

## The complex systems challenge of obesity

Obesity presents multiple, major challenges to countries around the world. It is associated with a wide range of health conditions, including type 2 diabetes, some cancers, musculoskeletal disease, and other chronic diseases. It is a stigmatised condition, and people with obesity may experience discrimination and abuse (1).

Obesity is defined by the World Health Organisation (WHO) as 'abnormal or excessive fat accumulation that may impair health.'. It is most commonly defined using body mass index (BMI), calculated as a person's weight in kilograms divided by the square of their height in meters ( $\text{kg}/\text{m}^2$ ). In adults, WHO defines overweight as a BMI greater than or equal to 25  $\text{kg}/\text{m}^2$ , and obesity as a BMI greater than or equal to 30  $\text{kg}/\text{m}^2$  (2).

The global epidemic of excess weight has developed over several decades, and no country has yet achieved a sustained reversal in this trend, although in a number of high income countries the population prevalence of obesity appears to have plateaued (3). This is encouraging, but it is far too soon to celebrate, as any levelling off that is observed is invariably at a high prevalence within the population, and aggregate figures such as these mask widening inequalities in both the distribution and the severity of obesity (4).

The UK Government Foresight report, published in 2007, emphasised the complex nature of obesity, and argued for it to be addressed using systems approaches (5). The Foresight system map explicitly illustrated this complexity, linking over 100 different factors with more than 300 lines representing different reinforcing or balancing relations (6, 7). Beyond these feedback loops, obesity exhibits many other characteristics of a complex system, such as adaptation and emergence. Adaptation can be seen in many different forms, at both individual and system level: individuals may adapt by, for example, increasing their food intake in response to increased physical activity. There may also be wider system level adaptations, such as the food industry altering pricing, or increasing marketing and promotions, in response to regulations on labelling. Obesity itself can be conceptualised as an emergent property of food, physical activity and other systems, with the rising trend in prevalence of excess weight an unintended but inherent consequence of human behaviour within those systems.

However, despite the widespread rhetoric of complexity that is now commonplace when describing obesity, true systems responses are rare. Public, political and media discourse around obesity is dominated by a persistent skew towards a conception of obesity not as a complex societal problem primarily driven by the obesogenic environments in which we live, but as one driven by individual level choices. This is then reflected in policies and actions towards interventions that act at individual, group or community level, often with a focus on individual level behaviour change. This is the case despite a broad understanding that upstream, population level factors underpin many of these behaviours, and carry major benefits (8). This phenomenon has been characterised by Hunter et al as 'lifestyle drift' (9), and a similar situation obtains for obesity-related research. The evidence base on interventions to tackle obesity is heavily biased towards actions at individual level. These approaches tend to require high levels of personal agency, to have low levels of

effectiveness, and to widen inequalities (10), yet there is a strong scientific consensus, from Foresight onwards, that the focus of attention needs to move upstream.

This misplaced focus on individuals carries a number of other risks. Placing our collective attention on the behavioural decisions made by people with overweight and obesity, rather than the contexts within which those decisions are framed, contributes to the stigma associated with the condition. Discourse about 'responsibility' is hugely skewed towards the responsibilities of individuals, and very rarely addresses the responsibilities of corporations to their customers or wider society (11).

Biomedical research is grounded in a dichotomous hypothesis-testing approach, but the definition of 'obesity' is based on arbitrary thresholds along a continuum of excess weight, and treating it as a binary construct is an unhelpful oversimplification. Geoffrey Rose emphasised the value not only of responses targeted at people with the greatest risk, but also of population level responses. Any one action might only make a tiny, perhaps even unmeasurably small, change in a single individual, but large numbers of small changes in both energy intake and energy expenditure across populations and over time can lead to meaningful reductions in population risk profiles (12, 13). Policy responses to obesity should not only address short-term treatment, but also long-term prevention, with the most important impacts of actions, especially those to tackle child obesity, perhaps not manifesting themselves for many decades.

The taxonomy that describes the methods and tools that have been developed to answer dichotomous questions places the double-blind randomised controlled trial (RCT) at the top of the research hierarchy, ideally suited to assessing the effectiveness or otherwise of interventions with measurable, short-term, direct effects. But many aspects of the required response to obesity do not involve these kinds of impacts – they may be measurable only at population level, over longer periods than trials can be conducted, with only indirect effects. The feedbacks and adaptations within the system create problems of their own. Unlike a double-blind RCT in which all factors beyond the intervention in question can be held equal, many interventions to address obesity are accompanied by adaptations at both individual and system level. An example of this might be a tax on sugar-sweetened beverages. If all other things remain equal then increasing the price of these drinks through taxation should reduce consumption. But the likelihood is that not all things do remain equal, and industry will respond to such measures through changes to pricing structures, increases in marketing and promotions, and so on. These adaptive responses do not negate the value of the measure – although they may need to be addressed for it to be fully effective – but they complicate the interpretation of an evaluation of its impact.

So, what should be done? There is no single, or simple, prescription available for the complex problem of obesity (14). But there are some important steps that would help.

It is important to recognise that obesity presents a complex set of challenges, and that one should not expect it to be amenable to simple solutions. Our responses to obesity should not only consider immediate, short-term actions but also establish a long-term vision. What are we aiming for as an endgame, what would we regard as success if we looked back on progress in 20 years time? This should involve much more than a mere headline prevalence

figure, and include the elimination of social and other inequalities, as well as a strong focus on environmental drivers of diet and physical activity. We must also not forget the needs of people with severe obesity, who may benefit greatly from surgical or other treatments, and make adequate provision for this within health services.

Our actions should also reflect the chronic nature of the condition much more than they tend to now. Short-term impacts, such as those from intensive weight management interventions, are helpful, but the biggest impacts will result from changes that persist over the long term, resulting in a lower burden of excess weight over the life course at both individual and population level. And our policy responses and other interventions should take adequate account of the complex systems nature of the problem, acting at different levels of the system, and in multiple domains, over time (6, 15). This will entail actions that move beyond direct effects on individuals to reshaping the system itself, such as reconfiguring agricultural subsidies to promote production of healthy foods, or prioritising compact urban development that minimises motorised transport and encourages active mobility. Feedback within the system can be addressed by changing pricing signals through taxes or subsidies which may go well beyond directly influencing the cost of products bought by consumers. It could, for example, include carbon pricing to drive reductions in fossil fuel use that could generate major positive shifts in the types of foods that are produced, and the forms of transport that we take.

There are thus important actions for researchers, and the organisations that fund them, to take. The biomedical approach remains centrally important to obesity research, but it is not sufficient on its own to answer questions about the effectiveness of each of the component parts of a response with many different elements, each acting within a complex *adaptive* system that reconfigures itself in response to interventions (16).

We are in the middle of an evolving global epidemic of obesity that may well take another 10-20 years truly to reverse in high income countries, and will require concerted efforts by low and middle income countries. Although no country has yet succeeded at reversing the epidemic there are important and encouraging signs of progress. As we continue to develop our understanding of the problem it is becoming increasingly apparent that obesity is not, fundamentally, a problem of individuals making 'poor' decisions, but one in which we all face an environment of abundance, convenience and choice in which many people need to apply appreciable effort to maintain a healthy weight. Effective responses to obesity over the coming years will thus place increasing emphasis on changing the environments in which we live to make it easier, and more appealing, to consume a healthy diet and engage in regular physical activity.

Dr Harry Rutter MA MB BChir MSc FFPH FRCPE  
Senior Clinical Research Fellow  
London School of Hygiene and Tropical Medicine  
harry.rutter@lshtm.ac.uk

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