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## **Abstract**

This paper provides a summary of the British Nutrition Foundation Annual Lecture by Professor Susan Jebb held at the Royal College of Physicians, London, on 14 November 2017. Professor Jebb, recipient of the 2016 British Nutrition Foundation Prize for outstanding achievement in the area of nutrition, spoke of her research on diet, obesity and cardiovascular disease (CVD) risk and her work to translate science into action to help improve the nation's diet.

This paper briefly summarises her research, including analyses of the links between dietary patterns and cardiometabolic risk in prospective cohorts, mechanistic studies such as the effect of portion size on energy intake, a series of randomised controlled trials to test the impact of diet composition on markers of CVD risk, and clinical trials of interventions to treat obesity in primary healthcare settings. She emphasised the need to translate the considerable scientific knowledge about the prevention of CVD through modification of risk factors such as obesity, into systems embedded in routine practice and population-level interventions, in order to improve public health and tackle health inequalities.

## **Keywords**

Diet, obesity, cardiovascular disease, behaviour change

This paper provides a summary of the British Nutrition Foundation Annual Lecture held at the Royal College of Physicians, London, on 14 November 2017.

The recipient of the 2016 British Nutrition Foundation Prize for outstanding achievement in the area of nutrition was Susan Jebb, Professor of Diet and Population Health, University of Oxford, for her influential work on diet, obesity and cardiovascular disease (CVD) risk. Professor Jebb's research in this area has progressed from detailed mechanistic studies to epidemiological studies and pragmatic, large-scale field trials. She has conducted a series of randomised control trials (RCTs) of dietary interventions to change eating behaviours and improve biomarkers of CVD risk. Translating research in this area into policy and practice is a continuing focus of her work and in 2008 she was awarded an OBE for services to public health; notable roles include Science Advisor for the Foresight obesity report (Butland *et al.* 2007) and Chair of the Cross-Government Expert Advisory Group on Obesity (2007-2010) and the Public Health Responsibility Deal Food Network (2010-2015). Professor Jebb provided examples throughout her talk of the important contributions she has made to the study and implementation of research in the area of diet, obesity and CVD.

### **The importance of diet to good health**

The *Global Burden of Disease Study* showed that diet tops the list of risk factors for preventable ill health, accounting for almost 12% of disability adjusted life years lost in the UK, with a further 8% due to excess bodyweight (Newton *et al.* 2015). Most of this is attributable to CVD, and diet has both a direct effect on CVD risk and indirectly through excess bodyweight. CVD causes more than a quarter of all UK deaths and results in healthcare costs of £9 billion per year (British Heart Foundation 2017). Although there has been steady progress in prescribing medication to control risk factors such as high blood pressure and high LDL cholesterol, rates of obesity continue to rise. Thus, improving the nation's diet will bring significant health and societal benefits. Although decades of nutrition research have led to a reasonably good understanding of dietary risk factors for CVD, which are expressed in national dietary recommendations, the rate of change in dietary intake is slow. It is increasingly evident that advice alone is not enough to change behaviour and more work is needed to help people implement the dietary recommendations to reduce the burden of diet-related ill health.

### **Evidence from observational studies: Dietary patterns**

Dietary recommendations are largely based on analyses of prospective cohorts which provide insights into the impact of diet on long-term health outcomes. A large body of epidemiological

research has shown associations between specific nutrients, or food groups, with obesity and/or CVD risk (World Health Organization 2003), but these associations cannot be considered causal and some may lack plausible mechanisms. There is growing interest in considering dietary patterns that consider the whole of the diet since the consumption of many foods and nutrients are strongly correlated or collinear. Professor Jebb's team have focused on the use of reduced rank regression as a method which builds on *a priori* information in the form of intermediary response variables in order to examine specific diet-disease pathways (Ambrosini 2014).

One example of this approach is analyses based on a cohort born in 1991-1992, the *Avon Longitudinal Study of Parents and Children (ALSPAC)* cohort, which includes data on children's dietary habits and health outcomes since birth. It was hypothesised that a dietary pattern characterised by energy-dense, high fat and low fibre foods (measured at 7, 10 and 13 years of age), would be associated with increased obesity risk in later childhood (measured at 11, 13 and 15 years). The results showed that for each standard deviation unit increase in the dietary pattern score, the odds of being in the highest quintile of adiposity increased by 13% (Ambrosini *et al.* 2012), and with each increase in dietary pattern quintile there was a 5% increase in the odds ratio of being obese. This dietary pattern was particularly characterised by low intakes of fruit, vegetables and high fibre breakfast cereals, and high intakes of confectionery, crisps, low fibre bread, cakes and biscuits (Ambrosini *et al.* 2014). Understanding the contribution of specific food groups to the risk of obesity may provide a basis on which to develop food-based dietary guidelines, which may be a more useful tool for dietary education than nutrient recommendations.

### **Evidence from experimental studies: The portion size effect**

An example of Professor Jebb's contribution to the understanding of the mechanisms underpinning the relationships between diet and health is her work on the effect of portion size on energy intake and appetite control. There is considerable evidence that offering large portion sizes of energy dense foods can lead to increased energy intake at that eating occasion (Hollands *et al.* 2015), sometimes termed the 'portion size effect'. However, it is not clear whether reducing portion sizes leads to reduced energy consumption at that meal and, if so, whether there is any compensatory increase in intake at subsequent meals (Hetherington & Blundell-Birtill 2018).

With PhD student Hannah Lewis, Professor Jebb conducted one of the first studies to specifically consider the impact of reduced portion size on appetite control and energy intake in a randomised, crossover laboratory study (Lewis *et al.* 2015). The three test conditions were: a control breakfast (based on estimated daily energy requirements), and breakfasts with 20% and 40% less energy than

the control, given in random order on three separate days. Self-reported appetite, levels of gastrointestinal hormones and energy consumed were measured later in the day. Participants reported increased appetite and had lower levels of satiety hormones as the size of breakfast decreased. However, there was no significant difference in the energy consumed during the rest of the day, resulting in a lower daily energy intake after the smaller breakfasts. This implies that covert reductions in portion size can be a useful strategy for reducing overconsumption. Ongoing research in collaboration with colleagues at the Universities of Bristol, Cambridge and Liverpool, is considering the optimal magnitude of reduction to limit intake without prompting overconsumption, enhancing the satiety value of smaller portions and field trials of the impact of smaller portions in workplace canteens.

### **Randomised controlled trials**

Evidence from randomised controlled trials is important both to establish causal relationships and to examine the extent to which changes towards a healthier diet might be expected to change health outcomes. In a series of highly controlled studies, often involving the provision of specific foods to participants, Professor Jebb has investigated the impact of diet composition on biomarkers of CVD risk including the effects of increased consumption of wholegrains (Brownlee *et al.* 2010) and fish (Moore *et al.* 2006), the proportion of protein in the diet (Larsen *et al.* 2010) and reductions in saturated fat (SFA) (Jebb 2010).

An example of this work is the *Reading, Imperial, Surrey, Cambridge and Kings (RISCK)* trial (Larsen *et al.* 2010), a large multi-centre study which tested the hypothesis that reducing SFA either by replacing with monounsaturated fat (MUFA) or carbohydrate in a diet with either a high or low glycaemic index (GI), improves insulin sensitivity (primary outcome measure) and blood lipid profile (secondary outcome measure). Seven hundred and twenty participants, from five sites across the UK, followed a standardised high SFA/high GI diet for a 4-week run-in period. They were subsequently allocated to one of five isoenergetic dietary interventions for 24 weeks: a high SFA and high GI diet (the reference diet); a high MUFA/high GI diet; a high MUFA/low GI diet; a low total fat/high GI diet and a low total fat/low GI diet. Insulin sensitivity, using a labelled intravenous glucose tolerance test, and fasting blood lipid profiles were measured at the start and end of the intervention period. To encourage adherence to the test diets, the participants were provided with diet-relevant foods for consumption at home during the run-in and intervention periods. Reducing SFA in the diet (by increasing MUFA or lowering total fat intake) and altering the type of carbohydrate consumed (low GI or high GI) was found to have no significant effect on the

participants' insulin sensitivity. Blood lipid profiles were found to be improved following reduction of dietary SFA, regardless of the way in which SFA was reduced within the diet (*i.e.* either through replacing SFA with MUFA or carbohydrate). There was also some evidence from exploratory post hoc analysis that consuming a low GI diet lowered LDL cholesterol when compared to a high GI diet. Overall, the results indicated that reducing SFA intake, however achieved, lowers LDL cholesterol. The dietary fat manipulation was achieved largely through use of products with a specific fatty acid profile, showing promise for reformulation of foods and also through simple substitutions of foods which might be possible through dietary advice.

### **Supporting dietary change**

Despite important advances in understanding of the dietary changes required to reduce the risk of CVD, the grand challenge remains to achieve these changes at the population level. One approach with considerable success in recent years is reformulation of the food supply. For example, in the UK, salt intake has dropped by 15% in a decade largely due to reformulation by the food industry (He *et al.* 2014). Work led by Professor Jebb as part of the Responsibility Deal Food Network (Jebb 2012) sought to expand this to include reductions in SFA and in total energy (including reductions in total fat and sugars), which is now continuing through Public Health England.

While population level dietary interventions can result in widespread improvements in the nation's diet, Professor Jebb emphasised the continuing need to understand how best to motivate individuals to make positive changes to their diet. There is a particular opportunity to take action in primary care settings where patients might reasonably expect to receive advice on strategies to reduce their risk of CVD, for example as part of Health Checks. Professor Jebb highlighted that there is a lack of evidence about the nature and content of effective interventions and a perception that health professionals lack the time and training to deliver high quality dietary advice.

Professor Jebb described how her team are working with health professionals to develop and test technological tools that can provide patients with personalised support to change their diet, including an 'app' which offers healthier food options while shopping and a system to provide nutritional feedback on purchases based on data from supermarket loyalty cards. The success of these tools relies on the credibility and authority of health professionals to motivate people about the importance of making positive dietary changes and then to encourage patient engagement with the intervention. However, it avoids the need for health professionals to have detailed knowledge about a patient's diet or the composition of foods. These approaches are currently being tested in feasibility studies and if there is evidence they are acceptable to health professionals and patients,

practical to implement and evaluate and, if there is sufficient signal to suggest they may be effective in changing dietary habits, they will be taken forward into larger, more definitive RCTs with health endpoints.

### **Treating obesity – what works?**

Although improving dietary composition is important to reduce CVD risk, it is insufficient to overcome the increased risk associated with being overweight. Moderate weight loss for people who are overweight brings significant benefits across a range of CVD risk factors, including reductions in blood pressure, LDL cholesterol and triglycerides. Moreover, if people consume less energy, typically they will consume less SFA, free sugars and salt as well.

With a quarter of the UK population who are obese and more than 3 in 5 people who are overweight or obese (Health Survey for England 2017), Professor Jebb commented that we cannot rely on 'boutique interventions', involving teams of highly specialised staff working one-to-one with patients, instead there needs to be systems embedded in routine practice, delivered by generalist practitioners or lay people to support weight loss on an 'industrial scale'. Her team have conducted a number of systematic reviews which have highlight the approaches to treating obesity that can be effective in this context, including self- help (Hartmann-Boyce *et al.* 2015), behavioural weight management programmes (Hartmann-Boyce *et al.* 2014), meal replacements (*in preparation*) and very low energy diets (Parretti *et al.* 2016).

However, before interventions can be offered in the NHS it is also necessary to demonstrate that they will be cost effective. In a recent trial involving 1269 participants (mean age 53 years; 68% female; mean BMI 34.5 kg/m<sup>2</sup>) from 23 practices around the UK, Professor Jebb has shown that for people seeking support to lose weight, referrals to community based weight loss groups such as WeightWatchers™ leads to significantly greater weight loss than a self-help intervention (Ahern *et al.* 2017). In an intention-to-treat analysis, at 1 year weight loss was approximately 3 kg greater than self-help after a 12 week programme and 5 kg after a 52 week programme, with the respective effects being 1 and 3 kg after 2 years. The real benefit in treating obesity is the prevention of CVD and long-term health economic modelling has shown that this 12-week programme is likely to be cost saving when calculated over a 20 year period. A 52-week programme, while more clinically effective, is more costly, but still very cost-effective by usual NICE standards for NHS interventions.

Professor Jebb and her team have recently completed the *Doctor Referral of Overweight People of Low Energy Treatments (DROPLET)* trial (Jebb *et al.* 2017) to establish whether a total diet

replacement programme is acceptable and effective in routine care. Total diet replacement programmes have been used successfully in research settings and specialist secondary care (Parretti *et al.* 2016) and more recently to treat type 2 diabetes in a primary care settings (Lean *et al.* 2017); however, concerns about acceptability, safety and whether weight loss is sustainable means that they are not currently recommended for use in primary care. The results are now under peer-review, but broadly support the findings seen in a systematic review of trials in specialist services or research settings and suggest that a total diet replacement programme offers the chance to achieve significantly greater weight losses in primary care than most existing services.

Accordingly, there is now good evidence of effective programmes to support weight loss but the issue is that these are not currently offered by the NHS. Data extracted from electronic health records in primary care showed that less than 10% of those who are obese had any record of an offer of support to lose weight, even just basic advice (Booth *et al.* 2015), Professor Jebb described this gap between evidence and practice as an ‘implementation failure’.

### **Achieving change**

In closing, Professor Jebb gave examples of her work to bridge the gap between scientific evidence and its implementation. She set out a model in which greater efforts are needed at the individual-level (though delivered at scale) to encourage and enable people to adopt a healthier diet, while also taking action at a population level to change the environment to make the healthier choices the easier choice. She described ongoing work with GP colleague, Professor Paul Aveyard, to implement the evidence of effective interventions to treat obesity by training GPs to initiate conversations with patients about bodyweight (Aveyard *et al.* 2016), setting up beacon practices and producing commissioning guidance for the Department of Health on weight loss services.

Developing population-level interventions largely requires engagement and action by policymakers but researchers have a role in developing the evidence base for these actions and evaluating their effectiveness. Professor Jebb gave examples from her work of modelling studies to examine the likely impacts of a tax on sugars-sweetened beverages (Briggs *et al.* 2017; Quirmbach *et al.* 2018) and trials to test the effectiveness of nutritional labels (Crockett *et al.* 2018). She also described the importance of presenting evidence to policymakers in an appropriate format and the value of skilled knowledge brokers. She referred to the success of the Foresight obesity report (Butland *et al.* 2007), which has subsequently informed three obesity strategies within the UK: ‘Healthy weight, Healthy lives: A cross-government strategy for England’ (Department of Health and the Department for Children 2008); ‘Healthy lives, Healthy people: A call to action on obesity in England’ (Department of

Health and Social Care 2011) and 'Childhood Obesity: A plan for action' (Department of Health and Social Care 2016). The Foresight report has not only transformed the approach to obesity in the UK but it has also been cited internationally as a model of good practice. Nonetheless, she noted that although the rate of increase in obesity has slowed in the 10 years since the publication of the report, the high prevalence of overweight and obesity and widening of health inequalities shows more needs to be done to change the nation's diet.

## Summary

In closing, Professor Jebb paid tribute to the many members of her research team past and present and to many collaborators who have been instrumental in the work she described. She noted that nutrition research has come a long way towards providing a solid understanding of the dietary determinants of CVD, yet the nation's diet is far from meeting nutritional recommendations. Future research efforts need to be directed towards stimulating and measuring change, among individuals, the food industry and policymakers, if we are to secure improvements in public health nutrition and reduce avoidable deaths from CVD.

## Author Contributions

The content of this paper was developed by SAJ and the report was written primarily by AW.

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