

Original Article

Sustaining dietary changes for preventing obesity and diabetes: lessons learned from the successes of other epidemic control programs

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A degree of success has been achieved in controlling several epidemics of infectious and non-infectious causes of death in countries, such as, Australia and New Zealand. Using the epidemiological triad (host, vector, environment) as a model, the key components of the control of these epidemics have been identified and compared to the current status of interventions to prevent obesity and its main disease consequence, type 2 diabetes. Reductions in mortality from tobacco, cardiovascular diseases, road crashes, cervical cancer and sudden infant death syndrome have been achieved by addressing all corners of the triad. Similarly, prevention programs have minimized the mortality from HIV AIDS and melanoma mortality rates are no longer rising. The main lessons learned from these prevention programs that could be applied to the obesity/diabetes epidemic are: taking a more comprehensive approach by increasing the environmental (mainly policy-based) initiatives; increasing the 'dose' of interventions through greater investment in programs; exploring opportunities to further influence the energy density of manufactured foods (one of the main vectors for increased energy intake); developing and communicating specific, action messages; and developing a stronger advocacy voice so that there is greater professional, public and political support for action. Successes in the other epidemics have been achieved in the face of substantial barriers within individuals, society, the private sector and government. The barriers for preventing obesity/diabetes are no less formidable, but the strategies for surmounting them have been well tested in other epidemics.

Key words: Diabetes, epidemics, obesity, prevention.

Introduction

Individuals and populations are able to sustain behaviour changes in order to reduce disease risk to varying degrees depending on the perceived risk, the knowledge about how to change behaviour and the ease of making those changes. Mortality from several causes has been reduced through prevention programs that have changed population behaviours. Examples in Australia and New Zealand are smoking-caused diseases,¹ cardiovascular diseases,² road deaths,³ some cancers (e.g. lung⁴ and cervix⁵) and sudden infant death syndrome (SIDS).⁶ In addition, HIV AIDS mortality has remained in reasonable check compared to its potential as an expanding epidemic and the previously rising mortality from melanoma appears to be levelling off.^{7,8}

Some changes in dietary intake have been sustained during the past few decades in response to increasing evidence about the relationship between diet and health. The reductions in saturated fat intake and its associated falls in serum cholesterol levels are one example.² However, the rising prevalence of obesity and type 2 diabetes is testament to the difficulties of changing total energy intake to match the declining energy expenditure from physical activity in modern societies.⁹

The purpose of this paper is to examine the previous experiences in Australia and New Zealand in influencing population behaviours (including dietary patterns) to reduce the risk of various diseases and injuries. What are the lessons to be learnt from these strategies that can be applied to influencing the population's diet and physical activity patterns to attenuate and eventually reverse the ever-increasing prevalence of obesity and type 2 diabetes?

Models for influencing population behaviours

There are a number of broad frameworks in common usage in health promotion that provide the theoretical basis and the overarching structure for a set of complex and interconnected strategies for influencing population behaviours and disease end-points. The Ottawa Charter is probably the most well known framework and it has been used for a wide

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variety of health promotion programs.¹⁰ Other models are helpful for specific interventions or specific populations.^{11,12} The value of any particular model is that it helps to explain the problem and to provide a framework for action and, naturally, there are substantial commonalities between models. In the area of obesity, the energy balance equation has been expanded into a broader 'ecological model'^{13,14} that has been valuable in placing the environmental influences on eating and physical activity into the traditionally narrow, individual focus of energy balance.¹⁵

One model that has been used widely in addressing epidemics is the 'epidemiological triad'. It was originally used to tackle infectious disease epidemics, but it has also been applied to non-communicable disease epidemics (Table 1). Figure 1 shows the triad as it relates to obesity.¹⁴ The agent (the final common pathway) for obesity is a positive energy balance. Some host factors are non-modifiable, such as, genetic makeup, age and gender, and others are modifiable, such as, behaviours and individual attitudes. The vectors for reduced physical activity are time/energy saving machines (i.e. cars, computers, power tools and appliances) and time-using machines (i.e. television, computer games and videos). The vectors for passive over-consumption of total energy are primarily energy dense foods and drinks (high in fat and/or sugar) and possibly large portion sizes.¹⁶⁻¹⁹ The environments are external to the individual and are commonly considered in a setting (micro-environment) or sector (macro-environmental) context.¹³ They provide the 'structure' within which people live and as such they are powerful determinants of behaviours.

All components of the triad are obviously interconnected but the strategies for intervention differ somewhat for each corner. Host-related strategies tend to be educational (one-on-one education, public education) or medical (pharmaceutical, surgical). The vector-related solutions are often based in technology or engineering or otherwise modifying the carrier of the agent. Environment-related solutions can be physical (changing structures and the availability of goods, services, amenities), economic (influencing costs of goods and services and the incomes to pay for them), policy (altering the rules) and sociocultural (influencing attitudes, beliefs and perceptions).¹³ Historically, food and nutrition intervention strategies have been dominated by the education-based approach and environmental options have been used to a limited extent.

Previous successes in influencing health-related behaviours

Tobacco control

Australia and New Zealand, like many high-income countries, have instituted multilevel interventions to reduce smoking.¹ These have been successful in reducing smoking rates and smoking-caused diseases.^{1,20} Host-based strategies have been mainly educational, health warnings on packets, support from quit programs and Quit line, nicotine replacement therapy, and television-based quit advertisements. The fact that smoking kills half of its users prematurely appears

to be widely known but is insufficient motivation for most smokers to quit and is an insufficient deterrent to prevent new smokers from starting. The vector is clearly the cigarette and the toxic compounds in the smoke are the agents. Although increasing the price of cigarettes has reduced consumption, there have been few controls on tobacco additives and cigarette design. This has left the tobacco industry free to manipulate the vector into a more palatable and more addictive product. Design changes, such as microvents, near the filter allowed them to make claims about 'low tar', 'mild' and 'light' without significantly reducing the toxic and addictive components inhaled by the smoker.²¹ They also added many other compounds, such as, sugar and flavourings to increase palatability, ammonia compounds to increase addictive potential, theophylline derivatives to open the airways and so on.²¹ These industry-initiated vector changes have seriously undermined the gains made from otherwise comprehensive tobacco control programs.

The environmental influences against smoking have been strong and effective – tax increases, smoke-free environments, multiple regulations and restrictions (e.g. on advertising, promotion, health warnings, sales to minors), litigations, and social pressure. Vocal advocacy groups, such as, Action, Smoking and Health, have been vital to keep the issue public. The New Zealand tobacco control program achieved the greatest reduction in smoking in OECD countries during the 1980s and 1990s averting over 12 000 premature deaths between 1985 and 1996.¹

The lessons learned from turning around this epidemic are that: even with a highly addictive product and a powerful industry, population behaviour can be changed; knowledge itself is a weak determinant of behaviour but well-communicated, action-specific messages influence behaviours; television-based communications are expensive but effective; environmental strategies are powerful; all elements of the triad must be tackled simultaneously (and in this case, omitting vector control has been a weakness);

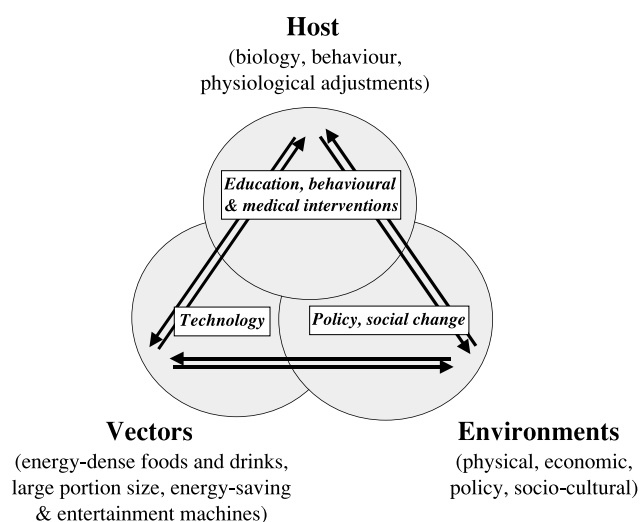


Figure 1. The epidemiological triad as it applies to obesity (the 'agent' is energy imbalance).

Table 1. Examples of strategies from the successful control of some epidemics in New Zealand and Australia

Cause of death	Host	Vector	Environment
Tobacco (Agent = toxic substances in the smoke)	Education about not starting (children) and quitting (smokers) Action messages (ad campaign) Medications Quit support Health warnings	Cigarette price increases Regulation of cigarette additives (minimal)	Taxation Smokefree environment laws Advertising bans Litigation laws Major investment in quit campaigns and programs Vocal advocacy group Supportive social attitudes
Coronary heart disease and stroke Agents = atherosclerosis, thrombosis, arrhythmogenesis)	Education about diet, smoking, exercise, medical treatment (high-risk individuals, population) Medications Other medical and surgical interventions Food labelling (nutrient information panels, 'nutrition signposts') Nutrition claims (nutrient content, nutrient function, health-nutrient relationship)	Tobacco control measures (above) Decreased saturated fat content of foods (meat, processed foods) Food labelling and nutrition claims (influencing food formulation)	Tobacco control measures (above) Huge investment in treatment (hospitals, subsidized medications, surgery) Regulatory framework for labelling and claims Advocacy groups
Road trauma (Agent = speed)	Education about speeding, alcohol, drowsiness (population), road safety (children) Action/consequence messages (ad campaign)	Multiple improvements in car safety features (seat belts, airbags, impact absorption design features, antiskid brakes, prominent brakes lights, etc.)	Legislation (e.g., seat belts, speed, alcohol) Heavy penalties for breaking law Road design features (e.g. median barriers, safe pedestrian crossings, traffic calming features) Major investment in communicating specific messages Public attitudes against drink driving
Skin cancers (Agent = ultraviolet light)	Education (population, children) Specific action messages (ad campaign) Screening programs for mole checks and removals	Sunscreen Hats and sun-protective beach wear Shade cloths and other sun shelters	Major investment in communicating specific messages School policies (e.g. 'no hat, no play') Local government policies (e.g. planting shade trees) Advocacy groups Social attitudes to sunbathing, sunburn

Table 1. (Continued)

Cause of death	Host	Vector	Environment
Cervical cancer (Agent = papilloma virus)	Education about regular Pap smears (adult women) Pap smear screening	Condoms	Major investment for cervical cancer screening program, follow up systems Lower economic barriers for patients to have screening Advocacy groups
HIV Aids (Agent = HIV)	Education about safe sex, safe needle use (high-risk groups, population) Medications	Condoms Needle exchange programs	Major investment in communicating specific messages Screening blood donations Increased access to condoms Vocal advocacy groups Public attitudes on unprotected sex
Sudden infant death syndrome (SIDS) (Agent = unknown)	Education about sleeping position, passive smoking, head covering, and bed-sharing (new parents) Quit smoking support Apnoea alarm systems		Major investment in communicating specific messages

social attitudes often follow or are strongly shaped by policy changes; strong advocacy groups are very important; powerful commercial interests often influence policy; and 'normalization' of behaviours (e.g. non-smoking in offices) is a powerful force for sustainability.

Cardiovascular disease

Coronary heart disease (CHD) and stroke mortality rates have also declined in Australia and New Zealand as a result of multiple interventions.^{2,22} The large number of medical/surgical interventions available for those with CHD or associated risk factors has probably been a major contributor to the decline in CHD mortality rates.²³ Other host-related interventions have included education about the reduction in saturated fat²⁴ and this has contributed to the decline in cholesterol levels.²⁵ Important messages can be transmitted to the consumer via food packages. Nutrient information panels, nutrition claims (i.e. on nutrient content, nutrient function or the nutrient–health relationship) and 'nutrition signposts' (i.e. logos from authoritative organizations identifying foods that have met particular nutrient standards) are the main strategies for achieving this. These communication programs also influence the formulation of foods.

The agents could be thought of as the three key processes in the development of CHD and stroke morbidity and mortality: atherogenesis, thrombosis and arrhythmogenesis. The main vectors are aspects of the diet, cigarette smoke and the machines that promote physical inactivity. The dietary vectors of CHD are mainly foods high in saturated fats, *trans*-fatty acids and salt. Some foods, such as, fish and vegetables, are vectors for protective factors.

The food industry has contributed to influencing these vectors in several ways. Farmers and processors have responded by producing leaner meat and manufacturers have developed large numbers of products that are substantially reduced in harmful components or increased in cardio-protective components. The ability to gain a marketing advantage is an important driving force behind many of these positive changes and nutrition claims are one of the main ways of achieving this. Approximately 20–25% of new products launched onto the US market each year carry some form of nutrient claim, with about half of them being low-fat claims.²⁶ A further, less acknowledged, response of the food industry has been to make changes to product formulations that are not sufficient to allow a claim but are still important for population health. For example, half of the products registered for the 'Pick the Tick' program of the National Heart Foundation of New Zealand either reformulated or formulated products to meet the program's nutrition criteria.²⁷ The formulation and reformulation of just 23 products (breads, breakfast cereals and margarines) resulted in the reduction of 33.5 tonnes/year of salt from the New Zealand diet.²⁷ Nutrient information panels may also have a significant impact on consumer behaviour and food formulation.^{28,29} The real health benefit from product formulation comes from the high volume food items where even small nutrient changes can have large population consumption effects.

Machines that reduce the energy cost of tasks (e.g. cars and computers) or increase physical inactivity (e.g. television) are the main vectors for reducing physical activity. Unfortunately, there have not been many successful strategies to increase overall physical activity levels in the face of declining energy expended in occupational and everyday tasks.³⁰ Urban environments are becoming increasingly car-dominated and thus reduce the ease of choosing active transport and active recreation options.^{31,32}

Environmental influences on CHD include the large investment in medications, medical and surgical procedures for secondary prevention, the food and nutrient claims regulatory frameworks, and smoke-free environments legislation.

The lessons learned from the CHD epidemic about influencing behaviour for disease reduction include: the need for a broad-based approach although in this instance the medical/surgical response has been dominant because there are multiple effective interventions available; a dominant medical strategy is extremely expensive and difficult to control costs; the major influence of food formulation and reformulation in response to consumer demand, nutrition claims, nutrient information panels and nutrition signposting programs; the consumer support for regulations to disclose nutrient content of foods; and the value of advocacy groups (e.g. Heart Foundations).

Road deaths

The decline of the road toll has also been the result of a broad-based approach incorporating all corners of the triad.³ Host-based strategies have been mainly educational with a heavy investment in graphic road safety advertisements.³ These messages are backed up by powerful environmental strategies, such as, speed cameras and heavy penalties for transgression. The sudden and dramatic nature of road deaths adds a real urgency to the public and political commitment to invest in prevention. The vector (the car) has undergone major technological and engineering changes (e.g. seat belts, airbags, and impact-absorption designs) to minimize the risk of serious injury or death in the event of a crash.

In the 1970s, Haddon used the epidemiological triad to identify speed as the main agent in road injuries and to note that little attention at the time had been paid to influencing the environment.³³ Since then, median strips, lighting, traffic calming features and a multitude of road engineering features have been a fundamental part of road safety. Public attitudes to wearing seatbelts, drink driving and speeding have all changed over the years in response to legislation, media campaigns and heavier penalties.³⁴

Skin cancers

Sun exposure is the vector for the ultraviolet light that is the agent in the promotion of most skin cancers. Campaigns in Australia and New Zealand to reduce sun exposure have been successful in changing attitudes and behaviours, especially among younger children.^{35,36} The perception of a suntanned body as a sign of health and beauty has, however,

been a major barrier and this still remains the case for many adolescents and adults. The multipronged campaign has involved a long-running and well-funded communications strategy with clear, action-directed messages (i.e. 'Slip, Slop, Slap') aimed at blocking the vector (sunlight) by putting on a shirt, sunscreen, and hat.³⁶ This has been supported by the sun protection policies in schools (e.g. the 'no hat, no play' rule) and in local governments (e.g. the planting of shade trees). Mole screening programs for early detection and treatment have also improved.

The success in changing people's behaviours in relation to sun protection (especially in children) has been in getting across unambiguous action messages backed up by strong policies, particularly in schools. The advocacy of groups like the Cancer Society has also provided a voice for the issue. The rising mortality from melanoma appears to have flattened out probably as a result of all the above strategies,⁸ although screening and early treatment probably influence mortality rates long before the primary prevention strategies take effect.

Cervical cancer

The main strategy for reducing the mortality from cervical cancer has been the implementation of a free screening and early detection program.⁵ This is an effective, medical-based approach although it is very costly for the number of lives saved.³⁷ There has been some supportive education-related activity, such as, advising the use of condoms, but this has not been a major feature of the overall program. The support of women's health groups was important in gaining political backing for the screening program.

HIV AIDS

The HIV AIDS epidemic has been reasonably well contained within Australia and New Zealand due to a comprehensive approach, with education for high-risk groups at its core.^{7,38} In the early stage of the epidemic, there were very few medical approaches but a heavy investment in research has resulted in the development and use of effective drugs. Large investments were also made in testing for blood transfusion services and for individuals. Education about protected intercourse and safe needle practices featured strongly among high-risk populations. Behaviour changes have occurred in a relatively short space of time despite the delicate nature of the messages and the societal prejudice against high-risk populations, such as, homosexuals and illicit drug users. Vocal advocacy groups have driven the public debate and maintained the pressure for action.

Sudden infant death syndrome

With the identification of the key risk factors for sudden infant death syndrome (SIDS; baby sleeping on its front, parental smoking, covering over baby's head, bed-sharing) highly specific, action orientated messages were able to be developed and a major investment was made in education programs aimed at new parents (particularly in high-risk populations, such as, Maori and Pacific people).⁶ It is

interesting that in the absence of any clearly identified agents or vectors, a successful reduction in SIDS incidence has been achieved because highly specific messages had been developed and communicated to a well-defined population of highly motivated people. Very few vector or environmental strategies were possible.

Current strategies to prevent obesity and diabetes

Host-based interventions

Current host-based strategies to increase physical activity and decrease the intake of energy-dense foods and drinks in the Australian and New Zealand populations are minimal. For example, the physical activity guidelines for Australians were developed through an extensive consultation process and have been largely adopted in New Zealand, but they have not been promoted to the public at all.³⁹ Also, the proposed dietary message on the prevention of weight gain in the forthcoming Australian dietary guidelines ('prevent weight gain by being physically active and eat according to your needs') is vague and not specifically action-orientated enough to be useful.

Nutrition information often comes to consumers from the package – nutrient data, nutrition claims and company/product information – and this has the potential to both inform and misinform. Mandated nutrition information panels that have been present in the USA since 1994 are soon to be introduced in New Zealand and Australia. They appear to facilitate the food choices of those who are trying to reduce their fat intake and can potentially influence the food choices of a large proportion of the population.^{26,40}

The recently published results of the Diabetes Prevention Program in the USA reinforced the findings of three previous studies that prevented (or delayed) the development of diabetes in people with impaired glucose tolerance.^{41,42–44} These impressive results would be very costly to implement at a population level because of the very high cost of screening large numbers of people to identify high-risk individuals for high intensity lifestyle interventions and the very high cost of long-term (possibly lifelong) follow up to maintain the lifestyle changes. Salutary results come from another diabetes prevention study where the dietary intervention was of 1 year duration. The initial benefits in weight loss and glucose tolerance at the end of the intervention period were lost or greatly diminished by 5 years.⁴⁵

The range of medical interventions to successfully treat people with current obesity is very limited and therefore, unlike cardiovascular disease, this 'treatment approach' to reducing the burden of obesity is not a fruitful strategy for a large investment of money, despite the fact that the majority of people are overweight. Until the obesogenic environments that are promoting obesity are addressed, individual-based interventions will remain modest in effectiveness.¹³

Vector-based interventions

Consumers prefer foods that are tasty, inexpensive and convenient and unfortunately that tends to mean energy dense foods that are high in fat and sugar.⁴⁶ Interventions

that may help to promote the development of foods that are lower in energy density are labelling-based approaches, although it would be important to ensure that reduced fat products that make nutrition claims or qualify for a nutrition signposting program have a proportional reduction in energy density. For some restrained eaters, 'low fat' or 'low calorie' claims can become an unconscious message to eat more of the product or accompanying foods.⁴⁷ In some manufactured products, the fat is removed so that a low fat claim can be made, but it is replaced with sugar such that the energy density remains relatively unchanged.⁴⁸ This reduces the impact of low fat products for preventing weight gain.

A general principle in relation to vectors is that small changes in high volume vectors can have significant population impacts. For example, French fries and potato crisps are a high volume source of fat for the New Zealand and Australian populations and small achievable changes in the average percentage of fat in those products can have a significant population impact.^{49–51} Similarly, short trips are frequent and are often made by car. In New Zealand, one-third of car trips are less than 2 kilometres, and less than half of children walk or ride to school.⁵² Small changes in the mode split would have significant effects on the population's activity levels. A marketing program in Perth informing people about alternative transport options to private car use changed the average number of walking and cycling trips by 63 out of a total of 1160 trips per year.⁵³ However, this seemingly small change in reducing the use of that great vector of inactivity, the car, increased the mean physical activity level of residents by about 30 min per week.

Environment-based interventions

This is an area of major deficiency in the prevention of obesity and diabetes. There is only modest investment in appropriate environment-based prevention programs, research and evaluation. Very few national or state policies have been initiated to promote healthy food and activity choices. Policies to influence the access and availability of healthier foods, increase the amount of physical education at school, reduce the volume of highly sophisticated advertisements for energy-dense foods and drinks directed at young children, and promote active transport are not currently being seriously considered. The infrastructure to promote active transport (walking, cycling, public transport), such as, increasing the cost and inconvenience of parking in the city, is weak in most Australasian cities and where it is being developed, the main purpose is to reduce pollution and congestion – increased physical activity is a side benefit.

The use of the Analysis Grid for Environments Limited to Obesity (ANGELO) framework to scan environments in settings (e.g. schools and communities) and sectors (e.g. the food industry and the transport sector) produces a large number of physical, economic, policy or sociocultural factors that potentially influence eating and physical activity patterns.¹³ Many of them are amenable to interventions within the context of a broad approach to obesity prevention.

Table 2 Lessons learned from successful control of epidemics in Australia and New Zealand compared with the current features of obesity and diabetes prevention

	Lessons learned from successful control of epidemics	Current approaches in obesity/diabetes prevention
Hosts	<p>Priority audiences clearly identified</p> <p>Specific, action-orientated messages</p>	<p>Increasing consensus on children and disadvantaged communities as priority groups</p> <p>Current messages are few, some are specific (e.g. current exercise recommendations and about reducing fat) but many are non-specific</p>
Vectors	<p>Effective medications and medical interventions</p> <p>Effective options for influencing the vectors are usually present</p> <p>Food labelling options (nutrient information panels, 'signposts' and nutrition claims) are effective in influencing consumer choice and product formulation</p> <p>Food formulation is a significant opportunity to influence intake</p>	<p>Few medications, not very effective or cost effective</p> <p>Vectors for energy intake – energy density is able to be influenced, increasing portion size will be difficult to counter</p> <p>Vectors for energy expenditure – increasing use of energy-saving machines and passive entertainment machines will be difficult to influence</p> <p>Food labelling options may help in obesity/diabetes prevention although low fat products may still be energy dense and 'low fat' labels may be a signal for some people to eat more</p>
Environments	<p>Major investments in communications campaigns or health care responses</p> <p>Major investment in health care infrastructure</p> <p>Significant role of policies, regulations, legislation</p> <p>Strong advocacy groups</p> <p>All corners of triad tackled</p> <p>Progress has been made despite major barriers in: individuals (e.g. addiction), society (e.g. attitudes to suntanning, homosexuality), private sector (e.g. powerful lobby force), and government (e.g. reluctance to make public health policy)</p> <p>Professional, public and political support for action</p> <p>Policy changes often lead social attitudes</p>	<p>Opportunities to make small reductions in energy density of high volume foods has not been fully explored</p> <p>Virtually no investments in communicating action messages</p> <p>Health care systems are a major barrier to obesity management</p> <p>Very little use of policy tools available to governments and institutions</p> <p>No vocal advocacy groups</p> <p>Environmental strategies have not been widely used</p> <p>Major commercial barriers to progress remain (e.g. automobile industry, food industry involved in energy-dense foods and drinks)</p>
Overall		<p>Growing support but insufficient to create the necessary pressure for action</p> <p>Currently major commercial opposition to policy-based interventions</p>

Adequacy of the overall approach to obesity/diabetes prevention

Table 2 shows the contrast between the lessons learned from the successful strategies from the control of other epidemics and the current approaches in obesity/diabetes prevention. Few of the necessary conditions appear to be present for a successful broad-based approach to obesity and diabetes prevention. It is clear that more environmental (mainly policy) initiatives are needed to achieve a comprehensive approach and that a much greater investment is needed to achieve the necessary 'dose' to make a difference.

It is interesting to note the major barriers that have had to be surmounted to achieve progress with the other epidemics. Tobacco control, for example, has been up against the highly addictive nature of cigarettes, the entrenched social norms around smoking, and a powerful tobacco industry in opposition. The barriers to be surmounted for the control of obesity/diabetes are no less formidable. However, the judicious application of the lessons learned from other current epidemics may help us to overcome these barriers.

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