

Dissecting Obesogenic Environments: The Development and Application of a Framework for Identifying and Prioritizing Environmental Interventions for Obesity¹

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Background. The “obesogenicity” of modern environments is fueling the obesity pandemic. We describe a framework, known as ANGELO (analysis grid for environments linked to obesity), which is a conceptual model for understanding the obesogenicity of environments and a practical tool for prioritizing environmental elements for research and intervention.

Methods: Development of the ANGELO framework. The basic framework is a 2 × 4 grid which dissects the environment into environmental size (micro and macro) by type: physical (what is available), economic (what are the costs), political (what are the “rules”), and sociocultural (what are the attitudes and beliefs). Within this grid, the elements which influence food intake and physical activity are characterized as obesogenic or “leptogenic” (promoting leanness).

Results: Application of the ANGELO framework. The ANGELO framework has been piloted at the population level (island communities) to prioritize the settings/sectors for intervention and at the setting level (fast food outlets) to prioritize research needs and interventions. Environmental elements were prioritized by rating their validity (evidence of impact), relevance (to the local context), and potential changeability.

Conclusions. The ANGELO framework appears to be a flexible and robust instrument for the needs analysis and problem identification stages of reducing the obesogenicity of modern environments.

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Key Words: obesity; dietary fats; exercise; environment; intervention studies; public health.

INTRODUCTION

Background

The increasing prevalence of obesity in developed and developing countries means that obesity is now being regarded as a pandemic [1,2]. To date, approaches to obesity, which have been mainly educational, behavioral, and pharmacological, have met with limited success [3,4]. They appear to be necessary but not sufficient to reduce obesity because people struggle against environments which increasingly promote a high energy intake and sedentary behaviors. The challenge is to create supportive environments for making the healthy choices which are promoted by the education messages. Systems-based, environmental interventions are therefore needed to increase the rather modest impact of individual and public education programs [1,5,6,7].

The importance of creating supportive environments achieved formal recognition with the Ottawa Charter in 1986 [8], and since then more sophisticated environmental models have been developed for dealing with a variety of modern health issues [9–11], including behaviors such as eating patterns [12] and physical activity [13] which are key mediators for obesity. While the importance of the environment in controlling obesity may be widely acknowledged, a recent World Health Organization report conceded that such environmental strategies remain relatively unexplored [14].

An Ecological Model of Obesity

One way of conceptualizing the interdependence among people, their health, and their environment is

¹ We are grateful for the support from the Health Research Council of New Zealand and The National Heart Foundation of New Zealand and input from the Secretariat of Pacific Communities, the Pacific Nutritionists Forum, and Heather Wright of Auckland Healthcare.

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through ecological models [11, 15]. We have recently proposed an ecological model for understanding obesity (Fig. 1) which incorporates environmental as well as biological and behavioral influences on obesity [16]. The model regards an individual's or population's level of obesity as a "settling point"—the net result of multiple influences which impact on fat mass by acting through the mediators of energy intake (especially energy-dense food [17]) and/or energy expenditure (especially physical activity). At the individual level, physiological adjustments in response to weight loss or gain, such as changes in metabolic rate, nutrient partitioning, and the energy costs of physical activity, may moderate the impact of energy imbalance on changes in fat mass [18].

Of the three influences shown in Fig. 1, the biological and behavioral have attracted the most attention with respect to causes, treatment, and prevention of obesity. Indeed, these "host" factors explain most of the differences between individuals when they are placed in a changing environment. For example, in the classic overfeeding study by Bouchard et al. [19], there was a wide variation in the weight gain response of subjects (monozygotic twins) to an identical 1000 kcal/day hypercaloric diet over a 100-day period. Much of the variation could be explained by genetic factors—in other words a typical gene–environment interaction. The focus of this paper is on the driving forces of the obesity epidemic, rather than the differential responses of individuals to those forces.

While these driving forces are clearly environmental in nature, they have not previously been studied in a systematic fashion. Moreover, as with other major public health issues, such as smoking reduction [20], injury prevention [21], and infectious disease prevention, success at the population level is not likely to occur until environmental influences are identified and modified. In injury prevention, for example, Haddon led a "paradigm shift" in thinking when he redefined injury in epidemic terms and focused on the environment as a major modifying influence [21].

Although it is recognized as being complex, there are

numerous advantages to systems-based / environmental approaches. For example, environmental measures may influence those population groups which are hard to reach with health education programs such as those with lower educational attainment, lower incomes, and language barriers [22]. Environmental changes may also be cost-effective and have a more lasting effect on behavior change because they become incorporated into structures, systems, policies, and sociocultural norms. In addition, in the area of obesity, environmental changes minimize the direct messages to the public about body size thereby reducing the chance of contributing to eating disorders and distorted perceptions of body image. It is important to view environmental interventions as complementary to individual approaches to obesity such as drug treatment and behavioral therapy rather than replacing them.

The development and execution of environmental intervention programs require the following steps: (1) needs analysis, (2) problem identification, (3) strategy development, (4) intervention, and (5) evaluation [23]. Major barriers to progressing through these steps for environmental programs include the lack of suitable paradigms and tools for understanding and measuring the environment [10]. There is an urgent need for a conceptual and practical framework to dissect the rather nebulous concept of the environment into concrete elements which are amenable to measurement and intervention. The aim of this paper is to describe the theoretical development and pilot testing of a framework for identifying obesogenic factors in the environment. We have called this tool the ANGELO framework (analysis grid for environments linked to obesity).

DEVELOPMENT OF THE ANGELO FRAMEWORK

Classifying Environments

Central to understanding the impact of environments on obesity is the concept of "obesogenicity" of an environment which is defined here as "the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations." The term "leptogenic" (leptos is Greek for thin) could be used as the opposite of obesogenic. A leptogenic environment is one that promotes healthy food choices and encourages physical activity. In terms of predisposing, enabling, or reinforcing factors [24], obesogenic elements are the barriers and leptogenic elements are the enhancers for the maintenance of healthy weight.

There are a wide variety of ways to classify environments and the value of any one model will depend on its ability to extend our understanding of the environments and identify opportunities for intervention [25]. Previously described classification models of environments [26–28] contained important categories related to obesity but the ANGELO framework was specifically

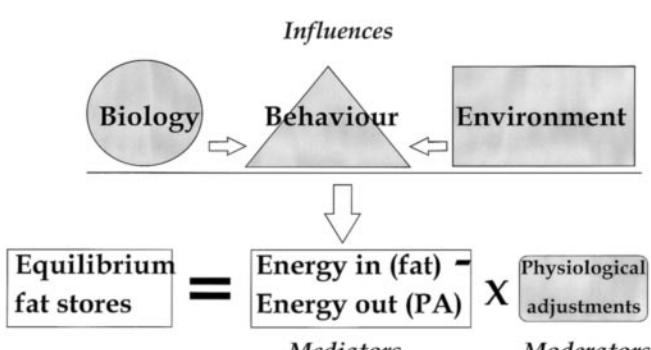


FIG. 1. An ecological model for understanding obesity (PA, physical activity).

developed to conceptualize obesogenic environments and to identify potential interventions.

The ANGELO framework is a grid which comprises two *sizes* of environment on one axis and four *types* of environment on the other. Individuals interact with the environment in multiple micro-(local) environments, or settings, including schools, workplaces, homes, and neighborhoods. Microenvironmental settings, in turn, are influenced by the broader macroenvironments, or sectors (such as the education and health systems, all levels of government, the food industry, and a society's attitudes and beliefs), which are less amenable to the control of individuals.

Within these settings or sectors there are different types of environment. We have categorized these as physical, economic, political, or sociocultural. Put in simple terms, these relate to what is available, what are the costs, what are the rules, and what are the attitudes and beliefs. Both food and activity (the two mediators) then become subcategories within these cells and it is either (or both) of these which mediates the effects of the broader environments on body fat levels. An environmental element such as access to cycle paths or school policies on physical education may be considered obesogenic or leptogenic depending on the local circumstances. It may be helpful to consider them barriers (negative) and enablers (positive), respectively, in relation to maintaining a healthy body weight. The most critical, but not the sole, mediator on

the energy intake side is the fat content or energy density of the food. Similarly, in relation to energy expenditure, it is physical activity. Table 1 shows an example of the ANGELO grid with some of settings, sectors, and environmental elements filled in for Pacific countries (to be discussed in detail later). The characteristics of the two different size environments and the four types of environmental influences will be discussed in turn.

A. Environmental size

Microenvironmental settings. A microenvironmental setting is one where groups of people gather for specific purposes which typically involve food, physical activity, or, frequently, both. These settings are usually geographically distinct, are relatively small, and are potentially influenced by individuals. Some examples of microenvironmental settings which may influence the development of obesity are listed in Table 2.

Macroenvironmental sectors. A macroenvironmental sector relating to obesity is a group of industries, services, or supporting infrastructure which influence the food eaten and/or physical activity carried out within the various settings (Table 2). A microenvironmental setting such as a supermarket will be influenced by a number of supporting macroenvironmental sectors such as the food production, manufacturing, distribution, and marketing sectors. These sectors are common to the wider population, often operating at regional,

TABLE 1

Examples of Prioritized Projects for Further Investigation in Pacific Island Communities

Size			Type	
	Physical (Food and PA)	Economic (Food and PA)	Political (Food and PA)	Sociocultural (Food and PA)
Micro (settings)				
Festivities				Cultural importance of high-fat foods
Neighborhoods	Recreation and sports facilities Safe walking paths			
Schools	Canteens serving local food		Policies on physical education Promotion of traditional activities, e.g., dancing	
Homes	Home gardens			
Churches				Church leaders as role models
Markets	Availability of local food (especially fish and vegetables)			
Macro (sectors)				
Transport	Availability of buses and bus stops			
Health regulatory system			Policies and standards on imported food quality/labeling	

Note. PA, physical activity.

TABLE 2

Examples of Microenvironmental Settings and Macroenvironmental Sectors

Microenvironmental settings	Macroenvironmental sectors
Homes	Technology/design (e.g., labor-saving devices, architecture)
Workplaces	Media (e.g., women's magazines)
Schools	Food production/importing
Universities/tertiary institutions	Food manufacturing
Community groups (e.g., clubs, churches)	Food marketing (e.g., fast food advertising)
Community places (e.g., parks, shopping malls)	Food distribution (e.g., wholesalers)
Institutions (e.g., hospitals, boarding schools)	Food catering services
Food retailers (e.g., supermarkets)	Sports/leisure industry (e.g., instructor training programs)
Food service outlets (e.g., lunch bars, restaurants)	Urban/rural development (e.g., town planning, local councils)
Recreation facilities (e.g., pools, gyms)	Transport system (e.g., public transportation systems)
Neighborhoods (e.g., cycle paths, street safety)	Health system (e.g., Ministry of Health, medical schools, professional associations)
Transport service centers (e.g., airports, bus stations)	
Local health care (e.g., GP, hospital)	

national, and international levels, and tend to be geographically diffuse. At the operational level of measuring and intervening within macroenvironments, the multiple and interconnecting layers of influence (for example industry groups, local and regional authorities, central government, transnational corporations) may make the process complex. However, the opportunities for intervention are likely to be relatively few and quite specific, thereby simplifying the process. Macroenvironmental structures are essentially beyond the influence of individuals and even governments and nongovernmental organizations usually have difficulty in influencing these sectors because of their size, complexity, and other priorities (especially the profit motive within the private sector and politics within the public sector).

B. Environmental Types

Physical. The physical environment, in the widest sense, refers to "what is available." It includes not only the visible world but also less tangible factors such as the availability of training opportunities, nutrition and exercise expertise, technological innovations, and information.

In relation to food, the physical environment refers to what is available in a variety of food outlets including restaurants, supermarkets [29], vending machines,

schools [30], worksites [31], and community, sports, and arts venues [32,33]. Point-of-purchase information such as nutrition labels, product demonstrations, and the Australian and New Zealand Heart Foundations' "Pick the Tick" logo [34] have been shown to be important leptogenic influences affecting consumer choice [35,36]. The availability of training opportunities (such as the inclusion of nutrition in chef training courses) and access to technology and expertise (such as the development of reduced-fat products) are also important factors in the physical environment.

For physical activity, the physical environment includes the opportunities for participation in leisure, occupational, or incidental activity. Environmental factors which influence the use of active transport (walking, cycling) over motorized transport (cars, lifts, escalators) include the availability of cycle paths, foot paths, street lighting, public transport, and accessible stairs in buildings [13]. Factors which influence participation in active leisure activities include the availability of quality recreation spaces, parks, sports grounds, and community clubs [13].

Economic. The economic environment refers to the costs related to food and physical activity. In relation to food, the major economic influences are the costs of food production, manufacturing, distribution, and retailing. These costs are largely determined by market forces, but some opportunities exist for public health interventions. Three economic interventions which may effect food intake are: (1) monetary incentives and disincentives in the form of taxes, pricing policies, and subsidies [37], (2) financial support for health promotion programs [12], and (3) "purchasing" healthy food policies and practices through sponsorship [32].

In contrast to food, participation in physical activity does not necessarily have a direct financial cost. However, as with food intake there are some economic factors which can influence the amount of physical activity people engage in. For example, some factors may reduce the cost of physical activity (such as gym membership subsidies), increase the opportunities for physical activity (such as budget allocations for building recreation centers or cycle paths), or increase the motivation to engage in physical activity (such as funding health campaigns and improved public transport).

The economic environment may be important, not only in terms of costs but also in terms of income. Factors which affect income (national and personal) are important determinants of body weight, through food choices and physical activity. In industrialized countries, higher socioeconomic status, educational levels, and occupations tend to be associated with a lower prevalence of obesity, especially in women [38,39].

Political. The political environment refers to the rules related to food and physical activity and include

laws, regulations, policies (formal or informal), and institutional rules. These rules have profound effects on the behavior of individuals and organizations. For example, at the microenvironmental level of the school, the political environment includes the school nutrition policy and school rules related to food [30]. These will influence the food options in school meals, vending machines, and other food served at school. The home is another important micro setting where family rules about food purchase and consumption can alter the obesogenicity of the home environment.

At the macro level, the political environment concerning food refers to government food and nutrition policies, regulations and laws, and food industry policies and standards [12]. Food regulations are important because they determine the kinds of labels on foods, the use of health claims on food packages and in advertising, and the use of health-related nutritional descriptions in the consumer marketplace (e.g., supermarkets and restaurants), all of which can significantly influence food choices [29,35]. Another important component of the macro political environment is the regulation of the nature and amount of food advertising aimed at children and young people [1,40].

The political environment also influences physical activity. An example of the political environment influencing physical activity in the home would be family rules on the amount of television watched [41]. Measuring political influences may be quite difficult at the micro level as rules are often not formalized or overt. At a macro level, the regulations, laws, and town planning policies which give priority to active transport (cycling or walking) or public transport use over car use will increase physical activity levels [13]. Examples include restricting inner city centers to foot or bicycle traffic, zoning for the protection of open spaces, and policy priorities which promote the development of cycleways and walkways [13]. Local government policies have a profound effect on recreational activity through provision of parks, community recreation centers, and sporting facilities. Building codes and regulations can be used to promote “physical-activity-friendly” buildings with attractive, safe, and readily accessible stairs [13]. It is also important to measure the political environment because political changes may often lead to and accelerate sociocultural changes. Examples of this include the legislation related to seat belt wearing and smokefree environments, which have acted as catalysts for wider attitudinal and behavioral changes in society [42,43].

Sociocultural. The sociocultural environment principally refers to a community’s or society’s attitudes, beliefs, and values related to food and physical activity. These social and cultural norms, which are influenced

by gender, age, ethnicity, traditions, religion, and subgroup affiliations, have a powerful effect on the behavior of individual members of the community group.

At a micro or setting level, these sociocultural influences combine to give what is variously described as the “culture,” “ethos,” or “climate” of a school, home, workplace, or neighborhood. In schools, for example, the school ethos is considered a central component of a “health-promoting school” [30]. It is influenced by, among other things, the relationships among staff and students, the value a school places on participation in sports and physical education, the degree to which the teachers serve as healthy role models for the students, and how much good nutrition features in the philosophy of the school food service [30]. Role models, such as sporting heroes, celebrities, and fashion models, have a major influence on formulating community attitudes, beliefs, and values, which is why they are in such demand as a marketing strategy for changing consumer behavior.

At the macroenvironmental level, the mass media are an important sector influencing the sociocultural aspects of food and physical activity [44–46]. They directly and indirectly influence society’s attitudes, beliefs, and values. They not only reflect and reinforce the “common culture” but also shape it, particularly through the effects of advertising and marketing [47,48].

Clearly, measuring the sociocultural aspects of different environments is complex and difficult. The media environment may be more amenable to measurements such as the frequency and content of food advertising to children [49,50]. However, in general, developing reliable and valid indicators of sociocultural environments is complex because of the often intangible and interconnected nature of its elements. Although influencing the attitudes and beliefs can be difficult and costly, their impact on behavior related to food and physical activity should not be ignored in any comprehensive analysis of environmental factors influencing obesity.

APPLICATION OF THE ANGELO FRAMEWORK

Having developed the theoretical basis for dissecting environments, we have piloted the framework at two levels. At the population level, we have used it with stakeholders from island communities (Torres Strait Islands and Pacific Islands) and at the setting/sector level we have applied it to fast food outlets in New Zealand.

Application across Several Settings/Sectors—Island Communities

The ANGELO framework was applied in the Torres Strait Islands off the northern tip of Australia, in conjunction with the GutBuster “waist loss” program [51]

which was modified for indigenous men [52]. The islands are small in size (often less than 10 square km) and population (several hundred) and the communities are relatively homogeneous. Obesity is a major problem with over half of the population classified as overweight or obese and a prevalence of type 2 diabetes of over 20% [53].

The contents for the ANGELO grid were generated from group and individual interviews with local people and health workers. Some examples of the elements identified were the availability of cars, cost of reduced fat foods, the quality of imported foods, traditions related to festive eating, elders as role models, and cultural values placed on sport [52]. The variables were put into a spreadsheet format and scored on a scale on the basis of their magnitude of effect as either a barrier (obesogenic) or an enhancer (leptogenic). This allowed for semi-quantitative comparisons to be made, highlighting the main environmental opportunities for potential interventions. In particular, influencing the food supply to the islands, reducing the costs of healthy foods (through Government subsidization), and improving cultural attitudes to exercise were identified as intervention goals and some changes in these areas have already been initiated.

Many Pacific Islands communities have obesogenic elements in common with each other and with the Torres Strait Islands. At a workshop for nutritionists from Pacific Islands held by the Secretariat for Pacific Communities, the ANGELO framework was applied by participants to their island communities. They generated a long list of potential obesogenic elements which they then rated according to the perceived relevance to their community and their potential changeability. Participants gained a wider view of environmental determinants which could be modified and used the rating system to develop a preliminary priority list of potential settings and sectors for interventions (Table 1). Some elements identified as being highly relevant were not included in the list because they were not considered very amenable to modification. Typically these were economic elements such as the low cost of fatty meat, the relatively easy access for loans for cars, and the financial incentives for fishermen to export their fish rather than sell them on the local market.

Application to a Single Setting—Fast Food Outlets

In New Zealand, as in most developed countries, fast food outlets are an important setting for influencing fat intake. About 44% of New Zealanders eat hot chips at least once a week and approximately 135,000 tons of potatoes are eaten as hot chips annually (Vegefed, personal communication). A group of health and industry stakeholders identified reducing the fat content of hot chips as a measurable and achievable target. A one-percentage-point drop in the average fat content of

chips would result in an average annual reduction in fat consumption of about one-third of a kilogram of fat per capita. However, the lack of knowledge about the deep-frying practices and fat content of hot chips in New Zealand was a major barrier to developing suitable interventions, so research became a priority.

Research was needed to provide an evidence base for the process on three separate, but related, levels: (1) Validity research. What are the main determinants of *fat uptake in chips?* This evidence was derived from the literature but other "benchtop" experiments were also needed where no data were available, for example, the fat uptake when chips were cooked from frozen versus thawed. (2) Relevance research. What are the main determinants of the *fat content of chips in New Zealand?* This involved a national survey of deep-frying practices in fast food outlets and relating these variables to the measured fat content of the chips they produce. (3) Monitoring research. What are the key environmental indicators for monitoring and what are their baseline levels? The development of a few key indicators for future monitoring will also come from the national survey. The ANGELO framework ensured that all relevant elements were considered: physical (e.g., type of frying fat), economic (e.g., profit margins on thin versus thick chips), political (e.g., use of procedural guidelines), and sociocultural (e.g., belief among outlet managers about their potential to improve the health value of their product).

The potential interventions to flow from this are the development of training programs, best practice guidelines for deep-frying, promotion of larger chip sizes, and the incorporation of best practice techniques in the judging criteria for the annual "Best Fish and Chip Shop" competition. The research will provide the evidence base for these interventions but will also provide some external validity for the various elements in the fast food outlet environment ratings for future ANGELO analyses.

Process Outline

From these experiences in implementing the ANGELO framework, a general process has been developed to capitalize on the discipline that the framework imposes and the value of the rating process for prioritizing action (Fig. 2). A stakeholder group(s) is used to apply the ANGELO framework at a community or setting/sector level. The broader the scope of the exercise, such as considering a large number of settings/sectors, the more superficial is the process of identifying obesogenic / leptogenic elements. From this first stage of the process, a comprehensive list of potential elements is identified. The next stage involves rating the elements for: (1) validity: (what is the evidence that this element has an important influence on intake of

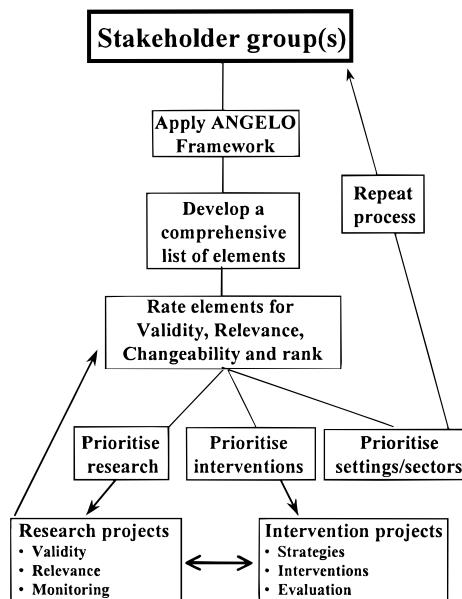


FIG. 2. The proposed process for applying the ANGELO framework to prioritize further interventions and research.

fat or level of physical activity?). (2) relevance (how big is a problem is it in this case?), and (3) changeability (what is the potential for changing it?). A final ranking of elements is achieved by combining the scores for each element and these form the basis for setting priority areas for further action.

If the ANGELO process encompasses several settings/sectors (such as in the island communities), the outcome is likely to provide an overview of potential settings/sectors for intervention which would need further investigation with specific stakeholders. If the ANGELO process is conducted within a single setting or sector, a set of prioritized interventions would be identified for further project development. Throughout the process, the research needs will become apparent and these should end up as a set of prioritized research projects to provide the evidence and baseline data for the intervention projects. The whole process provides an important mechanism for gaining the commitment of key stakeholders to common goals.

CONCLUSION

We have taken the first steps in the development of a broad environmental approach to obesity prevention by evolving the theoretical base of an ecological model of obesity into a framework for understanding obesogenic environments. The value of this framework will depend on how much it advances conceptual understanding of the area and how useful it is at a practical level. The ANGELO framework appears most valuable at the needs analysis and problem identification/prioritization steps of planning health promotion interventions

for reducing obesity at a population level. It provides a conceptual construct for dissecting obesogenic environments, a broad grid for brainstorming, and a process for getting stakeholders to prioritize future environmental interventions and research. The framework is currently undergoing further testing in a variety of settings and sectors as well as with larger populations. If its value is confirmed in a wide range of environments, the ANGELO framework may become an important tool in the continuing efforts to control the rising obesity pandemic.

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