

Dusting off the epidemiological triad: could it work with obesity?

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Summary

The search for effective ways of dealing with obesity has centred on biological research and clinical management. However, obesity needs to be conceptualized more broadly if the modern pandemic is to be arrested. The epidemiological triad (hosts, agent/vectors and environments) has served us well in dealing with epidemics in the past, and may be worth re-evaluating to this end. Education, behaviour change and clinical practices deal predominantly with the host, although multidisciplinary practices such as shared-care might also be expected to impact on other corners of the triad. Technology deals best with the agent of obesity (energy imbalance) and its vectors (excessive energy intake and/or inadequate energy expenditure), and policy and social change are needed to cope with the environment. The value of a broad model like this, rather than specific isolated approaches, is that the key players such as legislators, health professionals, governments and industry can see their roles in attenuating and eventually reversing the epidemic. It also highlights the need to intervene at all levels in obesity control and reduces the relevance of arguments about nature vs. nurture.

Keywords: Epidemic, epidemiology, obesity, prevention.

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Introduction

The epidemic growth of obesity, its medical consequences and rapidly growing health costs, has governments, health professionals and non-governmental organizations around the world searching for approaches to its control (1). Most of the efforts to deal with the problem to date have been directed at individuals, either through commercial weight loss programmes and aids, or through clinical management. However, the weight regain by many individuals following a clinical management programme suggests that while this approach is necessary, it is not sufficient to reverse the epidemic. Also, obesity is now so common that it is neither feasible, nor cost-effective to expect all those who are overweight to receive successful one-on-one attention. A population approach, on the other hand, could potentially attenuate and eventually

reverse the epidemic, although this has not yet been demonstrated (2). Even if it was successful, such a broad approach, which aims to achieve small changes across large sections of the population, could leave those most in need relatively untouched, and hence have similar problems of insufficiency. Similarly, the widespread availability of reduced-fat, low-calorie and sugar-free foods does not seem to be sufficient to influence the increase in obesity worldwide.

All this points to the need for a more integrated approach than has been evident to date. We have previously described an 'ecological' model for understanding obesity based on the energy balance equation (3). In this paper, we draw together the opportunities for action at both individual and population levels and show how these complementary prevention and management strategies can be incorporated into a tried and true model for managing epidemics.

1

The epidemiological triad

Historically, epidemics have been best controlled when attention is paid to all three points of an epidemiological triad: hosts, agents (and their vectors) and environments (4). The interrelationships between these points and typical initiatives for dealing with each are summarized in Fig. 1.

In the case of infectious diseases (where the triad was first applied), this implies education, behaviour change and pharmacological protection of the hosts; technological developments such as sprays and chemicals to kill the agents and/or their vectors (in the case of insect-borne diseases); and action-based policies to limit the agent's or vector's breeding environments. The treatment of hosts who have contracted an infection is also an important part of the broad approach to reducing the population burden of the disease.

The triad model has been successfully applied to various infectious disease epidemics over the years. However, the advent of the behaviourally based, non-communicable disease (NCD) epidemics in the 1960s and 70s (e.g. smoking, drug abuse, heart disease and injuries) reduced its use. This was largely because of problems in conceiving these as 'true' epidemics, as well as the difficulty of defining 'vectors' in non biologically induced diseases. In 1980, a paradigm shift in thinking began in this area when William Haddon (5) successfully applied the triad approach to injury prevention. Haddon recognized the importance of the host, vector and environment in the 'epidemic' of motor vehicle injuries. The application of this approach led to large-scale reductions in motor vehicle injuries in western countries in the ensuing years (6). The decline of other epidemics such as smoking and coronary heart disease (7) has also been enhanced by an integrated approach influencing all three corners of the triangle. We propose here that obesity should be tackled in a similar fashion and we clarify the points of the triad relating to obesity

and identifying potential interventive approaches at each level.

Influencing the hosts

The hosts are the target for most current weight control interventions. A four-step approach (8) summarizing the main current initiatives at this level is shown in Fig. 2.

The bottom step in Fig. 2 represents primary prevention aimed at the general population. This includes people who are normal and those who are overweight. The main intervention appropriate at this level is public education through standard health promotion techniques such as mass media, community organization and community development.

The second step relates to individual or small group education and is aimed at those who are currently overweight. This information needs to be compatible with the wider population messages. While many overweight people request or need more than information and some coaching to lose weight, this is sufficient for some who have simply been making the default choices offered by the 'obesogenic environment' over many years and who have insufficient knowledge and/or motivation to counteract this (9).

The third step builds on the knowledge base of the previous step but includes behavioural and/or cognitive modification strategies. This might be appropriate, for example, for individuals with a long history of repeated dieting and weight cycling where lack of knowledge is less of an issue than habits, cognitive structuring and reactions to stress. The influence of the environment, particularly the media with its emphasis on diets and body size, is particularly important for this group of people. Mixed messages are potentially a significant contributor to the physical, psychological and social burden of obesity (10).

The top step in Fig. 2 generally involves the overweight or obese people with comorbidities. Although intensive medical interventions, such as drugs, surgery and very low-calorie diets may be necessary at this level, lifestyle change

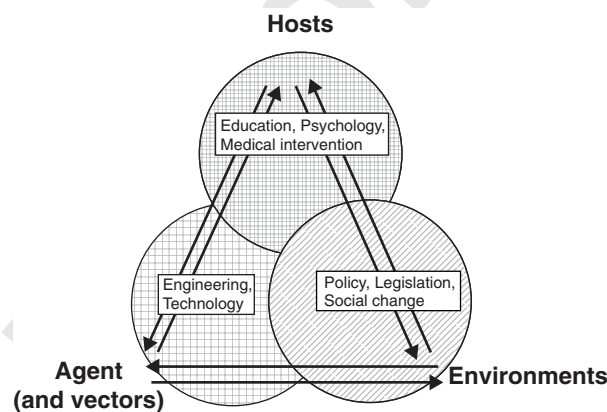


Figure 1 The epidemiological triad and approaches to interventions in relation to obesity.

Target population

Interventions

Overweight/obese (with comorbidities)

Medical surgical Rx

Overweight/obese (with disordered eating patterns or cognitions)

Behaviour modification

Overweight/obese

Individual education & skills training

General population

Population education and awareness raising

Figure 2 A four-step approach to influencing the hosts for obesity prevention and management. Rx, xxxxx.

through increases in knowledge and cognitive and behaviour change are still fundamental, as are supportive environments.

While the interventions on the top three tiers are directed at individuals, the potential impact at the population level is also important. For example, a widespread training and accreditation programme for general practitioners (GPs) could potentially shift the medical and lay perception about the value of nutrition and physical activity interventions. In Australia, training programmes for GPs have been run since 1997, and to date, over 20% (4000) of Australian GPs have successfully completed at least stage one of a three-stage post-graduate 'Medical Certificate in Weight Control and Obesity Management' (11). In New Zealand, over 50% of GPs are now using written exercise ('Green') prescriptions (12) on a regular basis. In Sweden, networks for obesity treatment have been formed in several counties. Because over 80% of people visit their GPs in these countries each year, there is substantial potential for population as well as individual changes through these strategies, particularly if they are combined with other corners of the epidemiological triad.

Influencing the agent and its vectors

The agent in an epidemic is the active cause of the disease, whereas the vector is the carrier of the agent. With infectious diseases, the agent is obviously the microbe, and the vectors range from biological carriers such as mosquitoes and ticks to non-biological carriers such as air conditioning units, faeces, water and food.

In an NCD epidemic such as obesity, the vector and agent are much less obvious. In motor vehicle injury, for example, the vector is the vehicle, and the agent is the speed at which the vehicle travels. For smoking, the agents are the carcinogenic compounds and the vectors are the cigarettes and nicotine as the addicting substance. In the case of obesity, the agent is chronic positive energy balance. The vectors, therefore, are related to both sides of the energy balance equation. For energy intake, these are energy-dense foods (i.e. foods high in fat and/or sugar) or large portion sizes. For energy expenditure, the vectors are inherent in modern technology.

Traditionally, the approach to vector management has involved technology or engineering (Fig. 1), albeit backed by education and/or policy initiatives. Examples include insecticides to reduce mosquitoes, sunscreens to reduce skin cancer, and airbags, seat belts and median barriers to minimize the impact of speed in traffic injuries. In the case of obesity, technology has a paradoxical role in both the aetiology and potential solutions to the problem. On the energy-input side, food processing can both increase and decrease the energy density of manufactured foods. On the energy-expenditure side, technology has been a much

greater contributor to the problem (e.g. through cars, computers and remote controls) than to the solutions (although exercise machines and sports equipment fit into the latter category). Indeed, it could be asserted that the vast majority of technological innovation is aimed at time- and energy-saving, or time- and energy-wasting (e.g. inactive entertainment) (13), both of which are prime catalysts for obesity.

The potential impact of influencing a vector can be substantial, particularly in the case of 'high-volume' foods or activities. For example, a survey of fast food outlets in New Zealand showed that the average fat content of hot chips (French fries) was 11.5%. Many deep-frying practices were found to be sub-optimal and a shift in the average from 11.5 to 10% fat seems achievable through training programmes for the operators. Because hot chips are a high-fat, high-volume food (mean annual consumption is about 40 kg capita⁻¹), this 1.5% reduction in fat content would result in an estimated decrease in fat consumption of approximately 0.5 kg capita⁻¹ year⁻¹ (14). As the current average annual weight gain of adult New Zealanders is around 0.3 kg year⁻¹ (15), even a small change such as this could have a significant effect on population levels of obesity.

Examples of vector modification in energy expenditure are harder to find. Making television-viewing contingent on the use of a cycle dynamo has been found to have benefit in obese children (16). TV switches to limit viewing time have also been found to reduce inactivity and body weight in children (17). Other innovative technologies such as movement sensors that switch off a TV or video game if a minimum level of movement is not carried out offer potential opportunities for the future, but these are generally only of limited scope. Technology replacement with an active alternative is perhaps a better way of dealing with an obesogenic inactivity vector. The concept of a 'walking school bus', in which parents walk with children, picking up additional children as they go, would be an example.

Vector modification has had its main impact to date in providing reduced-energy food alternatives. Its impact through increasing physical activity remains marginal, but potentially worth considering.

Influencing environments.

The increasingly obesogenic environments modern humans live in are clearly a driving force for the obesity epidemic (18). Changes in food production, distribution and availability in modern societies have led to a food environment that offers a wide range of highly palatable, energy-dense foods at a reasonable price and with minimal effort. Perhaps even more important have been the major advances in energy-saving technologies, which have resulted in declines in energy expenditure favouring a positive energy balance.

A recent World Health Organization (WHO) report on obesity (1) conceded that while environmental interventions are necessary to deal effectively with the obesity epidemic, these strategies currently remain relatively unexplored. Environments are inherently complex and require a sophisticated diagnostic approach before interventions can even be considered. We have developed a model that has been tested in a variety of situations to help simplify the diagnostic process by scanning particular environments for obesogenic factors (19).

2 The ANGELO (Analysis Grid for Environments Leading to Obesity) framework divides environments into two sizes (macro and micro) and four types (physical, socio-cultural, economic and political). Micro-environments are ‘settings’ where people gather, such as schools, workplaces and homes. Macro-environments represent ‘sectors’, which influence whole populations such as the food industry, education system and local governments. Within each type of environment, consideration is given to both of the two main vectors of obesity (energy intake and energy expenditure). The questions shown in Fig. 3 are put to stakeholders to identify key obesogenic elements, and these are then ranked according to local relevance, potential impact and changeability to identify high priority areas for intervention.

There are many forces that shape modern environments but the drive to maximize profits underpins many of them (e.g. the promotion of energy-dense food and sugary drinks). On the other hand, to make environments less obesogenic often requires underlying changes at the policy and/or social levels (such as the banning of fast food advertisements in TV programmes for young children).

Influencing obesogenic environments may have an impact through host behaviour (e.g. building cycle paths to increase cycle transport and recreation) or it may act directly on one of the vectors (such as the effect that food labelling laws and nutrition standards have on influencing

the formulation of foods). The synergies between creating environments that offer easy access to healthy food and activity choices and the promoting of those choices at the individual and population level are obvious.

Obesogenic environments are possibly the least considered of the three corners of the triad, and yet because they are the drivers of the obesity epidemic, they hold the most potential for curtailing and eventually reversing the current upward trends in obesity prevalence. We do not believe, however, that any focus discussed here should be dismissed or downgraded in favour of any other. Clearly, different situations require different emphasis on each corner of the triad, without ignoring the others. Future success will depend on health experts identifying the required emphases, and developing interventive practices to deal with these.

Conclusion

Most large-scale epidemics take considerable time to be modified. Smallpox, for example, took around 300 years to be eliminated. A large part of the challenge with the obesity epidemic is that the vectors are very pleasant – the overconsumption of high-fat foods and the use of technology which saves energy, or provides passive entertainment. It is unlikely therefore that this epidemic will be contained in the short term (at least in the absence of some catastrophic, Malthusian-like event). However, if the obesity epidemic is to be attenuated in the medium term and reduced in the long term, clearly a more expansive approach is needed than is currently being taken. We believe that resurrecting the epidemiological triad and applying it to obesity has value for a variety of reasons:

1. It takes obesity from the biomedical paradigm, where it now predominantly sits, and places it into an epidemic framework that has a much broader view and thus offers much more options for interventions.
2. The linkage with previous epidemics that have been turned around offers important insights into epidemic control as well as concrete examples of successful strategies that might have parallels in obesity prevention.
3. The key players in obesity treatment and prevention such as health professionals, government policy makers, and the food industry can see their roles in the context of a wider picture. For players whose primary role is not in health but in other areas like legislation, education, food service and transport planning, this is particularly important.
4. By incorporating individual and population approaches, the triad shows how treatment and prevention strategies support each other and where the potential synergies lie.

Environment type	Micro-environment (settings)		Micro-environment (sectors)	
	Food	PA	Food	PA
Physical	What is available?			
Economic	What are the financial factors?			
Policy	What are the rules?			
Socio-cultural	What are the attitudes, beliefs, perceptions and values?			

7 **Figure 3** An approach to environmental diagnosis: the ANGELO (Analysis Grid for Environments Leading to Obesity) model. PA, xxxxx.

5. This broader view of the obesity problem highlights the key opportunities for future research and interventions, many of which lie in the neglected area of obesogenic environments.

Currently we are testing the model as part of a WHO initiative to contain obesity in certain Pacific Island Countries, where obesity rates are among the highest in the world.

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