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Brug, Johannes, Kremers, Stef P., van Lenthe, Frank, Ball, Kylie and Crawford, David 2008, Environmental determinants of healthy eating: in need of theory and evidence, *Proceedings of the Nutrition Society*, vol. 67, no. 3, pp. 307-316.

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A Meeting of the Nutrition Society, hosted by the Scottish Section, was held at the West Park Conference Centre, Dundee on 27 and 28 March 2008

Symposium on ‘Behavioural nutrition and energy balance in the young’

Environmental determinants of healthy eating: in need of theory and evidence

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In order to promote healthful nutrition, insight is needed into the determinants of nutrition behaviours. Behavioural determinant research and behavioural nutrition interventions have focused mostly on individual-level motivational factors. It has been argued that the individual's socio-cultural and physical environments may be the main determinants of nutrition behaviours. However, the theoretical basis and empirical evidence for environmental determinants of nutrition behaviours are not strong. The present paper is a narrative review informed by a series of systematic reviews and recent original studies on associations between environmental factors and nutrition behaviours to provide an overview and discussion of the evidence for environmental correlates and predictors of nutrition behaviour. Although the number of studies on potential environmental determinants of nutrition behaviours has increased steeply over the last decades, they include only a few well-designed studies with validated measures and guided by sound theoretical frameworks. The preliminary evidence from the available systematic reviews indicates that socio-cultural environmental factors defining what is socially acceptable, desirable and appropriate to eat may be more important for healthful eating than physical environments that define the availability and accessibility of foods. It is concluded that there is a lack of well-designed studies on environmental determinants of healthful eating behaviours. Preliminary evidence indicates that social environmental factors may be more important than physical environmental factors for healthful eating. Better-designed studies are needed to further build evidence-based theory on environmental determinants to guide the development of interventions to promote healthful eating.

Nutrition: Behavioural determinants: Environment

Diet and nutrition are important for population health, but large majorities of populations in many countries do not comply with recommendations for healthy eating^(1,2). Healthful diet promotion is mostly focused on reducing saturated fat and energy intake and on promoting fruit, vegetable and fibre intake.

According to a basic model for planned promotion of population health (Fig. 1) the identification of major health problems and its nutritional risk factors are the first steps in

the development of healthful nutrition promotion interventions. These first two steps define why effective nutrition interventions should be implemented and what nutrition behaviours should be targeted. However, to further develop such interventions, insight is needed into why individuals engage in such risk behaviours⁽³⁾.

Until recently, studies on determinants of eating behaviours primarily focused on individual-level factors, such as taste preferences, nutrition knowledge, attitudes and

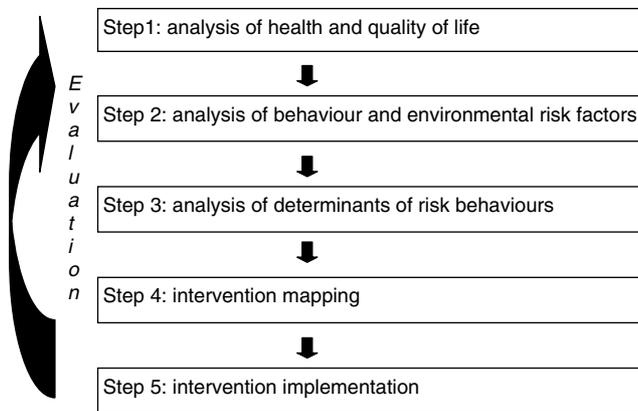


Fig. 1. A model for planned health education and health promotion.

intentions, and insight into these motivational determinants have informed health education interventions promoting more healthful eating habits⁽³⁾. More recently, it has been argued that the individual's environment may be of crucial importance in shaping and maintaining nutrition and eating habits⁽⁴⁾. In most countries with established market economies palatable energy-rich foods that are high in fat, sugar and salt are available anywhere and anytime, while fresh fruit and vegetables and other foods rich in fibre may be much more difficult to obtain. This factor, combined with the tendency to eat when food is available and eat more when more is on offer^(5,6), may lead to overeating of some foods and lack of consumption of others. Poor eating habits increase the risk of overweight and obesity, high serum cholesterol levels and hypertension, and consequently an increased risk for metabolic syndrome, diabetes, CVD and some cancers. Such environmental determinants of nutrition behaviour warrant a health protection approach, i.e. policy measures to realise environmental changes to healthful nutrition promotion rather than simply health education.

The present paper will review the theory and evidence relating to environmental determinants of health behaviours. The main focus will be on nutrition behaviour, but reference will be made also to evidence from reviews on environmental determinants of physical activity, given the similarities between behavioural nutrition and physical activity⁽⁷⁾. The present paper will build on a series of reviews on these topics that have been conducted in the past few years as well as recent original studies in which the authors have been involved.

Introducing theories on environmental determinants

Most current health behaviour theories hypothesise that health behaviour is determined by an interrelated set of personal and environmental factors. For example, it has been proposed that individuals' health behaviours are determined by three broad interrelated categories of determinants: motivation; abilities; opportunities⁽⁸⁾. The chances for individuals to engage in health behaviours are greatest when they are motivated to act healthily, have the abilities to engage in the healthy behaviour and when their social and

physical environment offers the right opportunities for engaging in the healthy behaviour. Motivation and abilities can be considered to be personal determinants of health behaviour, while opportunities are based on environmental determinants. However, these categories are not independent. In an environment that offers easy opportunities for healthy behaviours, an individual may need less motivation and fewer skills. Social cognitive theory explicitly highlights this interaction between the individual and the environment in predicting health behaviour⁽⁹⁾.

Just as personal factors have been further subdivided into more-specific determinant constructs such as intentions, attitudes, outcome expectancies, subjective norms, self-efficacy and perceived behaviour control⁽¹⁰⁾, the environment can also be further defined by distinguishing various environmental factors.

Different classifications of possible environmental determinants of health behaviours have been proposed that show overlap and similarities. So-called ecological models of health behaviour arguably put most emphasis on the environmental factors in shaping health behaviours⁽¹¹⁾. Social environmental influences (inter-individual influences), physical environmental influences (influences within community settings) and macrosystem influences (influences at the societal level) have been identified⁽¹²⁾. Social and cultural environmental influences have been differentiated, and a further distinction made between ultimate, distal and proximal factors⁽¹³⁾. Based on the distinctions between categories of environment factors combined with the proximity of these environmental factors, a matrix can be designed with cells that represent different classes of environmental influences.

Such a matrix or grid structure is explicitly proposed in the analysis grid for environments linked to obesity (ANGELO) framework⁽¹⁴⁾. This framework enables the identification of potential intervention settings and strategies. ANGELO was developed for the investigation of environments that promote excess energy intake and sedentary lifestyles (i.e. 'obesogenic' environments).

The ANGELO framework is a grid with two axes (Fig. 2). On the first axis two 'sizes' of environment (micro and macro) are distinguished. Micro-environments are defined as environmental settings in which groups of individuals meet and gather. Such settings are usually geographically distinct and provide opportunities for direct interaction between individuals and the environment. Examples of micro-environments are homes, schools, workplaces, supermarkets, bars and restaurants, other recreational facilities and also neighbourhoods.

Macro-environments encompass the more anonymous infrastructure that may support or hinder energy-balance behaviours. Examples of macro-environments are national or international food and nutrition policies, and how food products are marketed, taxed and distributed.

On the second axis four 'types' of environments are distinguished: physical; economic; political; socio-cultural. The physical environment refers to the availability of opportunities for healthy and unhealthy choices, such as points-of-purchase for different foods, availability of healthy food options in school canteens or worksite cafeterias etc. The economic environment refers to the costs

	Micro-environment	Macro-environment
Physical environment		
Economic environment		
Political environment		
Socio-cultural environment		

Fig. 2. The analysis grid for environments linked to obesity (ANGELO) grid. (Based on Swinburn *et al.*⁽¹⁴⁾.)

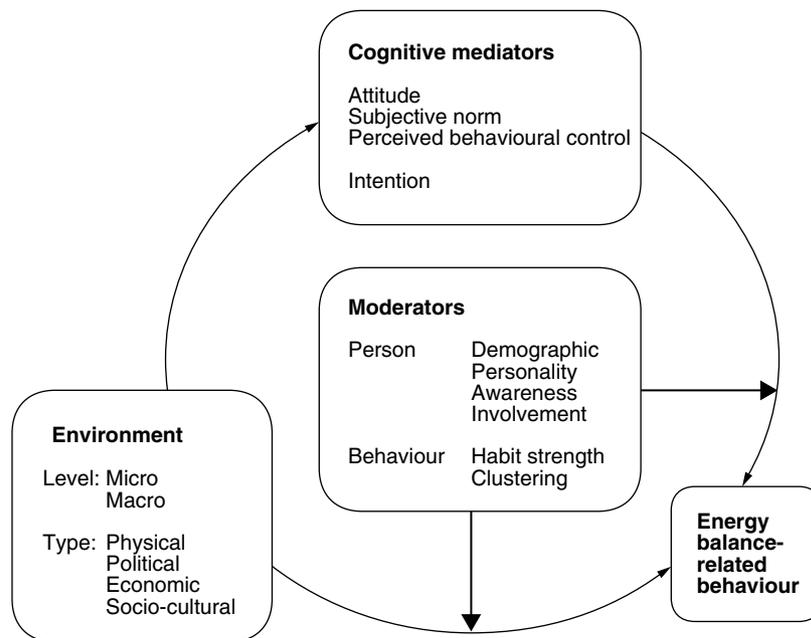


Fig. 3. The environmental research model for weight gain prevention. (From Kremers *et al.*⁽¹⁵⁾.)

related to healthy and unhealthy eating. The political environment refers to the rules and regulations that may influence food choice and eating behaviour. School nutrition policies, e.g. on bans on soft-drink vending machines or on what treats can and cannot be brought to school, and family food rules are examples of political environmental factors. The socio-cultural environment refers to the social and cultural subjective and descriptive norms and other social influences such as social support for the adoption of health behaviour or social pressure to engage in unhealthy habits; socio-economic position can also be regarded as a socio-cultural factor, but is sometimes included in the economic environment.

The ANGELO framework is very useful for categorising different environmental influences on nutrition or other health behaviours. However, ANGELO is not a theoretical framework in the sense that it describes (hypothetical) mediating or moderating pathways highlighting how and under what conditions the different environmental factors may influence engagement in health behaviours, and ANGELO, as well as most other socio-ecological health behaviour models, lacks a description of how individual-level factors, i.e. motivation- and ability-related factors and environmental factors, interact in shaping health behaviours⁽³⁾.

Recently, a conceptual framework to further study the interplay between individual factors and environmental factors in predicting energy-balance behaviours has been proposed (Fig. 3)⁽¹⁵⁾. A dual-process model is outlined that can be used to gain insight into the causal mechanisms that underlie the relationship between environmental influences and behaviours that may influence the energy balance.

This so-called environmental research model for weight gain prevention (EnRG) builds on recent reviews that have shown a lack of consistent results relating to the impact of environmental factors on nutrition behaviours and physical activity⁽¹⁶⁾. A meta-analysis based on sixteen studies has confirmed the ambivalence in current empirical evidence relating to physical activity, but could not identify a single ‘crude’ environmental factor as being consistently related to physical activity⁽¹⁷⁾. It is argued that the evidence relating to environmental determinants of energy-balance-related nutrition and physical activity behaviours collected to date has often been the result of non-theoretical approaches, which do not provide any knowledge on causal mediating relationships between environmental factors and health behaviours⁽¹⁵⁾. The fact that a majority of research in the field to date has been ‘opportunistic’, drawing on existing data rather than being based on purpose-designed studies, has also been highlighted⁽⁴⁾. Using the application of

knowledge mapping techniques, a panel of experts from diverse professional fields has highlighted a particular need for research to document the extent of environmental influences and how such environmental factors influence behaviour⁽¹⁸⁾. Thus, an outline is given of how environments might affect behaviour, with the inclusion of mediating pathways and potential moderators of the relationships between environment, personal behavioural determinants and health behaviour⁽¹⁵⁾. The main ingredients of EnRG are derived from the ANGELO framework and one of the most popular socio-cognitive behavioural determinants models, the theory of planned behaviour⁽¹⁹⁾.

EnRG is a dual-process model⁽²⁰⁾ in the sense that it presumes that on the one hand behaviour can be the result of direct 'automatic' responses to environmental cues⁽²¹⁾, and on the other hand individuals may invest time and effort in systematically building beliefs and decisions to guide their health behavioural choices. It is argued that the application of the dual-process view in the study of personal and environmental determinants of health behaviours will help to gain insight into the circumstances under which health behaviour is a conscious action or an action that is more automatically induced by environmental cues, and such insights may inform intervention strategies to change health behaviour⁽¹⁵⁾. In the case of mediation by individual cognitions a health education approach may be appropriate, while in the case of automatic responses to environmental cues a health protection approach aimed at changing the environment may be more effective. This strategy implies an 'either/or' approach, but it is likely that both pathways will operate and therefore both intervention approaches are important.

EnRG thus hypothesises that the environmental factors such as those categorised in the ANGELO framework can have a direct influence on health behaviour by triggering more or less automatic responses to environmental cues. For example, in a home environment in which good-quality fruit is easily accessible in a fruit bowl, the sight and smell of the fruit may trigger consumption. On the other hand, environmental factors may influence health behaviour via personal motivation. For example, a restaurant environment that offers an impressive salad bar may induce more-positive beliefs related to eating a salad, which will increase intentions to eat a salad and make actual consumption more likely. The model further hypothesises that factors such as habit strength, personality characteristics and awareness of personal health behaviours may moderate the direct and indirect influences of environmental factors on health behaviours.

Reviews of the evidence

Most publications arguing that environmental factors drive unhealthy eating habits are position papers or narrative reviews, and therefore do not provide systematic evidence in favour of a causal association between environmental factors and unhealthy eating habits or its consequences. Furthermore, most of these position papers focus primarily on the presumed importance of the physical environment; the availability, accessibility and

affordability of foods that contribute to unhealthful eating patterns.

Recently, six systematic reviews of the scientific literature up to 2005 on environmental correlates (297 papers were included in the reviews) and interventions (112 papers were included) for nutrition behaviours and physical activity for children, adolescents and adults in countries with established market economies were conducted and published as a series of papers in different scientific journals^(22–26). In this series of reviews the potential determinants and interventions were categorised according to the cells of the ANGELO grid.

First, these reviews reveal that research on potential environmental correlates of nutrition and physical activity is becoming more and more popular, particularly among children and adolescents, given the sharply increasing number of publications on this issue in the last decades⁽²⁷⁾. Furthermore, the reviews indicate that micro-size environmental factors have been studied much more often than macro-level factors. In the studies reviewed socio-cultural and physical environmental factors were included most often.

More importantly, the reviews of observational studies do not yet strongly support the recent claims that the environment has an important influence on nutrition and physical activity behaviours. The reviews reveal that the evidence is inconsistent for all the categories of environmental factors; less than half the studies have reported significant associations between environmental factors and the health behaviours investigated. Furthermore, these observational studies were mostly cross-sectional. Such studies require less time and other resources than more rigorous research, but even the presence of significant associations would not have provided evidence that environmental factors predict or cause unhealthful behaviours. Longitudinal and experimental studies are necessary to identify true environmental predictors and determinants of nutrition or physical activity behaviours.

Although strongly outnumbered by observational studies, the intervention studies that were reviewed provide more consistent evidence relating to relevant environmental factors, but the range of environmental factors studied was much smaller.

The combined findings from 297 observational studies and 112 intervention studies that were included in the different reviews lead to the following overall conclusions: (1) social support and modelling appear to be important for physical activity, in youth as well as in adulthood; (2) parents play a crucial role in influencing the health behaviour of their children in terms of modelling behaviour and also by using parenting practices and styles that encourage and support healthy habits in their offspring; (3) availability and accessibility of healthy and less-healthy foods are important for nutrition behaviours in youth and adulthood; schools and worksites offer good opportunities to improve the availability of healthful foods; (4) from the reviews of intervention studies it appears that increasing physical activity opportunities makes a difference, and schools and worksites offer suitable settings. In particular, increasing the period of time spent participating in physical education and physical activity in schools can make a

difference for children and adolescents. Improving opportunities for walking can make a difference in adults; (5) children and adolescents from more deprived families are likely to have unhealthier diets and less physical activity, and lower household income is associated with less-healthy diets in adults⁽¹⁶⁾.

The number of sound evidence-based conclusions about important environmental factors that could be drawn from reviewing the >400 original studies is not that impressive. The relatively-weak evidence that has been found thus far may not be interpreted as the absence of a relationship between 'the environment' and nutrition or physical activity behaviour. Despite the large number of studies, there is still a lack of high-quality studies and study replications, and many potentially-relevant environmental factors have not been studied. The available research has focused on only part of the environment, in particular micro-level factors in the socio-cultural environment and the physical environment. These factors are typically home-environmental social factors and school-physical environmental factors (parental influences and school availability) for children and adolescents, and social support and home and worksite availability and accessibility factors for adults, with few studies on neighbourhood environmental factors. Studies on macro-size environmental factors are almost completely absent.

Furthermore, most studies have applied weak study designs and non-validated measurement instruments. For example, most of the available observational studies have used cross-sectional designs, thus providing evidence for associations, but not for prediction or causation. Most studies have only presented bivariate associations between a presumed correlate and the behaviour; few studies have used multivariate analyses, adjusting for other potential personal or environmental correlates of nutrition or physical activity behaviours. Most observational and intervention studies have not examined the differences in environmental correlates for distinct subgroups based on the proposed moderators in EnRG, such as gender, socio-economic status, ethnicity and habit strength. Many intervention studies have not included a control group. Only some more recent studies have used multi-level analyses to take into account the fact that potential environmental correlates are often studied in non-independent samples, such as individuals clustered within neighbourhoods, schools or school classes⁽¹⁶⁾. Exposure to environmental factors and engagement in nutrition and physical activity behaviours have often been assessed with non-validated self-report measures.

Important issues and new insights from recent studies

The series of reviews has led to the identification of five important issues that require further exploration and investigation:

1. more insight is needed in the interplay between individual level and environmental factors in prediction and determination of health behaviour;
2. socio-cultural environments may be more important than physical environmental factors;

3. differences between objective and self-report assessments of the environment;
4. the use of observational studies or intervention studies to explore environmental determinants;
5. the specificity of behaviour and environments.

These issues will be discussed briefly and recent studies in which the authors have been involved that provide some preliminary evidence to help to resolve these issues will be reported.

Mediation and moderation between motivation, ability and opportunity

In most of the studies that were reviewed only direct associations between environments and nutrition behaviours were considered, and other categories of potential behavioural determinants such as motivational factors were not included. Some recent studies that have included both environmental factors and motivational factors have shown that motivational factors are more strongly associated with self-report behaviours than environmental factors, and that motivational factors mediate the environmental impact on dietary behaviour and physical activity^(28–32). The mediated route from environment to behaviour holds in various instances, individuals and behaviours studied. However, the cognitively-mediated route does not always take sufficient account of variations in behaviour. Since unmediated environmental effects are postulated to be important explanatory mechanisms in the field of dietary behaviour and physical activity⁽¹⁵⁾, future studies need to be aimed at the identification of the behaviours, individuals and circumstances under which environmental influences are or are not mediated by motivational factors.

The impact of parenting practices, i.e. a social environmental factor, on adolescent soft-drink consumption has been investigated in a study that also explored the potential moderating role of adolescent personality in relation to the parenting practices-adolescent soft drink consumption relationship⁽³³⁾. The results show that adolescents who perceive their parents to have stricter house rules on soft-drink consumption drink less soft drink. Importantly, the personality dimension 'agreeableness' moderates this relationship, with adolescents with medium levels of 'agreeableness' most likely to obey parental house rules.

The potentially moderating role of general parenting dimensions (i.e. strictness and involvement) on the association between parenting practices and adolescent sugar-sweetened beverage consumption has been further investigated⁽³²⁾. Consistent with published theory⁽³⁴⁾, the impact of content-specific parenting practices on consumption behaviour was found to be stronger among adolescents who perceive their parents as being both strict and involved. Specific restrictive practices relating to sugar-sweetened beverages have less impact on the child's behaviour for those parents who are generally less strict or involved with their child.

Other studies have focused on the moderating role of habit in the motivational control of dietary intake and physical activity. Habits are considered to be more or less automatic behavioural responses to environmental cues,

and when habit strength for a certain dietary behaviour or physical activity increases, this behaviour may be less guided by conscious intentions⁽³⁵⁾. Multiple studies have confirmed this notion. For example, the influence of intention on fruit consumption has been shown to be weak and non-significant for those individuals who have a strong habit towards fruit consumption⁽²⁸⁾. In contrast, for those individuals with a low or medium habit strength towards fruit consumption, intention has been found to be a significant predictor of fruit consumption. Similar results have been found for adolescent sedentary behaviour⁽³⁶⁾ and child physical activity⁽³⁷⁾.

Social or physical environment?

Most position papers on the presumed importance of the 'obesogenic' environment explicitly or implicitly highlight the importance of the physical environment, referring to the overabundant availability and accessibility of foods that contribute to overeating, and the presumed poorer access to healthy foods⁽¹⁶⁾. Support for a role of the physical environment comes from the USA. An increase in the number of supermarkets (with their larger variety of healthy foods) has been shown to be associated with an increase in fruit and vegetable consumption, and with a lower prevalence of overweight and obesity^(38,39). In other studies, however, such as the Brisbane Food Study conducted in Australia, the 'objective' availability of recommended foods has not been found to be related to actual food-purchasing behaviour⁽⁴⁰⁾. Similarly, the Socio-economic Status and Activity in Women Study in Australia has found that the density of supermarkets and fruit and vegetable stores in local neighbourhoods in Melbourne is not strongly related to fruit or vegetable consumption amongst women living in those neighbourhoods⁽⁴¹⁾.

The potentially weak association between the availability of healthy food and its consumption can be illustrated by neighbourhood studies. While neighbourhood inequalities in food availability have been reported, evidence on the directions of effects is equivocal. Some studies have shown that there are fewer healthy choices available in stores in deprived areas compared with less-deprived areas^(42,43) (K Ball, A Timperio and D Crawford, unpublished results), but others have shown few differences in healthy food availability between deprived and less-deprived neighbourhoods^(44,45) or differences favouring more-deprived rather than less-deprived neighbourhoods^(46,47). Lack of associations between the availability of healthy foods may thus be attributed to lack of consistent variation in 'availability' between (groups of) individuals. The majority of individuals in many Western countries, including those with less-healthy diets, may have sufficient access to healthy foods. It cannot be excluded that there is a larger spatial segregation in availability of healthy foods in the USA that may have driven the associations that have been reported⁽⁴⁸⁾. This possibility suggests that other factors may determine diet. Indeed, the series of reviews point out that the evidence for important socio-cultural correlates of nutrition behaviours is more convincing than that for physical environmental factors.

Recent studies conducted in The Netherlands further support this viewpoint. Associations between a wide range of potential physical and socio-cultural environmental factors and consumption of fruits and vegetables have been examined^(49,50) and the results indicate that family socio-cultural factors such as parental encouragement and modelling are stronger correlates of intakes than availability of fruits and vegetables. This finding is also supported by a systematic review of the literature⁽⁵¹⁾.

In relation to parenting as a socio-cultural environmental factor, a distinction can be made between general parenting styles and content-specific acts of parenting (i.e. 'parenting practices'). Through the use of parenting practices, parents have been shown to have a large impact on their child's dietary behaviours. For example, extensive previous research has shown that there are several child feeding practices (e.g. encouraging children to eat beyond satiety, using food as a reward) that lead to an increased risk of childhood overweight, mediated via children's eating behaviour. Two recent Dutch studies among adolescents have shown that more-restrictive parenting practices are associated with lower consumption of sugar-sweetened beverages^(32,33). In relation to general parenting styles, it has been found that fruit consumption is higher among children who describe their parents as being authoritative (i.e. high levels of parental control or 'strictness' and high levels of parental warmth or 'involvement') compared with children who have been raised with another parenting style (i.e. indulgent, authoritarian or neglectful)⁽⁵²⁾.

It is important to note, however, that while socio-cultural forces are often mentioned in the literature as an important determinant of eating behaviours, the definition and range of socio-cultural influences are typically not well-elucidated and there is little empirical research on many potentially-important socio-cultural factors. It has been argued that further research is required to elucidate the range of socio-cultural factors that might impact on eating behaviours⁽⁵³⁾. It has been suggested that future work should separate socio-economic status into specific components such as education, occupation and income in order to provide further insight into the specific aspects of socio-economic status that are most important. While the majority of empirical studies to date have focused on socio-economic status, the fact that socio-economic status is certainly not the only important socio-cultural influence on eating has been highlighted⁽⁵³⁾. Additional research is required to examine the nature of associations of social roles and relationships, social institutions, social pressure and norms and more macro-level cultural factors. In particular, there is a need for studies of the pathways by which socio-cultural factors influence eating behaviours.

Objective or subjective environments?

There is a lack of validated measurement instruments to assess environmental factors, especially physical environments. From a methodological point of view, objective measures are usually valued more highly than subjective self-report measures, because the latter are subject to social desirability bias, same source bias (where respondents judge both the perception of the environment and their

behaviour) or self-justification. Recent studies have shown poor agreement between measures of access to physical activity facilities obtained by self-report and by objective assessment (e.g. via geographic information systems or audits). In such a study in women a mismatch between perceived and objectively-assessed environments was found to be more common amongst younger and older women, those of low income, those with low self-efficacy for physical activity, those who were less active, and those who reported using fewer facilities⁽⁵⁴⁾. In a second study similar low agreement between perceived and objectively-assessed environments was found amongst adolescents (R Prins, A Oenema, K van der Horst and J Brug, unpublished results).

An exclusive focus on objective measures of physical environments neglects that individuals observe and review their environments, and this perception of the environment is likely to be more important for behavioural choices than the 'objective environment'. For example, a US study that compared boundary maps drawn by residents and census-defined block groups has found differences in both the areas mapped and social indicators, as well as inconsistencies between resident-drawn maps⁽⁵⁵⁾. Australian research with children has also shown that perceptions of the neighbourhood environment are highly individual^(56,57).

The series of reviews discussed earlier indicate that associations between environments and behaviour are stronger when subjective self-report measures of environments are used, and recent research also indicates that perceptions of availability and price of healthful foods are more strongly associated with food choice than with objective availability and price data⁽⁴⁰⁾.

Perceptions of the availability of healthy and less-healthy foods have been shown to be associated with eating such foods, rather than more objective assessments of availability based on audits (K van der Horst, A Oenema and J Brug, unpublished results). The perception of the environment has also been shown to be more strongly correlated with physical activities among Dutch adolescents than with measurements of the environment based on geographic information systems (R Prins, A Oenema, K van der Horst and J Brug, unpublished results).

This finding implies that it may be important to effectively intervene on perceptions of the environment, i.e. by making individuals more aware of the opportunities in their environments. In order to achieve such awareness, it is necessary to have a better insight into what influences an individual's perception of their environment. A recently-conducted study of the determinants of some perceptions of the environment (safety and area attractiveness) has shown that objective characteristics of the environment contribute substantially to perceptions of the environment, but that individual factors (such as self-perceived health and depression) additionally contribute to perceived neighbourhood environments (C Kamphuis, F van Lenthe, K Giskes and J Mackenbach, unpublished results).

Observational studies and intervention studies

In the majority of the studies that were included in the reviews of observational studies cross-sectional designs

were used and thus associations were studied; however, associations do not prove causation.

It has been argued that intervention studies are now needed to identify environmental pathways to encourage healthful nutrition and physical activity behaviours^(16,58). Such studies should use experimental and quasi-experimental research, including community trials and natural experiments, to test the effects of environmental change. Although strongly outnumbered by observational studies, the intervention studies that were included in the series of reviews have provided more consistent evidence in relation to relevant environmental factors.

In particular, in recent years school-based interventions to promote more healthful nutrition and/or physical activity behaviours among children and adolescents have been conducted using a more integrated health education and health protection approach, in which changes in the school or neighbourhood environments were an integral part of the intervention approach. Examples such as the Dutch Obesity Intervention in Teenagers Study and the European Pro Children Study indicate that programmes that include changes in the food and physical activity in school environments can lead to meaningful changes in nutrition and physical activity behaviours, and may contribute to better body compositions among children and adolescents^(59,60).

Many other interventions have successfully targeted the school environment in order to change dietary habits of children and adolescents in a more healthy direction. The most success intervention has been the improvement of food preparation in school cafeterias, such as decreasing the fat content of meals⁽⁶¹⁾. Decreasing the price of healthy foods such as fruits and low-fat snacks, either in cafeterias or vending machines, is likely to increase sales and probably consumption of these products.

Specificity of behaviour and environments

An important difference between observational studies and intervention studies that may explain the discrepancy in the consistency of results in both types of studies is the extent of specificity, particularly, but not exclusively, in outcome variables. Intervention studies in which, for example, prompts direct individuals to use the stairs, will measure (the change in) stair climbing as the outcome and not overall physical activity. However, observational studies in which environmental determinants are measured in more detail have often used an overall behavioural outcome variable when a specific outcome variable would have been much more appropriate. For example, the quality of green space can only be expected to be associated with those specific activities that can be facilitated by the availability of green space, and not with total physical activity⁽⁶²⁾. Future studies on environmental determinants of behaviour should therefore recognise that 'the angels are in the detail'⁽⁶³⁾.

Recently, it has been found that the contribution of environmental characteristics to specific outcomes may differ between subgroups; physical and social neighbourhood factors have shown independent associations with participating in sports *v.* not participating in sports. However, no neighbourhood factors were significantly

associated with meeting recommended sports activity levels *v.* not meeting these levels. It would seem that the importance of the environmental determinants for sports participation is higher for the most inactive individuals (C Kamphuis, F van Lenthe, K Giskes and J Mackenbach, unpublished results).

If progress is to be made in exploring the association between the environment and physical activity, a fundamental condition is linking specific environmental determinants to specific aspects of physical activity in well-defined populations.

Conclusions

Promoting healthy nutrition behaviours still relies mostly on health education techniques that try to motivate individuals to adopt more healthy lifestyles. Research indicates, however, that large majorities of populations are already motivated to prevent unnecessary weight gain, eat healthfully and to be physically active⁽⁶⁴⁾, and that nutrition education often has minor and short-lived effects at best. It has been argued that this outcome is the result of the so-called obesogenic environment preventing individuals from acting on their positive intentions. This obesogenic environment is characterised by high availability and accessibility of palatable energy-dense foods, strong subjective and descriptive norms and social pressure to eat such foods, as well as abundant opportunities to minimise participation in physical activity at work, for transportation or during leisure time. The most-recent systematic reviews do not yet provide strong evidence for the crucial importance of the environment in causing overeating and lack of physical activity, because of the scarcity of well-designed studies at the time of the reviews. However, the most robust studies, *i.e.* longitudinal studies and 'natural' experiments looking at associations between changes in the environment and changes in health behaviours and more recent intervention studies, do confirm that environmental factors are important. Social environments may be more important than physical environments, and the impact of the environment may be mediated and moderated by different individual-level determinants of behaviour.

As the obesogenic environment is presumed to be important, it has therefore been argued that interventions to promote more healthful nutrition and physical activity practices should adopt a health protection paradigm instead of, or in addition to, health education. A health protection approach implies a focus on environmental changes that help to 'protect' the population against unhealthy nutrition and lack of physical activity, *i.e.* environmental changes that would make healthy nutrition and sufficient physical activity easier, more likely or even unavoidable. From a public health perspective such 'upstream' approaches are particularly appealing because of their potential to impact on large segments of the population. This health promotion and protection approach, *i.e.* creating environmental opportunities for healthful behaviours but also protecting the population against opportunities for unhealthful behaviours, has been successful in the major achievements in the history of public health, such as the reduction and

sometimes eradication of infectious diseases, promotion of road safety and reducing the prevalence of smoking. In particular, recently conducted school-based interventions to promote more healthful nutrition and/or physical environments indicate that such more-health protection-orientated approaches can lead to changes in health behaviours and body composition^(59,60).

Acknowledgements

This research is being carried out with financial support from the EC, SP5A-CT-2006-044128 Health-promotion through Obesity Prevention across Europe (HOPE): an integrated analysis to support European health policy. The paper does not necessarily reflect the EC's views and in no way anticipates the future policy of the EC in this area. K.B. is supported by an Australian National Health and Medical Research Council Senior Research Fellowship (ID 479513). D.C. is supported by a Victoria Health Promotion Foundation Senior Research Fellowship. There is no conflict of interest.

Contribution of the authors: J.B. planned the paper, prepared a first draft and compiled the final manuscript. All other authors provided comments on the draft and contributed specific paragraphs or subparagraphs to the manuscript.

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