration of fundamental metabolism and systems researchers into the field to drive a focus on developing mechanistic understanding in nutrition research;
- support close interactions between researchers at all career stages to ensure new research networks are developed, new ideas can flourish with input from senior leader experience, and collectively contribute to the sustainability of the field.

SUMMARY OF RECOMMENDATIONS AND OUTCOMES

The IN-PACT workshop had a particular focus on the prevention and treatment of obesity and its associated metabolic diseases. The programme for the workshop (shown in Table 1) was designed to encourage the new thinking and approaches needed to develop novel research concepts which will enhance the UK nutrition field and improve our understanding of the metabolic interplay between nutrition and physical activity. As such, keynote presentations helped to frame the overall context of the interplay between nutrition and physical activity from clinical and evolutionary perspective. These were complemented by short, focused and thought-provoking presentations from leading researchers who were asked to address the following questions based on their own experiences and perspectives.

1. What could closer consideration of the interplay between nutrition and physical activity look like for the healthy lifestyle guidelines of the future?
2. How could increasing understanding of the metabolic interplay between nutrition and physical activity help in the prevention and treatment of obesity and its associated metabolic diseases?
3. What innovative tools could we use to better interrogate the metabolic interplay between nutrition and physical activity?

An opportunity was also provided for early-career researchers to showcase their recent data related to the workshop area. Collectively, the workshop presentations acted as stimuli for discussion among delegates which was then was facilitated in a range of ways including a moderated panel discussion, chaired question-and-answer sessions and small-group breakout discussions. In terms of recommendations and outcomes, we asked delegates to discuss in a small-group format what they deemed the top challenges for future focus based on the presentations and discussions in the workshop.

Feedback from those break-out groups could be generally summarized in to the following areas.

Priority research areas

Whilst a number of specific research areas were raised throughout the workshop, three emerged as the most important areas that, if fully understood and resolved, have the long-term potential to substantially influence healthy lifestyle guidelines.

1. *Nutrient-activity timing/chronobiology*: There is a greater need to understand how time of eating and physical activity independently and in relation to each other interact to affect metabolism and health across a variety of study populations.
2. *Nutrition*, *physical activity and weight management*: Contemporary perspectives including individual responses to interventions (i.e. behavioural and physiological), new models of human bioenergetics (i.e. constrained energy expenditure model) and the multi-dimensional nature of physical activity underpin the need to re-evaluate the role of diet/nutrition and physical activity/exercise in appetite control and long-term weight management.
3. *Mechanisms of nutrient-inactivity interactions in metabolic dysfunction*: Physical activity control in nutrition research is underappreciated and confounds clear identification of drivers and mechanisms of

TABLE 1 UK Nutrition Research Partnership workshop: Improving our understanding of the metabolic interplay between nutrition and physical activity (IN-PACT)

Time	Activity	Speaker/title
9:00	Arrival, welcome	Dr Gareth Wallis (University of Birmingham)
09:15	Keynote (live webinar): Clinical Perspectives 15–20 min + 10 min Q&A	Dr Gareth Wallis (University of Birmingham, Chair) Dr Abd Tahrani (University of Birmingham, Presenter) – *Obesity, a disease or lack of willpower? Why are we failing?*
09:45	Brief transition break	
09:50	Session 1: Challenging norms Moderated panel discussion with stimulus provided by all panellists preparing a 10–15 min pre-record addressing: What could closer consideration of the interplay between nutrition and physical activity look like for the healthy lifestyle guidelines of the future?	Dr Ed Chambers (Imperial College London, Moderator) Panellists: Professor Julie Lovegrove (University of Reading) Professor Ian Macdonald (University of Nottingham) Professor Dylan Thompson (University of Bath) Professor Emma Stevenson (Newcastle University)
10:30	Break	
10:45	Session 2: Getting into the science Chaired live presentations Four 10–15 min max talks, followed by 25–30 min roundtable style Q&A. Presenters asked to focus on: How could increasing understanding of the metabolic interplay between nutrition and physical activity help in the prevention and treatment of obesity and its associated metabolic diseases?	Dr Gareth Wallis (University of Birmingham, Chair) Presenters: Professor Paul Greenhaff (University of Nottingham) – *Critical importance of control for physical activity when investigating the mechanistic basis of metabolic dysregulation* Professor Alex Johnstone (University of Aberdeen) – *Appetite control, the interface between energy intake and energy expenditure* Professor Jason Gill (University of Glasgow) – *Physical activity and bodyweight: is it important, why isn't it the same for everyone, and can we do it better?* Professor James Betts (University of Bath) – *Understanding interactions between nutrition and physical activity to prevent/treat obesity: role of temporal and biological rhythms*
12:30	Lunch	
13:00	Session 3: Tools of the trade Chaired live presentations Four 10–15 min max talks, followed by 25–30 min roundtable style Q&A. Presenters asked to focus on: What innovative tools could we use to better interrogate the metabolic interplay between nutrition and physical activity?	Dr Javier Gonzalez (University of Bath, Chair) Presenters: Dr Sarah Berry (King's College London) - *Importance of collecting large scale and high resolution data to unravel the multiple interrelated determinants of responses to food* Professor Penny Gowland (University of Nottingham) – *MRI, a window into physiology and biochemistry* Professor Leanne Hodgson (University of Oxford) – *Stable isotope tracers* Professor Francesco Falciani (University of Liverpool) – *Inferring biological networks from observational data*
14:30	Break	
14:45	Early Career Researchers Showcase An opportunity for early career researchers to present 5 min overviews. 10 min slot per speaker.	Dr Ed Chambers (Imperial College London, Chair) Presenters: Dr Isabel Garcia Perez (Imperial College London) – *Diet-exercise-gut microbiota paradigm* Dr Caroline Anderson (University Hospital Southampton) – *Nutrition research in children with chronic kidney disease, translating research into clinical practice* Dr Peter Aldiss (University of Copenhagen) - *From human genetics to rodents in the neurobiology of appetite, addiction and obesity* Dr Kristine Beaulieu (University of Leeds) - *The DIVA study: Impact of matched weight loss to ≥5% via intermittent or continuous energy restriction on appetite control in women with overweight/obesity*
15:30	Research challenges Research priorities based on day	Breakout rooms for research challenge identification (5 rooms of 5–6 people, with leader in each for keeping focus and feeding back key points)
16:15	Keynote (live webinar): Evolutionary perspectives 15–20 min +10 min Q&A	Dr Gareth Wallis (University of Birmingham, Chair) Dr Herman Pontzer (Duke University, US, Presenter) – *Diet, Exercise and Metabolic Health, Evolutionary Perspectives*
16:45 – 17:00	Close Summary of day and next steps	Dr Gareth Wallis and Dr Ed Chambers

metabolic dysfunction. There is a need to clearly delineate the signals and mechanisms through which physical inactivity modulates the impact of diet to elicit deteriorations in metabolic health and in turn how increasing physical activity alters the metabolic impact of dietary intake.

Research approaches

The overwhelming view was that to influence policy, the field needs to move towards long-term human intervention studies that are large-scale (i.e. multi-centre), multidisciplinary and allow for multi-level investigation from molecular through to behavioural science. Mechanistic understanding must lie at the heart of subsequent translation and application of research. This includes the increased need to appreciate the role of human physiology studies that enable direct assessment of metabolic mechanisms (e.g. tissue metabolite fluxes, biomedical imaging) *in vivo* and their link to health and physical function. Moreover, novel approaches, such as digital and wearable technologies that allow large-scale interventions to be applied in 'at-home' environments and techniques that facilitate high-throughput analysis and biological interpretation (e.g. metabolomics, computational biology, artificial intelligence) from easily acquired samples (e.g. dry blood spots, urine), will be important for revealing the complexity of individual responses to nutrition and physical activity. These new technologies should also provide an accurate objective measurement of energy intake and expenditure compared to traditional self-reported food diaries and physical activity questionnaires.

Connect and collaborate

Delegates expressed the need for a dedicated forum or portal for collaboration to enable continued discussion and particularly to engage with stakeholders and clinicians to ensure that the best nutrition science is contributing to the most important societal needs.

Funding

Taking ideas forward, be that for improving the connectivity and collaboration between researchers and stakeholders or conducting nutrition research of the quality, type and scale needed requires ring-fenced and appropriate levels of funding from UK Research and Innovation (UKRI) and/or other mechanisms.

In summary, the IN-PACT workshop has identified research challenges and priority areas that, if addressed, would develop a better understanding of the interplay between nutrition and physical activity and their effects on human metabolism at the mechanistic level. This may in turn enable the development of integrated evidence-based dietary guidelines with improved potential to transform long-term health.

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CONFLICT OF INTEREST

GAW has received research funding and/or has acted as a consultant for GlaxoSmithKline Ltd., Sugar Nutrition UK, Lucozade Ribena Suntory Ltd, Dairy Management Inc. and Volac International Ltd. ESC declares no conflicts of interest relevant to the content of this article.

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