



NSW Centre for Overweight and Obesity



creating **HEALTHY** environments

A review of links between
the physical environment,
physical activity and obesity.

The NSW Centre for Overweight and Obesity, NSW Centre for Physical Activity and Health, and NSW Centre for Public Health Nutrition are initiatives of the NSW Health Department, and supported by the University of Sydney.

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Creating healthy environments:

A review of links between the physical environment, physical activity and obesity.

Prepared by

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FOREWORD

This document comprises two parts: an Overview Report that provides an integrated summary of how physical environments can influence physical activity, nutrition and obesity; and a Technical Report that provides a review of public health research on this topic.

The organisation of the document into these two reports represents the two stages in translating research into policy and practice. This translation process involves both a critical appraisal and review of research, and synthesis and integration according to the key concepts that are familiar to policymakers and practitioners.

The primary aim of the Overview Report is to communicate key concepts and research findings in ways that allow them to be applied to urban planning.

The technical report provides a scientific update of current research findings and evidence to support the associations between urban environments and both physical activity and obesity.

EXECUTIVE SUMMARY

The physical environment affects the way we eat, live and play. Over the last twenty-five years contemporary lifestyles have changed dramatically, impacting on what we eat and how much we move. Commentators have described the environment as ‘obesogenic’ - it encourages the over consumption of food and makes it easier for people to be sedentary, rather than physically active. These changes have been driven by technological advancements, urbanisation and the rise of the car dependent society. The way we design our cities and organise our lives impacts on our health behaviours in many subtle, varied and complex ways. People are more likely to make healthy behaviour choices when these choices are easily available to them; and thus environments that support or discourage health behaviours critically influence health.

Of course, environmental influences are not the only influences, or sufficient by themselves to influence behaviour - their impact is influenced by individual factors in the context of the political, social and economic milieu.

Increasing levels of physical activity and reducing the number of adults and children who are overweight and obese are national and state health priorities. If current trends continue, overweight and obesity will soon overtake smoking as the leading cause of chronic disease. Already in the USA, poor diet and physical inactivity, taken together, far outweigh smoking or any other risk factor in contributing to ill health. There is clear evidence that over the last twenty-five years there has been increased food consumption, particularly of energy-dense foods, and a shift to more sedentary work and leisure activities. While the key health message is for people to eat less and move more, this is not simple or easy to accomplish unless healthy choices are easily available.

The findings from our analysis of recent evidence on the links between physical environments and physical activity, nutrition and obesity are consistent with reports from earlier published reviews. While there is an accumulating body of evidence on how physical environments affect physical activity, there is very little published or available research on influences of the environment on nutrition and obesity. There are several urban form characteristics (natural and built environment) that tend to be associated with physical activity, and possibly nutrition-related obesity behaviours. These include:

- Mixed land use and density
- Footpaths and cycle ways and facilities for physical activity
- Street connectivity and design
- Transport infrastructure and systems, linking residential, commercial and business areas.

A key limitation in interpreting the available research is that even where there are reasonably consistent associations between environmental variables and health behaviours, the evidence cannot be interpreted as definitively ‘causal’. Drawing on theory, a social ecological model has been used to acknowledge the complexity of the links, and point to the necessity of more comprehensive approaches to research that integrate psychological, organisational, cultural, community planning, and regulatory perspectives. However, this is a very generic model, and a more sophisticated model remains to be developed and tested. The relationships with the built environment operate through several other factors, including individual socio-demographic characteristics, personal and cultural variables, safety and security, and time allocation.

EXECUTIVE SUMMARY

A comprehensive and integrated approach, with changes to social norms, improved community understanding about activity and nutrition, and also changing physical environments is needed to produce sustainable policy-level changes.

While the evidence about associations between environmental features and health behaviours is consistent, there is a lack of research on the types of interventions or built environmental change which will produce the most improvements in health enhancing physical activity.

Overall, this review of literature and international initiatives found recent improvements in research and policy work. Some of these developing strengths comprise:

- much better conceptualisation of the kinds of environments likely to be associated with physical activity, and improved measurement of these environments
- better measurement techniques and better analytic and statistical techniques for assessing causal relationships among variables
- consistent evidence across countries, environments, and settings tends to support the notion, despite the observational nature of the evidence, that it may be causal
- policy support globally is provided through the WHO Global strategy on diet and physical activity; this gives international imprimatur to this level of action
- within the next few years [2006-2008] key evaluation findings from large scale environmental interventions in Colorado, USA, in Bogota, Colombia and in Brazil will be available and will add to the smaller scale studies available to date.

The international perspective presented in the Overview Report not only presents information on major international initiatives, but also provides support for 'policy action' ahead of evidence of effectiveness. This is generally accepted as a useful direction, and many agencies are moving towards increased focus on this area. Some of the reasons why policy action ahead of definitive evidence is warranted include the seriousness and urgency of the problem of obesity, the long timeframes for harnessing cross-sector action, and the value of an incremental approach over a sustained timeframe. Some of these research and policy challenges are:

- the evidence is reasonable between environments and physical activity, and to a lesser extent obesity, but is not definitively 'causal'. Some agencies or sectors dismiss evidence unless it is causal; while a science based approach is desired, it is often prudent to intervene early, from a public health perspective; in some countries or settings this is used as a delaying tactic, or one to avoid forced and unwelcome collaborations and sharing of resources and planning.
- cross-sector initiatives requires high level endorsement and a long term time frame
- the lack of sustainable funding to organise cross-sector initiatives and to evaluate them appropriately
- there is not clear evidence to support decision makers regarding the kinds of interventions or built environmental change which will produce the most improvements in health enhancing physical activity.

EXECUTIVE SUMMARY

Overall, this document provides some promising evidence that aspects of urban form are likely to influence physical activity and weight status, and possibly nutrition, and that changes in environments could be one of the components that can contribute to population health benefits. From the health perspective, even slight increases in physical activity and the prevention of weight gain at a population level are of major significance.

Current health concerns require urgent action, and there are many advantages for public health and urban planning sectors to collaborate in further research on promising approaches in this area. Many of the environmental features and interventions discussed here are familiar to urban and transport planning sectors. Opportunistic evaluations of the impacts of new urban development, new road and track systems and new housing estates are a priority. We need joined up solutions that link health and planning expertise.

GLOSSARY

Accessibility. Distance to or from destinations or facilities.

Body mass index (BMI). The most commonly used measure for defining overweight and obesity. It is calculated as the quotient of weight in kilograms divided by squared height in metres. A weakness of this measure is that it does not differentiate between lean body mass and fat.

Built environment. Encompasses three main aspects: (a) land use patterns, (b) the transportation system and (c) design features of the built environment. Land use patterns refer to the variety of uses occurring in an area. A diverse land use mix includes residential, commercial, industrial and agricultural developments within a certain area and is associated with shorter travel distances between places of interest and activities. The transportation system encompasses streets and highways for automobiles, a public transport system and an infrastructure for active transport (e.g. walking and bicycling) including footpaths and cycle paths.

Case-control studies. Studies in which exposure to an acknowledged risk factor is compared between individuals from the same population with and without a condition. For example, individuals could be sorted on the basis of their activity level (e.g., active versus sedentary) into case and control groups to see whether there are statistically significant differences in environmental characteristics that may influence the propensity of the two groups to be physically active.

Connectivity. The directness of travel between destinations, which is influenced by the kind of intersections and their density in a given area.

Cross-sectional studies. Studies that examine the relationship between conditions (e.g., physical activity behaviours) and other variables of interest in a defined population at a single point in time. Cross-sectional studies can quantify the presence and magnitude of associations between variables. Unlike longitudinal studies, however, they cannot be used to determine the temporal relationship between variables, and evidence of cause and effect cannot be assumed.

Cul-de-sac. A street, that is closed at one end, which is a typical feature of the suburban-style street layout and contributes to lower levels of connectivity.

Density. Typically measured as employment or population per square kilometre.

Ecological models. Based on social cognitive theory, which explains behaviour in terms of reciprocal relationships among the characteristics of a person, the person's behaviour, and the environment in which the behaviour is performed. Ecological models emphasise the role of the physical as well as the social environment.

Energy expenditure. Represents the sum of three factors: (1) resting energy expenditure to maintain basic body functions (approximately 60 percent of total energy requirements); (2) processing of food, which includes the thermic effect of digestion, absorption, transport, and deposition of nutrients (about 10 percent of total requirements); and (3) non-resting energy expenditure, primarily in the form of physical activity (about 30 percent of total requirements).

Energy imbalance. The situation that occurs when energy intake (calories consumed) exceeds or is less than total daily energy expenditure. Weight gain occurs when energy intake exceeds total daily energy expenditure for a prolonged period.

Exercise. A subset of physical activity, which is not incidental, but planned and structured and has the purpose to improve or maintain various aspects of physical fitness.

Geographic Information System (GIS). A software used to present and analyse data that combine variables with their location. This system allows spatial linkages to be made between environmental factors such as distance, connectivity, density, safety and physical activity behaviour of residents.

Health. A state of complete physical, mental, and social well-being, not merely the absence of disease or infirmity.

GLOSSARY

Land use mix. Diversity or variety of land uses (e.g., residential, commercial, industrial and agricultural). A diverse land use mix is associated with shorter travel distances between places of interest and activities.

Longitudinal studies. Studies in which individuals are known to have various levels of exposure and are followed over time to determine the incidence of outcomes. Quasi-experimental designs and natural experiments are two categories of longitudinal studies. Quasi-experimental designs are those in which the exposure is assigned, but not according to a randomised experimental protocol. Investigators lack full control over the dose, timing, or allocation of subjects, but conduct the study as if it were an experiment. Natural experiments are situations in which different groups in a population have differing exposures and can be observed for different outcomes. Neither type of design is really an experiment because researchers have not randomly assigned the individuals to exposure groups.

Neotraditional developments. A street design, in which many possible and more direct routes are available for any given trip, and traffic is spread out over the entire street network, reducing congestion. If shopping is centrally located within a neotraditional neighborhood, it becomes possible for shoppers to walk to the store. A centrally located school not only makes it possible for children to walk to school, but also makes school athletic and playground equipment easily accessible to the members of the neighborhood in the evening and on the weekends.

Non-motorised travel. Travel by non-motorised means, including walking, cycling, small wheeled transport (e.g. skates, skateboards, scooters, and wheelchairs).

Obesity and overweight. Adults are defined as being obese if they have a body mass index (BMI) of 30 or greater, and as being overweight if they have a BMI of 25 but less than 30. BMI varies with age and sex during childhood and adolescence. The International Obesity Task Force recommends that children and adolescents be categorised as overweight or obese based on age and sex specific centile curves

that pass through the adult values of 25 and 30 at age 18. This definition is intended for use in epidemiological research. Alternatively, young people may be considered overweight if they have a BMI above the 85th centile on BMI-for-age charts, and obese if their BMI is above the 95th centile.

Pedometer. A monitoring device that counts steps and measures distance.

Physical activity. Any bodily movement produced by skeletal muscle that results in a substantial increase over the resting energy expenditure.

Physical fitness. The ability to carry out daily tasks with vigour and alertness, without undue fatigue, and with ample energy to enjoy leisure-time pursuits and to respond to unforeseen emergencies. Attributes of physical fitness include such characteristics as cardio respiratory endurance; flexibility; balance; body composition; and muscular endurance, strength and power.

Social marketing. The use of commercial marketing techniques for the analysis, planning, execution, and evaluation of programmes designed to influence the voluntary behaviour of target audiences, with the aim of improving their personal welfare and that of their society.

Traffic calming. Measures that attempt to slow traffic speeds in residential neighbourhoods and near schools and pedestrian ways through physical devices designed to be self-enforcing. These include vertical deflections (speed humps and bumps and raised intersections); horizontal deflections (serpentines, bends, and deviations in a road); road narrowing (via neck downs and chokers); and medians, central islands, and roundabouts.

Transit-oriented developments. Projects that involve mixed-use development (i.e. residential and commercial) near public transit stations.

Part A: OVERVIEW REPORT

Introduction

This Overview Report discusses how the physical (natural and built) environment can influence physical activity and obesity. The Overview is based on the Technical Report, but attempts to redress some of the limitations of the available evidence by applying theoretical perspectives. It aims to communicate health concepts and research findings in ways that allow them to be applied to urban planning.

Overweight and obesity

Over the last twenty years, overweight and obesity in children and adults have emerged as serious and urgent health problems. Over half of the Australian and NSW adult population are overweight or obese; and about 1 in 4 school age children are overweight or obese. Obesity has serious health consequences for adults and children; and even overweight people suffer an increased risk of health problems. These health consequences lead to significant social and economic consequences. If current trends continue, overweight and obesity will soon overtake tobacco smoking as the leading cause of chronic disease. The prevention of weight gain in adults, and the prevention of overweight and obesity in children are important health goals.

Overweight and obesity are states of abnormal or excessive accumulation of fat within adipose tissue. Obesity is regarded both as a disease in itself and an important risk factor for several diseases, notably type 2 diabetes and cardiovascular disease. Body mass index (BMI) is considered the most useful measure of overweight and obesity at the population level. BMI is defined as weight in kilograms divided by the square of height in metres, and both children and adults can be classified as underweight, healthy

weight, overweight or obese according to this measure (see Glossary).

The underlying process is a positive energy imbalance over time resulting in excessive fat storage. Overweight and obesity develop through a period of energy imbalance, where energy intake through food consumption exceeds energy expenditure. Energy intake is determined by nutrition-related behaviour while energy expenditure is determined largely by physical activity, as well as biological factors.

Lifestyle changes in the last twenty-five years, including increased food consumption, a shift to more sedentary work and leisure activities, increased car use, and reduced or continuing low level of physical activity are major reasons for this serious, new health problem. The World Health Organization has published a number of reports and recommendations about how to address this global problem. The 2003 Joint WHO / FAO Expert Report #916 on Diet, Nutrition and Prevention of Chronic Disease (WHO 2003) identifies key physical activity and eating behaviours that need to be increased or decreased to address overweight and obesity. These include regular physical activity, reduced sedentary behaviours, a diet high in fibre (e.g. fruit and vegetables), and reduced intake of energy dense foods that have limited nutritional value (e.g. soft drinks).

Experts agree that there is an urgent need to address this problem, and that effective action requires a concerted approach that goes well beyond the health sector. Of course, the health sector can make an important contribution, and many of the basic health policies and messages, as described below, have been endorsed by government and professionals in Australia.

PART A: OVERVIEW REPORT

At national level, the document Healthy Weight 2008. Australia's Future (NOTF 2003) provides national goals for children and families, including a goal to address the broader social and environmental determinants of poor nutrition and sedentary lifestyles.

The NSW Obesity Summit 2002 galvanised broad commitment to action in New South Wales. This has led to the development of a cross-portfolio plan: 'Prevention of obesity in children and young people: NSW Government Action Plan 2003-2007' (NSW Department of Health 2003). This plan identifies a range of changes in transport and physical environments that can build active communities.

Nutrition

The Australian Government, through the NHMRC, provides dietary advice at a population level. The Australian Dietary Guidelines (with different versions for adults, children and older people) are based on regular reviews of scientific evidence, and provide the basic messages to underpin national initiatives to improve nutrition (NHMRC 2003). The current dietary Guidelines for adults comprise:

- Enjoy a wide variety of nutritious foods
- Prevent weight gain: be physically active and eat according to your energy needs
- Care for your food: prepare and store it safely
- Encourage and support breastfeeding.

National and state governments each have developed health policies that describe the actions they will take to improve population nutrition, in line with these dietary guidelines. NSW Health policy, EatWell NSW (NSW Department of Health 2004), sets four priorities for action:

- increasing fruit and vegetable consumption (these are critical components of diet with a

variety of foods, and where people eat less than the recommended levels)

- addressing overweight and obesity and preventing weight gain
- promoting breastfeeding
- reducing food insecurity (where people have reduced access to quality food, for a variety of reasons)

Essentially, improvements in nutrition in line with the dietary guidelines and specific nutrition priorities depend on changes in consumer demand, in concert with changes in food supply. The built environment influences food supply directly. For example, access to quality and affordable fruit and vegetables is influenced by food production, food transport, retail mix and retail pricing policies (NSW Centre for Public Health Nutrition (CPHN), 2003a). Breastfeeding can be extremely difficult for mothers, where there are no convenient places to breastfeed available in shopping centres, commercial areas or workplaces (CPHN, 2005). Much fast food is energy-dense – that is, the food has a high calorie count in proportion to its nutritional value (CPHN, 2003b). A high prevalence of fast food outlets near schools and workplaces means that people have very limited ability to choose and make nutritious choices, and are more likely to consume energy-dense foods. This report will focus on those aspects of the environment that influence weight status.

Physical activity

Physical activity (PA) may be defined as “any bodily movement produced by skeletal muscle that results in a substantial increase over the resting energy expenditure” (Bouchard and Shephard in WHO 2000, p. 113). Physical activity thus includes both structured and unstructured activities. The

PART A: OVERVIEW REPORT

term ‘structured activities’ refers to supervised, regular and vigorous activities which are usually carried out in a facility or centre. In contrast to this, ‘unstructured activities’ encompass a much broader notion of lifestyle activities undertaken in different domains including domestic work and gardening, walking and cycling for transport or leisure, or work which incorporates physical activities. The total physical activity of an individual includes any physical activity undertaken during work, household and other chores, transport, leisure and sports.

Numerous epidemiological studies have confirmed the health benefits of regular moderate-intensity physical activity (Bouchard et al. 1994; Sesso et al. 2000; Kriska 2000). There now is a broad base of evidence that an active lifestyle reduces the risk of coronary heart disease, stroke and some cancers, improves mental health and lipid profiles (HDL/ LDL), lowers blood pressure, facilitates weight loss, and prevents falls in the elderly (USDHHS 1996). Therefore, physical activity has been called today’s best buy in public health because of its manifold benefits (Morris 1994).

However, around half of the adult Australian population is not sufficiently active and recent evidence indicates that the population levels of physical activity among Australian adults are declining further (Bauman et al. 2002), with an increased prevalence of sedentariness. Over recent years, physical activity recommendations have moved away from emphasising vigorous exercise and now highlight moderate level activities, as indicated in the current physical activity recommendations shown in the text box. As with nutrition, these recommendations provide the basic messages to underpin a wide variety of promotional initiatives.

National Physical Activity Guidelines

For Adults

- Think of movement as an opportunity, not an inconvenience
- Be active every day in as many ways as you can
- Put together at least 30 minutes of moderate-intensity physical activity on most, preferably all days
- If you can, also enjoy some regular vigorous exercise for extra health and fitness (CDHAC, 1999)

For Children – 5 to 18 years

- Children and young people should participate in at least 60 minutes (and up to several hours) of moderate-to vigorous-intensity physical activity every day.
- Children and young people should not spend more than 2 hours a day using electronic media for entertainment (e.g. computer games, Internet, TV), particularly during daylight hours (AGDHA, 2005)

PART A: OVERVIEW REPORT

The physical environment

The term physical environment includes the natural and the built environment. The latter encompasses three main aspects: (a) land use patterns, (b) the transportation system and (c) design features of the built environment (CDC ACES Report #1, 2001).

Land use patterns refer to the variety in which an area is used. A diverse land use mix includes residential, commercial, industrial and agricultural developments within a certain area and is associated with shorter travel distances between places of interest and activities. The transportation system encompasses streets and highways for automobiles, a public transport system and an infrastructure for active transport (e.g. walking and bicycling) including footpaths and cycle paths.

Aspects of the natural environment, which may have an impact on physical activity and nutrition also include topography, climate, vegetation, location (e.g. coastal or inland) or altitude.

The building is the smallest unit of the built environment. Factors that can influence physical activity in buildings are access to, visibility and design of stairwells, interior layout, and access to the site. However, very little research has been undertaken at the building level.

The neighbourhood is the next unit of interest, including residences, retail, commercial services and schools. There are various characteristics of the neighbourhood that have an impact on physical activity. For instance, the street layout and level of connectivity of streets (suburban or (neo)traditional layout) determine route choices and distances and thereby make active transport more or less practicable. As well, the existence and design of footpaths and bicycle paths determine the attractiveness of walking and cycling as means of transport or recreation. Furthermore,

the availability of parks and other recreational facilities provides residents with more opportunities to engage in physical activity. Also, the diversity or variety of land use mix (residential, commercial, industrial, agricultural) decides the distances between various places of activities. In a neighbourhood with a low diversity of land use mix distances are large, thus making active transport less attractive.

The region is the largest unit of the built environment and encompasses the places of residence and most destinations where people commute to work. Factors that are of interest on this level are the size of the region and the distances between residences and places of interest (jobs, commerce, schools) and transportation facilities, which include highways, public transport and an infrastructure for active transport such as cycling and walking trails (TRB, Transportation Research Board 2005).

To the extent that environmental factors are associated with physical activity and weight status, they offer enormous potential to promote health. Environmental changes can reach and influence large numbers of people, and are likely to achieve a sustainable outcome.

PART A: OVERVIEW REPORT

An ecological framework for understanding how environments influence physical activity, nutrition and weight status

Overall, the links between environments and physical activity and weight status are under researched, and often are not well conceptualised or understood (Fein et al. 2004). An ecological framework can provide a sophisticated way of conceptualising the various influences and their interactions.

Social ecology is concerned with the relationships (both inter and intra) between human populations and their environments (Stokols 1992), and provides an appropriate model for thinking about the influence of environment on physical activity and weight status.

The Social Ecology Perspective, according to Stokols (1992), is distinguished by four assumptions as outlined in Table 1 below:

Social ecology analyses emphasise the integration of multiple levels of analysis (for example macro

level preventive strategies of public health and epidemiology with micro level individual strategies from medicine) with diverse methodologies (epidemiological analyses, environmental recordings, medical examinations, questionnaires, and behavioural observations). One of the strengths of using the social ecology model in assessing the relationships between the built environment and physical activity is that it applies to multiple settings in which adults and children live, work and play. This allows for the development of a myriad of policy opportunities. Towards this end, interdisciplinary research is needed to help meld these disciplinary and methodological approaches.

Figure 1 presents the model applied to physical activity and the prevention of obesity (this has been adapted from Egger and Swinburn 1997; Sallis and Owen 2004; Stokols 1992, 1996). The figure shows the interplay and relationships between the physical environment, physical activity and obesity in the context of the macro environment (that is, the political and economic environment, and social norms).

Table 1. The core assumptions of a social ecological perspective. Stokols 1992.

Assumption 1: Multiple facets of both the physical environment (for example, geography, architecture, and technology) and the social environment are integral to a social ecological analysis.

Assumption 2: The relative scale and complexity of environments may be characterised in terms of a number of components such as:

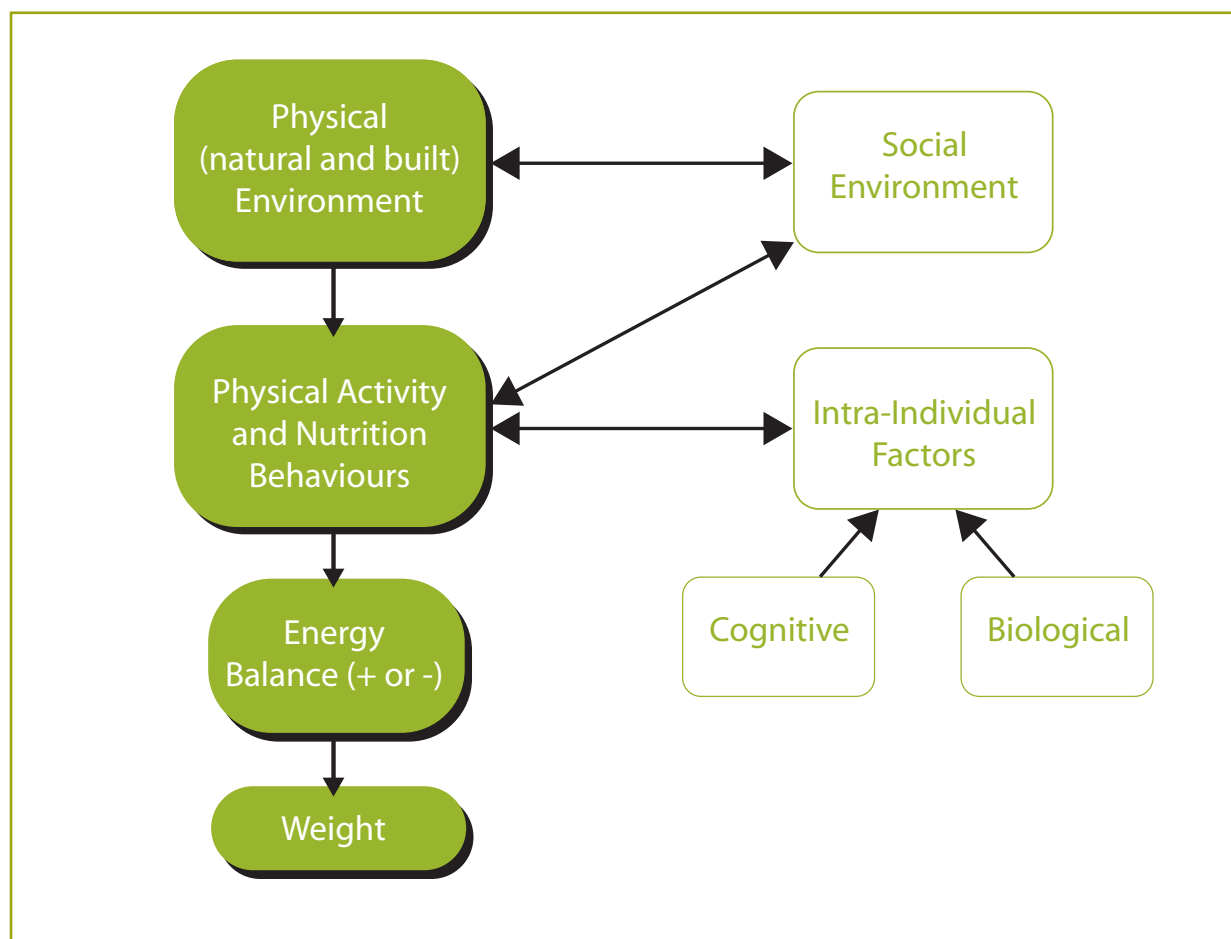
- a. physical and social components,
- b. objective (actual) or subjective (perceived) qualities, and
- c. scale or immediacy to individuals and groups

Assumption 3: The social ecological perspective incorporates multiple levels of analysis and diverse methodologies.

Assumption 4: The social ecological perspective incorporates concepts from systems theory to take into account both the interdependencies that exist among immediate and more distant environments, and the dynamic interrelations between people and their environments.

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Figure 1. A social ecological framework to conceptualise the influence of the physical environment on physical activity and obesity



In Figure 1 we propose a framework that allows us to understand how the physical environment could influence physical activity and obesity. Following through this model it becomes clear that poor nutrition and lack of physical activity can have a deleterious impact on energy intake and expenditure. It has been argued that contemporary nutrition and physical activity behaviours have created a chronic positive energy imbalance in many individuals, in response to an ‘obesogenic environment’ (Egger and Swinburn 1997).

As the framework illustrates, nutrition and physical activity behaviours are influenced by intra-individual factors and the broader social and physical

environment. Intra-individual factors include cognitive factors, such as knowledge, attitudes and beliefs, and biological factors, such as age, sex, race, individual physiological responsiveness and genetic makeup. Much of the research effort to date has focussed on the intra-individual factors and their influence on health behaviours.

The social environment includes any social, economic, cultural and political factors that affect physical activity and nutrition behaviour. Social networks and socio-economic status are just some aspects of the social environment that can influence an individual’s nutrition and physical activity behaviour (Bouchard et al. 1994).

PART A: OVERVIEW REPORT

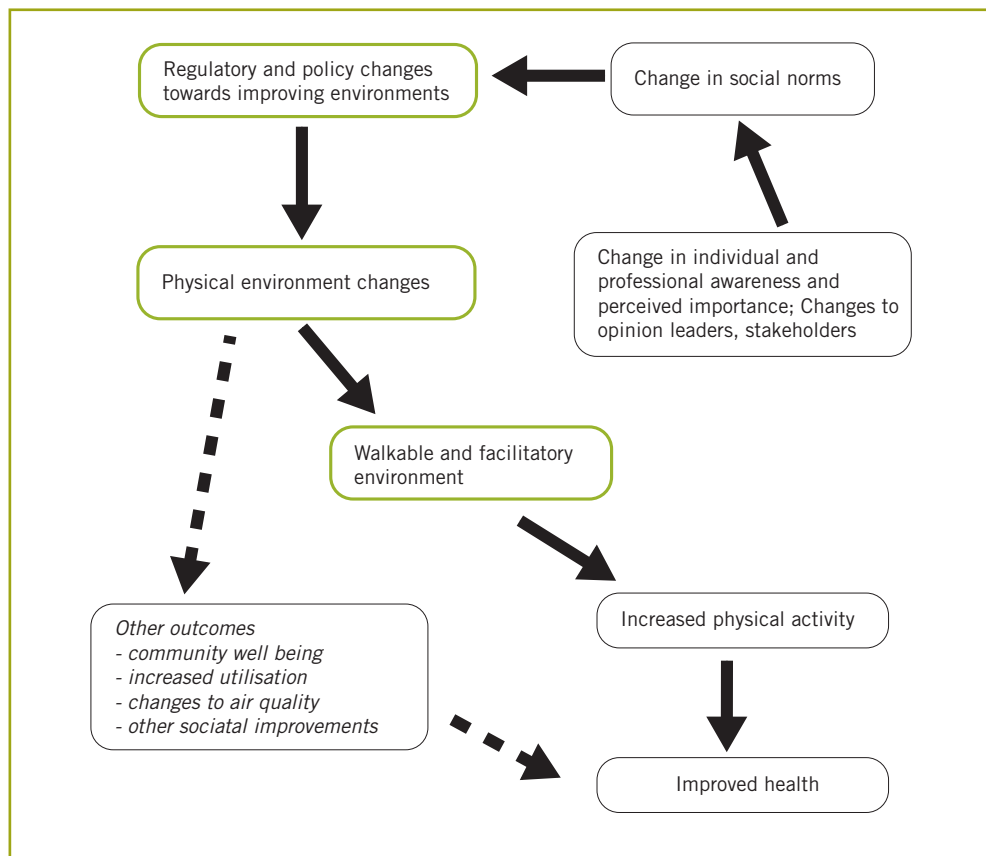
The framework shows how the physical environment, including both built and natural components, influences nutrition and physical activity behaviour, either directly or mediated by the social environment and the interplay with individuals, and thus contributes to the development of overweight and obesity at both the individual and population levels. These interactions are always considered in context – that is in the socioeconomic and cultural milieu (social norms, economic climate and reforms, and dominant political ideology).

This framework has significant implications for interpreting available public health evidence on how environments influence health behaviours. Firstly, while approaches to behaviour change may acknowledge the importance of the internal and social environments, few explicitly specify the role of the physical environment (Sallis and Owen 2004). Secondly, empirical studies often default to very simple interpretations about the links between variables, and do not recognise the complexities that characterise a social ecology perspective: “... most public health challenges ... are too complex to be understood adequately from single levels of analysis and, instead, require more comprehensive approaches that integrate psychological, organisational, cultural, community planning, and regulatory perspectives” (Stokols 1996, p. 203).

By contrast, professionals in the planning field have the capacity to make changes in environmental variables, and are likely to emphasise the environmental and transport factors, and neglect the role of individual and social factors in affecting how people behave in specific environments. A key point from this model is that the effects of any specific environmental feature will be mediated by the other influences, as shown in Figure 2.

Studies do not always have sufficiently powerful designs to measure or capture this complexity of interactions between variables. Investigating the social ecological factors influencing physical activity and nutrition is complex for many reasons. Difficulties include the lack of objective measures of environmental variables, deciding the appropriate scale for defining and measuring them (e.g. on a large or small area basis), and how to aggregate a mix of variables (such as in a composite neighbourhood score). A further difficulty relates to traditional public health analytic methods in this topic, as that they emphasise internal validity, and assume that the interventions studied can be generalised to other contexts and situations. These assumptions do not always apply to research on the built environment. For example, cities can be considered as a unit of analysis, such as occurs in case studies; and every city is arguably quite different, based on cultural, historical, landform, economic and demographic variables.

Figure 2. The links between environmental changes and physical activity



Links between the physical environment and nutrition

The food environment refers to the settings in which food is produced and distributed, and where it is purchased, stored, prepared and consumed (Webb and King 2004). While educating consumers about food and nutrition is important, food choices are also influenced by food supply.

Urban form and environmental characteristics that potentially influence the food and nutrition comprise:

- Location of agricultural lands
- Retail type and locations
- Food transport systems
- Transport infrastructure to food retail locations

- Food service locations (including fast foods and vending machines)
- Food advertising exposure within public places
- Facilities (water bubblers, community gardens, breastfeeding places)
- Affordable housing, and housing/commercial and industry mix.

These potential points of influence have been identified in two ways: from reviewing the small number of available research studies, as described in the Technical Report, and from a descriptive framework of the food and nutrition system and food supply factors (NSW Centre for Public Health and Nutrition 2003a).

PART A: OVERVIEW REPORT

As reported in the Technical Report, there is mixed evidence on the relationship between urban form and obesity. That is, there are some studies that find that land use mix, physical activity facilities and proximity to shops are associated with reduced levels of overweight and obesity in the local population. Some studies indicate that this relationship might be moderated by physical activity levels.

There is very limited research on how urban form influences nutrition, and nutritional risks for overweight and obesity. Essentially, there are a few studies that show that access to shops, and shops that stock healthy food choices can increase the purchasing of healthier foods. Case study 1 illustrates cross-sectional research describing associations between retail access and fruit and vegetable consumption.

Case study 1: Supermarkets can increase fruit & vegetable purchases.

A landmark 2002 study based on over 10,000 residents in 221 census areas in the US by Morland et al. (2002) found that the local environment was associated with residents' dietary intakes. The authors found that African American residents increased their fruit and vegetable intake by an average of 32% for each supermarket in their census area. This, and related research, is described in more detail in the technical report section; it suggests that access to fruit and vegetables encourages their purchase, even adjusting for socio-economic factors.

Two recent studies from British cities prospectively examined the impact on the diet of local residents of introducing a supermarket into an area which had previously been deprived of a major food retail outlet. The study in Leeds (Wrigley et al. 2003) found a substantial increase in consumption of fruit and

vegetables of 0.25-0.5 portions in local residents with the opening of the new supermarket, with the impact greatest in the lowest SES group. A study of the introduction of a similar retail outlet into an area of Glasgow found no significant impact, although there was an increase of 0.35 portions of fruit and vegetable found in those residents who switched to do all their shopping at the new supermarket (Cummins et al. 2004). It seems that there are small benefits from these large-scale retail interventions. There are no reported studies on the effects of small-scale retail interventions (Wrigley et al. 2003).

A descriptive framework of the food and nutrition system suggests potential influences of food production, food processing, transport, retail and food services on people's food consumption. Each of these factors is described, and their potential relevance to influencing overweight and obesity noted.

Food Production: refers to farming and agriculture, with key points of influence including market regulation, subsidisation and taxation, importation and exportation of goods, regulation / cost of capital and capital materials and quality and nutritional standards. These factors are important as they highlight the intervention points that may be triggered to stimulate or reduce food production. Food production can influence factors such as availability, price, quality and variety of food.

Food Processing: refers to turning primary produce into saleable food products. It includes milling, canning, freezing, packing, fortification, or the formulation of manufactured food products. Factors influencing food processing include food production / supply of raw materials, national or state standards or regulations, corporate food or nutrition policies, subsidisation and taxation, geographical location, land zoning and infrastructure, workforce availability,

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international competition, innovation and research and development. Food processing will have an effect on availability, price, quality, variety, promotion and labelling of food.

Food Transport: refers to the distribution of unprocessed, processed and manufactured food and food products. Factors that influence the food transport system include availability of transport systems and infrastructure, regulation, subsidisation and taxation, competition and profitability. Food transportation will have a direct influence on availability, price, quality and variety of food.

Food Retail Outlets: these include supermarkets and convenience stores. Factors that influence the location of food retail outlets include population density, transport routes and the zoning of land to allow construction. The external (for large chains) and internal management of the store may affect the type, availability, price, quality, variety and promotion of food within the store.

Prepared Food Outlets: these include commercial organisations (such as fast food and takeaway shops, cafes and restaurants), institutional food services (such as catering companies and workplace cafeterias) and community-based services (such as Meals on Wheels). Factors that influence the location and composition of prepared food outlets include land zoning, supporting infrastructure, corporate policies and / or strategies of large fast food franchises and shopping centres (e.g. Westfields), viability of the local market and workforce, and local community support. Corporations and franchises with large marketing budgets have the ability to influence the market share of consumption of prepared foods.

All of the supply factors described above can be affected by urban planning at state, regional and local levels, through policies, zoning and development application processes (Capon 2005). The complexity of studying

these factors means that there is minimal research to guide actions, and that efforts to incorporate nutritional considerations into local planning have adopted a local community approach, and have been documented as case studies rather than rigorous evaluation studies (CPHN 2003).

Links between the physical environment and physical activity

By contrast with nutrition research, there has been a significant volume of recent research (over 100 studies), as well as nine recent reviews, on the links between the built environment and physical activity. Most of the studies reviewed for this project look at associations (correlations) between specific environmental features (which can be difficult to define and measure) and specific physical activity behaviours. A small number of studies investigate the effects of environmental changes on people's behaviours, and thus provide a more direct indication of what could be achieved by making environmental changes. As discussed in the Technical Report, the evidence from the studies is not always consistent or strong. However, it is important to note that the conclusions across many different reviews and recent studies, conducted in different countries, cities and neighbourhoods, are highly consistent, although the influences are relatively modest in size.

There is consistent evidence that urban density, mixed land use and high street connectivity are associated with increased walkability (Badland and Schofield 2005; Saelens et al. 2003, Owen et al. 2004). A specific Australian study in Rockhampton found that connectivity was associated with recreational walking (Duncan and Mummery 2004). These same environmental features probably influence other forms of physical activity, not just walking, as found in Atlanta (Frank et al. 2005). Different studies and settings focus on differing features, but produce consistent findings.

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The importance of safety, and aesthetic features have been identified as important, both from a theoretical approach linking environmental features and activity by older people (Cunningham 2004), as well as through reviews (Badland and Schofield 2005), and specific studies, including the one in Perth (Giles-Corti et al. 2005) cited in case study 2.

Case study 2: Public open space is related to walking and other physical activities

Billie Giles-Corti and her colleagues (Giles-Corti et al. 2005) investigated the influence of proximity, attractiveness and size of Public Open Space (POS) on walking in Perth. POS included parks with and without play equipment, recreational grounds, sport fields, commons, esplanades and buffer strips. They found that access to proximate and large POS with attractive attributes such as trees, water features and bird life is associated with higher levels of walking. In addition, people who used POS were almost three times more likely than others to achieve the recommended levels of physical activity. However, proximity to parks, on its own, was not significantly associated with achieving sufficient levels of physical activity. Most interestingly, people who had very good access to attractive and large parks were 50% more likely to attain high levels of walking. They commented that even though walking is a very popular activity, a disproportionate amount of open space has been designed for organised sports, and a consequence they are not always as attractive as purpose built parks for more informal physical activities. They recommend that appropriate design and redesign of existing space has the potential to increase population levels of physical activity.

There is an increasing volume of research showing that better footpaths, and perceptions about good footpaths, increase walking. This finding comes from a number of studies in states in the USA, in Georgia

(Powell et al. 2003), Missouri (Hoehner et al. 2005), South Carolina (Sharpe et al. 2004) and West Virginia (Spangler-Murphy et al. 2004). A review of six studies that made changes in walking and cycling infrastructure found that this can result in reduced car use and change towards more active transport (Ogilvie et al. 2004). That is, while better footpaths increase walking, providing cycleways can increase cycle trips. One of the studies considered also found that restricting car use increased people's walking. A very recent study (not covered in any review) looked at local footpaths (rather than footpaths in a larger geographic area) and found that they were strongly related to people's walking (Addy et al. 2004). While there are mixed results on studies on this topic, it is clear that infrastructure interventions can have an impact, although the impact will be mediated by other psychological and social factors, and thus not always reproducible. The studies on footpaths and walking also underline the role of both actual and perceived infrastructure. Other facilities, such as parks and open space, are also associated with increased activity, where they are perceived as safe, attractive and accessible (Corti et al. 1997).

The importance of investigating and considering environmental features in combination with other characteristics is emphasised in one study in San Francisco, where demographic, topographical and weather factors were found to be important influences on physical activities, as well as other physical environment features (Cervero and Duncan 2003).

Writing for a planning audience, Lee and Moudon (2004) organise the public health research evidence into a form that reflects environmental arrangements – according to how the destination, the route and the local area influence activity. Destination and distance to destinations makes a difference to people's travel mode, and to their activity levels. Locating attractive

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Case study 3: If you build it and promote it - people will use it

In an environmental intervention study in Western Sydney, Merom et al. (2003) looked at the effect of a newly constructed rail trail that was promoted with a short-term media campaign on walking and cycling. The modest media campaign included local press advertisements about the trail and promotion on radio for a two week period. Unprompted awareness of the trail increased significantly from 1.8% pre to 4.8% post intervention, $p < .01$). Furthermore, the campaign achieved a significant increase of usage of the trail (from 1.6% before to 5.6% after the intervention $p < .005$). This particularly applied to cyclists living close (within 1.5km) to the trail and may have been due to the campaign portraying the track more as a cycleway than a footpath.

route destinations (including retail and other types of activity facilities such as parks) near homes encourages activity and active transport. As noted above, route related variables include footpaths, bike lanes, signage, lighting, and tamed traffic; and area related variables are land use mix, density, street types, as well as aesthetic and visual features (objective and perceived).

Overall, the value of activity-friendly environments is reinforced by recent health research. Walking is the preferred form of activity, and neighbourhood streets are the preferred place for active living. People want to access activity from outside their front door. There is also potential to convert this interest in walking, and to a lesser degree, cycling, into travel behaviour (Lee and Moudon 2004). Many environmental features influence people's walking; availability of playing fields, gyms, swimming pools and other facilities influence other physical activities.

The influence of urban form and environmental features on physical activity is summarised in Table 2.

International perspectives

This section of the report provides some international perspectives on the current research and practice specifically around physical activity and environments. Some work around environments and obesity are also noted.

The methods used here were to conduct short semi-structured interviews with key individuals involved in shaping the research or policy agenda in this area in North and South America and in Europe. Very little work of this ilk is occurring in Africa, the Middle East or Asia to date, so that the choice of regions will provide some global perspectives on this area of work. Notes were kept, but no formal content analyses were undertaken. The major question asked was "what are the current research, practice or policy initiatives around physical environments and physical activity in your region/country/city?"

Interviews were conducted with:

- Two developers and leaders of the Center for Disease Control (Atlanta, USA) 'Active Community Environments' (ACEs) project.
- Leaders of the Robert Wood Johnson Foundation (RWJF) \$50M research initiatives and programs, 'Active Living Research' and 'Active Communities by Design'
- PAHO staff responsible for physical activity [WHO, Americas]; directors of Agita Mundo, and program directors on Bogota and in several projects in Brazil, Argentina, elsewhere in Colombia and Mexico
- Other WHO staff from Head office, and from the European region involved in physical activity work; members of the Scottish PA Council; members of the European Health Enhancing Physical Activity (HEPA) network

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- 14 Academics involved in “PA – environment” research projects from Universities in the USA, Canada, Scotland, England, Netherlands, Norway, Finland, Austria

Major themes of the interviews

The major initiatives being carried out around the world focus on generating evidence and the measurement and research tools to support evidence development. In addition, strategic thinking around this area abounds in developed countries, and efforts to include this in transdisciplinary planning efforts are commencing in some areas. Finally, a small number of sites are engaged in large scale intervention research, the results of which are unlikely to be available for several years. These three arenas of work are illustrated in Figure 3 below. Most of the research efforts of the CDC Active Community Environments and the RWJF programs for Active Living Research in the USA have focused on approach 1 in Figure 3 - the conceptualisation and development of measures to assess environments. This has involved dialogue with multiple new agencies, such as urban planning, architecture and transportation, to develop relevant measures which may be related to physical activity [and obesity] patterns. Measures of urban density, safety, crime, street connectivity and related phenomena now rely on mixtures of self-report [perceived] and objective urban form measures. This phase of measurement development is in its mid-phase, having started around 2001 or 2002.

Much correlational research has been undertaken over the period 2000-2005, concurrent with the improvements in measurement quality; this has shown consistent relationships in many settings and forms the central focus of this technical report. Some perceived environmental attributes are more strongly related to physical activity, others are

correlated with objective measures. Some attributes, such as perceived aesthetics, or perceived safety, show stronger to objective environmental measures. The emphasis on research and on understanding these relationships was echoed in the most recent consensus meetings in the USA, published by the TRB (2005, page 7 ff).

Policy development and the initiation of interagency partnerships with a focus on physical environments is not new. The early physical activity networks and taskforces, especially the NSW Premiers physical activity taskforce (predecessor to PCAL, from 1996-2003) had developed clear theoretical frameworks for their environmental development goals, which were expressed through the development of partnerships with sport and recreation, transport, roads and traffic authorities, planning and other government departments (Bauman and Bellew 1999). Other taskforces in New Zealand, Canada, US and the UK adopted these planning and partnership ideas. European partnerships were in existence even earlier, with cycling and other environmental infrastructure developed and enhanced over the past four decades in Holland, Denmark and other Nordic nations.

Building on the work of researchers since 2000, in developing measures and exploring associations, policy makers have adopted the physical environment as a key strategy for promoting physical activity (approach 3 in Figure 3). This became a clear theme integrated into the May 2004 World Health Organization Global strategy on diet and physical activity (Bauman and Craig 2005). However, several of the policy and decision makers interviewed expressed concerns that this was premature, and may be considered too often in isolation, without the integrated approach of influencing social norms, increasing community awareness, changing relevant professionals, and finally adding conducive

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environments to a primed population who would be more likely to use these developed facilities.

Nevertheless, implementation of the Global Strategy has resulted in some WHO regions adopting a focus on physical environments. In the regional consultations on physical activity, the European region, Western Pacific region and the Americas expressed interest in this work (Bauman and Craig 2005). Specific translation is occurring especially in Central and South America, where interventions are being developed by regional and local government agencies to develop infrastructure to support physical activity. Much of this is unpublished, but the best examples are in the Agita program in Brazil, in Bogota city (Colombia), and in other programs in other cities in Colombia and Mexico (Jacoby 2004, Matsudo et al. 2003).

The final component of Figure 3 is intervention research. This has been opportunistic evaluation of developing environmental changes, and more often than not, the opportunity for evaluation of these interventions has been missed, due to lack of interest by agencies in funding transdisciplinary evaluation research (Sallis et al. 2005). A very few examples of evaluated interventions are in progress, assessing large scale urban or suburban development or the development of new urbanist communities and transport systems and their impact on physical activity for adults and children in those communities. This research agenda has been stimulated by the RWJF funding in the USA through Active Living Research at the University of San Diego in California (Active Living, UCSD). Note that these developments are a phenomenon of urban sprawl and related urban trends in Canada, USA and Australia, more than in densely populated and more connected European cities.

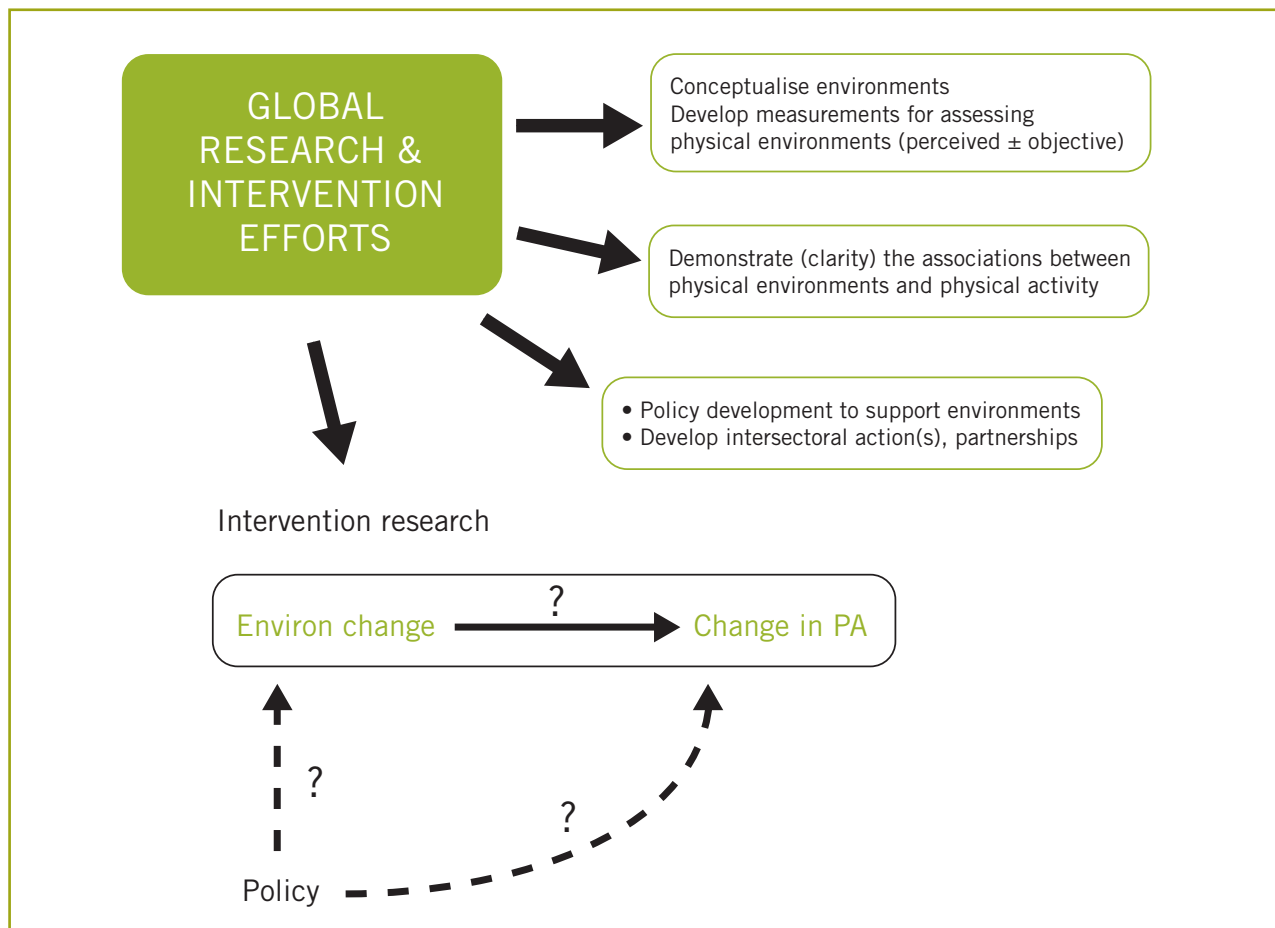
Conclusions

The findings from our analysis of recent evidence are consistent with reports from earlier published reviews. There are particular aspects of the urban environment and specific transport options that influence people's physical activity and food purchasing. These same environmental features have many other benefits, related to air pollution, social cohesion, and efficient transport. Key environmental features that contribute to increased physical activity and prevention of weight gain include:

- Mixed land use
- Housing density
- Footpaths and cycleways and facilities for physical activity
- Street connectivity and design
- Transport infrastructure and systems, linking residential, commercial and business areas.

People are more likely to make healthy behaviour choices when these choices are easily available to them; and thus environments that support health behaviours are a critical influence on health. Importantly, environmental influences are not generally the only influences or sufficient to influence behaviour, and their impact is influenced by social and individual aspects. An optimal approach is likely to require several strategies, including physical environment changes, in combination with social marketing and community education to support individual and social changes. While weather and topography also have an influence, they are not (generally) amenable to change; however, they may be important considerations in adapting how environmental changes are made and how health messages are framed.

Figure 3. The current stages of interest and efforts around physical environments



Neighbourhood environments are a key setting for promoting physical activity and preventing weight gain. Incorporating these health perspectives into design values that underpin urban and transport planning is a significant challenge but with potential social, economic and health benefits. Further, there are health and ‘non-health’ outcomes of improvements to the physical environment, and considering these diverse benefits could add value to the outcomes of approaches to enhancing physical environments.

Implications

Many of the environmental features and interventions discussed will be familiar to urban and transport

planning sectors, and the links between health and environments described in this report have been recognised in some planning guidelines (e.g. Planning guidelines for walking and cycling 2004) and design considerations. Nevertheless, there remains limited collaboration between health and urban planning sectors, particularly as there are differing research paradigms and types of evidence used to guide policy development.

Building our knowledge base and opportunities for ensuring health is protected and enhanced by physical environments, through cross-sector collaboration in research and policy-making is a priority.

Cross-disciplinary research would be invaluable in building a stronger scientific understanding about

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the links between environmental features and health-related behaviours, and about specific environmental interventions that can be implemented.

Opportunistic evaluations of the impacts of new urban development, new road and track systems and new housing estates are a priority. Part of a collaborative research process must inevitably involve new methodological approaches that span the different approaches underpinning public health and built environment fields.

In terms of policy and practice, there is scope for developing stronger communication channels between planning and built environment, health organisations and professions. Communication through multiple channels, at varying levels, in ongoing and sustained forms and in new formats is required.

There may be a need to include new or enhanced regulatory processes to ensure health considerations and principles are recognised at the beginning of development processes, rather than requested in the form of comments at a late stage. While health impact assessments provide one technical planning tool, a broader range of considerations and formats may be required. One of the challenges for the health sector in engaging with planners and making expert contributions to government legislation and policy on urban environments and transport, is the lack of a dedicated technical unit or infrastructure that has this specific expertise and role.

This report has identified some key ways in which the built environment can influence physical activity and obesity prevention, and noted implications for health and planning sectors. A range of cross-disciplinary and cross-sector initiatives are required, including research, communication and joint action.

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Table 2. Examples of urban form characteristics that can influence nutrition and physical activity

Urban Form Characteristic	Concept	Key features	Health-related Benefit
Street network characteristics and design	Interconnectivity of roads	Grid like pattern	Reduces distance between destination, encouraging the use of active transport
	Traffic calming and other street design features.	Street width, vehicular parking, kerb type; traffic management and control devices; Street crossings, crossing aides, verge width, driveway crossovers, continuity; Vehicular and cycle lane markings, sighting distance / Density of street design features.	Provides facilities that encourage cycling and walking and discourage driving
	Separate integrated network of walking and cycling routes		Provides facilities that encourage walking and cycling
Land use mix	Food retail	Accessible supermarkets, plus local food stores	Wide variety of nutritious food accessible at competitive prices.
	Food services	Limit density and number of fast food services around schools	Possible reduction in children's access to energy-dense food.
	Mix of residential, commercial and business uses.	Different uses within a defined zone.	Increases opportunities for active transport.
	Public Open Space	Create / preserve public open spaces close to residents, with pathway access, and good amenities and is large.	Increased physical activity opportunities.
	Physical Activity Facilities	Swimming Pools, Basketball courts, gyms, football fields, tennis courts, playgrounds, bubblers etc	Increases people's level of physical activity.
Housing Density	Density	Increase the number of residential and commercial premises in an area.	Increases active transport, with reduced distances to destinations. Increases access to physical activity facilities.
Site Design	Food production	Establishment of local community gardens, school gardens, home gardens and edible landscapes.	Cheap, fresh produce; potential educational, social and nutritional benefits.
	Breastfeeding	Establishment of public breastfeeding facilities.	Encourages breastfeeding, for longer, as recommended in dietary guidelines.
	Improve safety, aesthetics in local facilities and amenities.	Lighting; surveillance; maintenance and cleanliness of parks, gardens and streets; provision of public amenities and public transport facilities; Building design, orientation and setback.	Influences perceived and actual safety and aesthetics; creates an environment that is conducive to active transport and physical activity.
Transport Planning	Access to food retail	Footpaths, cycleways and public transport options to retail centres.	Improved access for food purchasing.
	Improve / develop public transport systems and facilities	Bus shelters, cycling facilities near stops, pedestrian and cycle access to public transport.	Increases opportunities for active transport

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Introduction

This Technical Report provides a scientific update of current research findings and evidence to support the associations between urban environments and both physical activity and obesity. The principal methods are to review existing studies or summarise existing systematic reviews in the area, based on specific search criteria. This document presents the scientific evidence, with the contextualisation and discussion of that evidence in the accompanying interpretative ‘Overview Report’.

Methods

This report is based on a selective review of determinants and intervention studies from published and unpublished sources about the link between [i] the physical and built environment, and [ii] physical activity and nutrition and obesity. This review used a systematic process to obtain references, search the literature and summarise results.

The research team identified peer-reviewed “reviews” published since the year 2000 and added to these significant studies that have appeared in the literature since these reviews were published [to early 2005]. In the area of nutrition and obesity associated with the physical environment, no reviews of the literature could be identified, although at least one consensus conference has produced proceedings¹. Therefore, all studies published since 2000 related to this topic were appraised to inform the debate. The literature includes published and unpublished (i.e. grey literature) and analogous studies that have direct implications to the area. Sources include health databases, social geography, transport, and urban planning.

Research types included in the review

The following study types have been considered for the literature search:

Correlation studies: Research that examines associations between different attributes of the natural or built environment and physical activity, nutrition and obesity.

Intervention studies: Research that determines the effect of changes to the physical environment on physical activity, nutrition and obesity.

The search criteria considered research published in peer reviewed journals, printed media or books, and also included “grey literature”, which was produced for internal use within organisations, and also research not intended for or not yet published in peer reviewed journals, printed media or books. A small number of current studies were included through informal interviews with international experts; this was research that is not yet completed or published.

Search criteria for the review

The review of evidence included a search of the published literature using electronic databases: Medline, CINAHL, DARE/EBM, Avery, Psychlit and Pub Med. The key terms for this search included:

Physical activity, Walking, Bicycling, Exercise, Physical activity behaviour, Physical activity behavior, Transportation, Active transport, Physical inactivity, Sedentariness,

Physical environment, Natural environment, Built environment, Environmental determinants, Environment, Environment and

¹ This is interesting – consensus conferences initially can be useful for generating ideas, but as is shown in this technical report, without evidence of a solid science base. The most comprehensive of these was the publication of proceedings of the NIEH Obesity and the built environment – improving public health through community design symposium, NIH December 2004.

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public health, Infrastructure, Perceptions, Public facilities, Public policy, Urban design, Urban environment,

Nutrition, Diet, Obesity, Overweight, Adiposity, Adipose tissue, Weight, Weight gain, Body weight, BMI, Body Mass Index,

Cross-sectional study, Longitudinal study, Intervention, Intervention study, Correlates, Epidemiology, Epidemiologic research design, Case-control study, Survey, Behavioural research, Behavioral research.

Search results and main findings

The relationship between the built environment and the physical environment and measures of physical activity or walking.

Nine review papers between 2002 and 2005 summarising this relationship were identified. These nine were the most recent review papers that were found. The nine review papers examined 81 original source papers mostly published between the mid 1990s and 2004 (see Appendix 1 for the articles that were reviewed). It is interesting to note that most of the reviews considered only a small subset of these primary papers. It is possible that some of them were not published by the time the reviews were conducted, but less than a third of them were considered by any of the review

papers². One of the main reasons for this is that several reviews took a specific focus, such as the environment and older adults, the environment and walking, or other focused searches. Thus, no review has really examined all available papers, and the ‘meta-review’ in the present document adds value to previous distillations through a consideration of a greater number of available papers examining the environment – physical activity/obesity relationship.

This observation, that most reviews did not assess all relevant papers has not changed our conclusions, as fundamentally the findings across any of the review papers are more similar than different. One exception in the style of review is the paper by Ogilvie et al. (2004) who in their section on engineering measures to promote walking and cycling examined 18 particular kinds (mostly published as urban or city reports of transport modification interventions in the ‘grey’ literature) of studies not included in the 90 primary studies³. This also indicates some of the definitional uncertainties in the field, because not all of the papers could be classified or all of the primary data extracted from original papers⁴.

Summary of main findings

The reviews respectively found similar associations between aspects of the urban or built environment and physical activity (see appendix 2 for a summary of the reviews in alphabetical order by first author’s

²This either points to the need for a more systematic review of all 81 papers, or indicates that the reviewers who wrote these summary papers were not as systematic as we have been, but that is probably a strength of this specific review. Each of the review papers that we considered examined respectively 26 papers, 16, 18, 20, 18, 19, 26 and 10 papers. Thus the maximum was 26 out of a possible of up to 81 primary or original source papers which we have reviewed.

³Ogilvie et al. (2004) refer to 18 sources in the six studies on engineering measures to promote walking and cycling that are included in their review. Twelve of these are unpublished reports (seven in English, three in German and two in Dutch), two are conference proceedings in Dutch, three are journal articles (two in English, one in Dutch and they were published between 1980 and 1988) and one is a chapter in an English book; the primary sources were not located for this review or included in the 81 studies shown in Table 1.

⁴Note that this review did use more transport literature and was less amenable to usual search terms in health related databases.

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name). The first review (Badland and Schofield 2005) was a transport related narrative review on the relationship between urban form and physical activity and it showed that urban density and mixed land use was associated with increased walkability. It also showed that perceived and objective measures of safety were associated with physical activity, and spoke about the issues surrounding injury reducing designs such as traffic calming and pedestrian access and availability.

The second review (Cunningham and Michael 2004) was a narrative review around the built environment and older adults. It identified a theoretical framework for the relationship between the built environment and physical activity, and this is particularly important because only a couple of the reviews did this, and it does indicate there is a clear theoretical underpinning to this area of work. For older adults safety and aesthetic features of the environment were related with physical activity.

The third review (Lee and Moudon 2004) was a narrative review on the physical environment and its relationship to physical activity, using a theoretical framework from an urban planning perspective. It looked at the relationships and generally found associations between the quality of pedestrian and bikeways, population density and mixed residential use, accessible destinations and freely available facilities with physical activity participation.

The fourth review by Ogilvie et al. (2004) focussed on a systematic review of interventions which tried to increase walking or cycling infrastructure instead of car use and examined the effects of those changes on modal shift in active transport. This was a systematic study, and was much more methodologically rigorous than some of the other earlier reviews. It examined six urban interventions, with the outcome being shift of transport mode. Four

of these looked specifically at improving cycling networks, and one found a positive shift in walking or cycling, and three found no change or a negative shift. The one that found the positive shift was a much stronger research design, so this does provide some evidence, but the situation is certainly far from clear. There was also a positive shift in one intervention that restricted cars in particular areas, and showed an increase in walking. There was another study which showed the traffic restraint or calming did not result in any significant changes. This was an important review, but it included studies which were not published elsewhere, so they were not part of the 81 primary source studies that are mentioned in the complete table [see footnote #3].

The sixth review was a narrative review of neighbourhood features and walking and cycling for transport (Saelens et al. 2003). It showed that neighbourhoods with a high population density, good land use mix, high connectivity and good provision of walking and cycling facilities are more likely to encourage walking and cycling for transportation. However, no difference was found between high and low walkable neighbourhoods for recreation.

The seventh review by Owen et al. (2004) showed that environmental attributes were reasonably consistently related to walking behaviours, but that these correlates varied by the 'type or setting for walking' being examined, and also varied by gender. Although an increasing number of prospective designs examined changes in walking in relation to environments, there remains a dearth of opportunistic intervention research evidence.

Humpel et al. (2002) investigated environmental factors associated with adults' participation in physical activity. They found that accessible cycle paths, local parks, density of shop facilities, awareness of and satisfaction with facilities,

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safe footpaths and a safe, friendly and attractive neighbourhood were positively associated with physical activity.

The review by Trost et al. (2002) was an update of earlier distillations of 'correlates of physical activity'; for the first time, physical environments were included. Ten studies were examined, and showed positive associations between physical activity and environmental access, aesthetics, safety and urban [versus rural] location.

The review by Sallis et al. (2004) summarises findings from the health, urban planning and transportation literature on active transportation. Levels of walkability were found to be associated with utilitarian trips, but not walking for exercise. Land use mix, density, footpaths and street lighting were associated with active transport.

The overall findings of these reviews are that there are reasonably consistent associations between high population density, mixed land use and street and urban form connectivity. There are also reasonably consistent associations for accessibility of physical activity facilities, and lesser evidence for accessibility of recreation facilities. Two of the reviews also mentioned road safety or cycle and pedestrian safety. Two studies also mentioned the need for safe, well lit areas which are well maintained, and one study indicated this was particularly important amongst older adults. Two studies mentioned aesthetic features of the environment as being important. One unique study systematically reviewed cycle or pedestrian improvements or restrictions of car use and the evidence here was inconclusive, but the very good study did show a positive effect and further research is needed to examine these kinds of interventions. In summary, aspects of the physical environment and of urban form seem to be consistently related to physical activity,

predominately from cross-sectional studies but also in those few cohort studies which have examined this relationship. This provides some promising evidence that aspects of the urban form are likely to influence physical activity, and a conclusion is tenable that changes to these aspects of the urban form would be likely to be related to slight increases in population levels of physical activity participation. From the public health perspective, even slight increments in physical activity participation would be a major step forwards.

Recent primary studies on physical activity and environments published since 2003

This section summarises the 15 studies published since the reviews, and distils the evidence from each of these studies, and indicates whether these more recent studies tend to support or refute the evidence available from the systematic and non-systematic reviews (see Appendix 3 for a summary of the main findings in alphabetical order by first author's name).

Summary of main findings

The study by Addy et al. (2004) indicated that local neighbourhood facilities, such as local footpaths, were more strongly associated with walking than broader community level structures. This indicates the very small geographical radius around which walkability might be defined, rather than aggregating it up to a 10 km radius. The next paper by Boarnet et al. (2005) studied parents of grade 5 students in California and showed cross-sectionally that increased walking and biking to school occurred in more facilitatory or improved physical environments. The next study by Cervero and Duncan (2003) studied more than 15,000 San Francisco households and examined the influence of urban landscapes on walking and bicycling. They found that street

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connectivity, small city blocks, mixed land uses and close proximity to shops were associated with non-motorised transport. However, topography, weather and demographic factors had a much stronger influence on walking and bicycling than connectivity or land use. This is an extremely important study, as it indicates that the individual and social factors, and factors other than strictly the morphology of the physical environment, are important. These include things like the hilliness and also climate factors and weather, which do influence behaviour. Demographic factors remain important. Other work by Giles-Corti (2003) indicates that intra-individual factors remain important even in the presence of environmental attributes.

The paper by Duncan and Mummery (2004) surveyed 1,200 adults in Rockhampton and showed that using GIS measured attributes and network distance connectivity was associated with recreational walking. A study by Evenson et al. (2005) in North Carolina was a before and after intervention study, which showed no change in physical activity in those using a built trail compared to those who did not use the trail. This study has some methodological flaws, and is not really a true temporal comparison.

The next study by Foster et al. (2004) showed among UK adults in a cross-sectional study that there was a range of self-reported environmental attributes, but only a few of them were associated with physical activity. For women, having no shop available decreased the likelihood of activity, and for men having a park accessible increased the likelihood of being active.

The paper by Frank et al. (2005) surveyed 357 adults in Atlanta, using objective measures of both urban form and physical activity. Urban form was measured using GIS, and physical activity using accelerometers. They noted that GIS land use

measures were associated with total physical activity, not just with walking, which in this very objectively measured study does suggest perhaps more than walking might be influenced by environments. Land-use mix, residential density and intersection density were associated with meeting the recommended 30 minutes of daily moderate physical activity. The study looked at total physical activity and did not distinguish between transportation, recreational and other kinds of physical activities.

The paper by Giles-Corti et al. (2005) surveyed 1,800 adults in Perth, and showed that direct observations of public space, particularly their attractiveness, was associated with self-reported physical activity.

The study by Hoehner et al. (2005) surveyed over 1,000 adults in Missouri and Georgia. They used subjective and objective measures of environments, and showed that where there were better footpaths and increased access to facilities there was more physical activity. They did propose there were different correlates for transport related physical activity such as bike lanes and having multiple destinations, compared to the correlates of active recreation or walking for exercise.

The study by Merom et al. (2003) was a before and after intervention study, using a cohort of 450 adults from Western Sydney. A trail was developed, and there was a slight but significant increase in trail use following the intervention.

The study by Morrison et al. (2004) was a small sample of 131 adults in Glasgow. This cohort was followed before and after a traffic calming intervention, and increased walking and increased observations of pedestrian activity were noted.

The paper by Patterson and Chapman (2004) was a small sample of 133 adults in Oregon, and this

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cross-sectional study compared urban and suburban environments. Urban women in particular walk more for utilitarian purposes, especially using footpaths, compared to suburban women.

The paper by Powell et al. (2003) surveyed more than 4,000 Georgians, and in this cross-sectional study noted that people with increased places to walk, specifically having local streets and footpaths to use, were more likely to meet physical activity recommended levels. The similar study by Patricia Sharpe and colleagues (2004) surveyed 1,900 South Carolinians, and showed that subjective estimates of sidewalk condition and safe places to walk was associated with increased likelihood of meeting recommendations.

Finally, a study by Spangler-Murphy et al. (2005) surveyed 253 adults in West Virginia and noted that those who reported they felt safer and had better footpaths were more likely to walk than those in less safe communities.

In summary, all of these 15 more recent studies generally tend to show the same consistent associations between aspects of the physical/built environment and being physically active. The relationships are not unequivocally consistent, and some of the studies suffer from very small samples. Nonetheless, as a whole, these studies replicate the findings from the reviews mentioned earlier. Particular issues relating to different kinds of physical activity are brought out by these studies, in that environments may influence walking, but also non walking forms of physical activity. Furthermore, different kinds of environmental attributes may influence transport related walking, compared to active recreation.

The relationship between physical environments and urban form and overweight, obesity and nutrition

Search results

There are relatively few studies in this area, and eight studies are reviewed in this analysis. These have different outcome variables, ranging from overweight and obesity through to dietary intake, so are not directly comparable. There is much less of a literature on the relationship between urban form and physical environments and these nutritional and obesity related outcomes, so the evidence is still being developed. The amount of research is very much less than is present for physical activity, so conclusions in any direction must be less definitive. Eight papers were reviewed, with a range of different outcomes. These papers are summarised in appendix 4. A brief summary of each paper's main findings is presented, and then a conclusion and recommendation reached.

Summary of main findings

Study 1 by Burdette and Whitaker (2004) was a cross-sectional study of more than 7,000 low income living 3-4 year old children. Objective environment measures were used. Proximity to fast food outlets, the presence of safe neighbourhoods and proximity to playgrounds was assessed. No association was noted between any of these environmental variables and the likelihood of an increased risk of obesity or overweight. The authors concluded that factors other than proximity to these environmental attributes might influence obesity risk.

The second paper by Catlin et al. (2003) was a cross-sectional study of 2,800 Missouri adults. Community perceptions of the physical environment, particularly aesthetics, and community infrastructure in terms of the availability of facilities was examined

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in relationship to the prevalence of overweight and obesity. Absence of facilities increased the likelihood of obesity by around 60%, as did negative community perceptions. Absence of sidewalks increased the likelihood of obesity even more, by around 180%. This study suggests there are associations between these physical activity environmental attributes and the likelihood of obesity and overweight.

The study by Cheadle et al. (1991) is a cross-sectional ecological study in 34 communities examining the association between dietary data and grocery store environments in terms of healthy food choices. There seems to be an association at the ecologic level, but this is a very preliminary study and could be explained by other phenomena. All that this study really shows is that where healthy food choices are available in localities, people are more likely to show healthier diets. This could be confounded by socio-economic status, which could explain this phenomenon.

The fourth paper by Frank et al. (2004) is a cross-sectional study of travel data of around 11,000 adults from Atlanta. This study showed that urban form variables and travel patterns were associated with body mass index. Some very relevant policy type statements could be made from this analysis. For each quartile of increasing land use mix there was a decrease in obesity rates of about 12%. For each kilometre walked there was a decrease of 4.8% in the risk of obesity. For each hour a day that people spent in their cars there was an increased risk of obesity of around 6%. These kinds of analyses have direct policy relevance and are very clear for decision makers, although the analysis was cross-sectional and was not necessarily causal.

The fifth paper by Giles-Corti et al. (2003) was a cross-sectional survey of 1,800 adults in Perth,

but suffered from a 50% response rate. The study showed that environmental factors and lifestyle factors both increased the risk or contributed to the risk of overweight and obesity. The strongest was living on a highway, which increased the risk more than three fold, whereas smaller increments in risk were noted for people who did not have footpaths or paths to walk on. Poor access to recreational facilities or poor access to shops increased the risk by more than 50% of being overweight or obese, but all of these findings could be confounded or explained by socio-economic status. Similarly, the contradictory finding that easy access to a motor car decreased the risk of obesity by 44% could also be due to socio-economic status.

The sixth paper by Lopez (2004) was an ecologic study of the relationship between urban sprawl and obesity. The urban sprawl was scored on a scale from 0-100, and there was a 0.25% increase in the risk of obesity for each percentage point increase in urban sprawl.

Paper 7 by Rutt and Coleman (2005) was a small telephone survey of 450 adults in Texas, but only half of these had their data matched to environmental variables. The study showed some unexpected findings in that increased land use mix was associated with increased obesity or increased body mass index. This contradicts the work of Saelens et al. (2003) and Ewing et al. (2003), who found that increased land use mix was associated with a decreased risk of obesity. It is possible that attributes of the urban form, particularly their socio-economic distribution in this part of Texas where the study by Rutt and Coleman was conducted, might explain some of these findings.

The last study by Turrell et al. (2004) from the Brisbane Food Survey examined the association between socio-economic status and food purchasing

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but did not find substantive significant associations. The sample size might have been too small to identify these correlates.

In summary, there is mixed evidence on the relationship between urban form and obesity. It is not clear whether this relationship might be moderated by physical activity levels, which is suggested in some studies, or whether there may be a direct causal relationship. Several of the studies found small or no effects, so this is an area where the patterns are not tending in the same direction consistently, so further research is indicated. Far fewer studies exist here than exist for physical activity in urban form, where the relationship is much more consistent.

The relationship between physical environments and access to nutrition – fruit and vegetable choices

Main findings

A separate series of studies focuses on fruit and vegetable purchases in relation to proximity to supermarkets. There are only a small number of studies in this area; these were identified by experts, not by a specific search strategy⁵.

There are only a few studies which have examined the impact of retail shopping facilities on the availability and consumption of healthy foods and weight status with a special focus on their impact on fruit and vegetable consumption. This is an aspect of the association between environments and nutrition, especially focusing on healthy patterns of food choice and consumption. The studies were not planned evaluations, but opportunistic examples

of assessing nutritional purchasing in relation to supermarket availability or new supermarkets opening.

One study examining the relationship between individual dietary practices and food stocked in the participant's local grocery store (Cheadle et al. 1991) found a significant association between the healthiness of the products in the grocery store and healthiness of the individual diet (that is, what individuals had eaten over a set period). This suggests that grocery stores that stock healthy food may have people with healthier diets residing within their local region. There needs to be some caution in its interpretation, as the association may actually run the other way and it may also be the case that the individual dietary preferences determine what the grocer will stock. A limitation to this study is that individuals were assumed to shop in their local region. Nevertheless, the Cheadle study does give some supportive evidence to the benefits of stocking healthier food products on dietary patterns.

A cross-sectional designed ecologic paper by Morland et al. (2002) examined the influence that access to a supermarket had on the fruit and vegetable consumption of 10,623 participants in a CVD risk reduction program conducted in four states of the USA. They examined the availability of supermarkets, convenience stores, restaurants and fast food outlets in the census tract of each participant and found that Black Americans fruit and vegetable intake increased by 32% (95% CI RR 1.04 – 1.60) for each additional supermarket within the census tract. For white Americans fruit and vegetables increased by 11% (95% CI RR 0.93-1.22) for each supermarket.

⁵Note that the search strategies for the section on obesity and environments failed to uncover these papers, so expert input was most useful here; this indicates the strength of triangulating search methods, beyond simply using routine electronic databases as search processes, as more studies are uncovered using this mixed method technique – see comments earlier about selection of studies in the published physical activity and environment reviews.

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This may indicate that supermarkets, rather than neighbourhoods with fast food outlets alone, may increase access to healthy food choices, even among disadvantaged population groups.

A later paper by Morland (2004) also examined the association between body mass index and access to food stores within this same study. She found that the prevalence of overweight was 9% lower in areas with compared to those without supermarkets (Prevalence ratio (PR)=0.91; 95% Confidence Interval (CI)=0.87-0.95). Obesity was 33% less common in areas with at least one supermarket (PR=0.75, 95% CI=0.67-0.85). After adjustments for other types of food stores and food service places, age, race, gender, education and income, the prevalence of obesity was 20% lower in areas with supermarkets (PR=0.83; 95% CI=0.76-0.92). This adjustment for obesity and individual level socio-economic status (SES) attributes is interesting, as it suggests environmental factors may influence nutrition, independent of individual level SES.

Similar evidence emanates from the UK. Two studies from British cities prospectively examined the impact on the diet of local residents of introducing a supermarket into an area which had previously been deprived of a major food retail outlet. Using a 'before and after' design, the Leeds study (Wrigley et al. 2003) found a substantial increase in consumption of fruit and vegetables of 0.25-0.5 portions in local residents with the opening of the new supermarket. The impact was greatest in the lowest SES group who doubled their weekly intake of fruit and vegetables. In contrast, when a similar retail outlet was introduced into an area of Glasgow, the impact measured using a quasi-experimental design was not as significant although an increase of 0.35 portions of fruit and vegetable was found in those residents who switched to do all their shopping

at the new supermarket (Cummins et al. 2004). In an editorial in the British Medical Journal, Cummins et al. (2005) argue that the design of the Leeds trial may have exaggerated the gains in fruit and vegetable intake, which are likely to be small but nonetheless still have the potential to positively influence health. These studies further suggest the impact of (environmental) access to healthy foods may influence their consumption.

Conclusions

The strengths and recent improvements in this area of research and policy work are:

- much better conceptualisation of the kinds of environments likely to be associated with physical activity, and improved measurement of these environments
- better measurement techniques and better analytic and statistical techniques for assessing causal relationships among variables
- consistent evidence across countries, environments, and settings tends to support the notion, despite the observational nature of the evidence, that it may be causal
- policy support globally is provided through the WHO Global strategy on diet and physical activity; this gives international imprimatur to this level of action
- within the next few years [2006-2008] key evaluation findings from large scale environmental interventions in Colorado USA, in Bogota, Colombia, and in Brazil will be available and will support the smaller scale studies available to date

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In summary, it is current global public health fashion to be committed to this area of thinking about physical activity and environments. Whilst this is a likely promising approach, it should always be remembered that it is only one component⁶. The relationships with the built environment operate through “many other factors, including individual socio-demographic characteristics, personal and cultural variables, safety and security, and time allocation” (TRB 2005). A comprehensive and integrated approach, with changes to social norms, improved community understanding about activity and also changing physical environments is needed to produce sustainable change. Failure to develop such an integrated and sustainable multi-strategy approach might result in 10 years time in relative disappointment with environmental approaches from the public health perspective (Bauman 2005).

⁶this was echoed in the TRB report, 2005- “the consensus committee emphasises ... that modifications to the built environment alone are unlikely to solve the public health problem of insufficient physical activity.... This will require a range of approaches Complementary strategies addressing individual and social as well as the [built] environmental determinants of physical activity need to be the subject of future research and interventions...” (TRB 2005, p.7-1)

APPENDICES

Appendix 1. Studies about physical environment and physical activity included in review articles

Author(s)	Year	Journal	Badland and Schofield 2005	Cunningham and Michael 2004	Humpel et al. 2002	Lee and Moudon 2004	Owen et al. 2004	Saelens et al. 2003	Sallis et al. 2004	Trost et al. 2002
Balfour & Kaplan	2002	AmJEpid	x	x						
Ball et al.	2001	PrevMed		x	x	x	x			
Bauman et al.	1999	AusNZLJPH			x	x				x
Berrigan & Troiano	2002	AmJPrevMed	x	x		x	x			
Blommaert et al.	1981	Conf. Proceedings							x	
Boarnet & Sarmiento	1998	UrbanStudies	x							
Booth et al.	2000	PrevMed		x	x	x				x
Brown et al.	1999	AustJRural Health								x
Brownson et al.	2000	AmJPrevMed				x	x		x	
Brownson et al.	2000	AmJPH								x
Brownson et al.	2001	AmJPH		x						
Carnegie et al.	2002	ResQExercSp					x			
Caughy et al.	2001	HealthPlace		x						
CDC	1999	MorbMortWklyRep			x	x				x
CDC	1998	MorbMortWklyRep				x				
Cervero	1996	TranspResA						x	x	
Cervero & Gorham	1995	JAmPlanningAss						x	x	
Cervero & Kockelman	1997	TranspResD						x	x	
Cervero & Radisch	1996	TransportPolicy	x					x	x	
Chapman & Beaudet	1981	JGerontology		x						
Corti et al.	1996	HPJAus				x				

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Craig et al.	2002	AmJPrevMed		x		x	x			
De Bourdeaudhuij et al.	2003	AmJHP	x				x			
Estabrooks	2003	AnnBehMed	x							
Ewing et al.	1994	TranspResRecord						x	x	
Ewing et al.	2003	AmJHP	x				x			
Eyler et al.	1998	HealthEdu&Beh				x				
Eyler et al.	2003	MedSciSpEx					x			
Frank & Pivo	1994	TranspResRecord						x	x	
Friedman et al.	1994	TranspResRecord	x					x	x	
Giles-Corti & Donovan	2002	PrevMed	x				x			
Giles-Corti & Donovan	2002	SocSc&Med	x		x	x			x	
Giles-Corti & Donovan	2003	AmJPH	x				x			
Hahn & Craythorn	1994	HPJAus				x				
Handy	1992	BuiltEnvironment						x	x	
Handy	1996	TranspResRecord						x	x	
Handy & Clifton	2001	Transportation						x	x	
Hanson & Schwab	1987	Environment & Planning						x	x	
Hess et al.	1999	TranspResRecord						x	x	
Hovell et al.	1989	PrevMed		x	x		x			
Hovell et al.	1992	ResQExercSp				x	x		x	
Humpel et al.	2004	AmJPrevMed	x				x			

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Humpel et al.	2004	AmJHP	x				x			
Humpel et al.	2004	AnnBehMed					x			
King et al.	2000	HealthPsychology		x	x	x				x
King et al.	2003	AmJHP	x				x			
Kitamura et al.	1997	Transportation						x	x	
Klesges et al.	1990	HealthPsychology				x				
Kockelman	1997	TranspResRecord						x	x	
Langlois et al.	1997	AmJPH	x							
Lee et al.	2000	AnnBehMed		x						
Leslie et al.	1999	PrevMed			x					
Leslie et al.	2005	Health&Place	x							
MacDougall et al.	1997	AustNZJPH			x					x
McNally & Kulkarni	1997	TranspResRecord						x	x	
Merom et al.	2003	PrevMed	x							
Newman & Kenworthy	1991	TransportReviews						x		
Owens	1993	LandscapeUrbanPl		x						
Parsons et al.	1993	PedestrianEnv (book)						x	x	
Rafferty et al.	2004	AmJHP	x							
Roberts et al.	1997	InjuryPrevention	x							
Ross	2000	SocSc&Med	x							x
Ross & Dunning	1997	Report						x	x	

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Rütten et al.	2001	JEpiCommHealth				x				
Saelens et al.	2003	AmJPH	x				x			
Sallis et al.	1989	PrevMed		x	x				x	
Sallis et al.	1990	PHReport			x	x			x	
Sallis et al.	1992	PrevMed			x					
Sallis et al.	1992	AmJDiseasesChildren							x	
Sallis et al.	1993	HealthPsychology							x	
Sallis et al.	1997	ResQExercSp	x	x	x	x	x			
Shaw et al.	1991	JLeisureRes			x					
Ståhl et al.	2001	SocSciMed			x					
Sternfeld et al.	1999	PrevMed			x					
Takano et al.	2002	JEpiCommHealth	x							
Timperio et al.	2004	PrevMed	x							
Troped et al.	2001	PrevMed	x	x	x	x			x	
Turner et al.	1998	TxTransplInstitute (report)						x		
USDHHS	1996	USDHHS (SG report)								x
Wendel-vos	2004	MedScExSp	x							
Wilcox et al.	2000	JEpiCommHealth		x	x	x				x
			26	16	18	20	18	19	26	10

Appendix 2: Summary of review articles examining relationship between physical environment and physical activity

Review Details	Review Type	Review Objectives	Review Results and Conclusions	Quality Considerations	Research Recommendations	Promising Interventions
Badland and Schofield (2005) Transport, urban design, and physical activity: an evidence-based update.	Narrative review – examining associations	Review the evidence surrounding various urban design factors and physical activity behaviours	High population and building density, grid street design, complete sidewalks and mixed land use have shown increased walkability of the neighbourhood with mixed land use likely to have the greatest influence. Suggestion of traffic calming devices increasing physical activity but no evidence thus far. Perceived safety of environment and accessibility (both subjective and objective) related to reported levels of increased physical activity. Designs linked to reduced injury levels for cyclists and pedestrians include traffic calming devices, automobile restrictions and pedestrian and cyclist sensitive designs.	Search criteria not specified. Paper does support the review objective, consideration of whole of population effects and appropriate exposure and outcome variables, but as search criteria are unspecified it is hard to know if any biases are within the review. There was no assessment of the limitations of this review.	Consistent use of transport and health measurement tools, enhanced understanding of traffic calming measures, further collaboration between health, transport and urban design sectors. More international studies.	<ul style="list-style-type: none"> • High population and building density • Grid like street design (Interconnectivity) • Mixed land use • Increased accessibility to physical activity facilities • Increased safety and safe design of road / path / cycle networks.
Cunningham and Michael (2004) Concepts guiding the study of the impact of the built environment on physical activity for older adults: a review of the literature.	Narrative review – examining associations	Identification of theoretical models and key concepts used to predict association between built environment and seniors' PA	Safety and aesthetics consistently important for older adults Mixed results for the association of microscale urban design elements such as footpaths and convenience to facilities with PA	Search and inclusion /exclusion criteria specified. Strengths and limitations of studies not specified. Limitations of review are not discussed.	Need for validated, consistent and objective measures of the built environment in combination with self-reported data	<ul style="list-style-type: none"> • Walking programs in areas with well-lit streets, nice landscaping and well-maintained footpaths

Appendix 2: Summary of review articles examining relationship between physical environment and physical activity

Review Details	Review Type	Review Objectives	Review Results and Conclusions	Quality Considerations	Research Recommendations	Promising Interventions
Humpel et al. (2002) Environmental factors associated with adults' participation in physical activity.	Narrative review - examining associations.	To provide an overview of the measures that have been used to assess environmental attributes and to review the patterns of environment-behaviour associations.	<p>Positive associations found between level of physical activity and accessible cycle paths, local parks, density of shop facilities and facilities on frequently travelled routes. Negative associations were found between levels of physical activity and busy streets, steep hills, lack of or inadequate facilities and distance to cycleway. No associations were found between physical activity and busy streets (when measured objectively) / steep hills (when measured subjectively), and no association was found between the physical activity and the number of, or access to, facilities.</p> <p>Looking at opportunities for activity, physical activity was positively associated with awareness of and satisfaction with facilities, as well as the provision of opportunities for physical activity. The presence of sidewalks was not associated with levels of physical activity.</p> <p>Safe footpaths and a safe neighbourhood were positively associated with physical activity as well as a friendly neighbourhood and attractive neighbourhood and pleasant scenery around the neighbourhood. Perceptions of how safe from crime a neighbourhood was, was positively associated with physical activity.</p>	Search criteria specified. Limitations of review are not discussed.	Intervention studies required	<ul style="list-style-type: none"> • Increased density • Cycleways • Local parks • Access and provision of facilities • Safe and aesthetically pleasing neighbourhoods

Appendix 2: Summary of review articles examining relationship between physical environment and physical activity

Review Details	Review Type	Review Objectives	Review Results and Conclusions	Quality Considerations	Research Recommendations	Promising Interventions
Lee and Moudon (2004) Physical activity and environment research in the health field: implications for urban and transport planning practice and research.	Narrative review – examining associations.	Review of empirical studies concerned with community based, physical environmental determinants of physical activity.	Quality of pedestrian and cycleways will influence a person's decision to walk or cycle. Population density, mixed land use and street pattern, presence of and accessibility to destinations all affect active transport. Freely available facilities, safety and aesthetic features affect people's opportunity to exercise.	Search criteria specified and relevant to review objectives. Review presented in a theoretical framework structure which may reflect its planning rather than health focus. Limitations of the review are not discussed.	More multidisciplinary research	<ul style="list-style-type: none"> • High population density • Mixed land use • Increased street connectivity • Increased access to and provision of recreational facilities • Increased or good quality of cycle and pedestrian networks • Aesthetic features are important for walking and cycling
Ogilvie et al. (2004) Promoting walking and cycling as an alternative to using cars: systematic review.	Systematic review – examining the effectiveness of interventions. This review used appropriate search methods and source of evidence. Quality of studies was assessed through common criteria. Limitations of the review were discussed.	To assess what interventions are effective in promoting a population shift from using cars towards walking and cycling to assess the health effects of such interventions. Appropriate use of exposure and outcome factors to meet this objective.	Of 22 studies included in this review, six studies were concerned with urban planning Extend / Improve cycle route networks Four studies, the best one (Delft), due to having a control group, found a positive shift in share of bike trips post extension / improvement of cycle way. The three other studies found zero (1 study) and negative (2 studies) bicycle shifts. Traffic restraint schemes One study, no evidence of change in travel patterns through a panel study. Auto restricted zones One study, positive shift in walking.	Rigorous systematic search.	More targeted interventions	Conflicting evidence as to whether cycle way and pedestrian friendly streets increase cycling and walking. Better studies appear to believe it does.

Appendix 2: Summary of review articles examining relationship between physical environment and physical activity

Review Details	Review Type	Review Objectives	Review Results and Conclusions	Quality Considerations	Research Recommendations	Promising Interventions
Owen et al. (2004) Understanding environmental influences on walking – review and research agenda.	Data base search, specifically seeking walking as outcome factor	Identification of self-reported and objectively assessed environmental attributes – association with walking	There were more significant associations [than non signif] for aesthetics, convenience, accessible, and local neighbourhood influences that were correlated with walking. Note one study in Belgium noted that the environmental factors in total, only explained 3-4% of the variance in walking behaviour for men and women.	Design examined and described; objective environ measures separated from self report	Different correlates existed for different types of walking, such as LTPA, for recreation, to get to places / active transport; correlates also varied by gender	Most were cross-sectional designs; some used longitudinal designs, but there remains a lack of purposive intervention studies
Saelens et al. (2003) Environmental correlates of walking and cycling: findings from the transportation, urban design and planning literatures.	Narrative review – examining associations.	Review papers assessing neighbourhood environmental characteristics on walking and cycling for transport – this objective was successfully undertaken through appropriate examination of exposure and outcome factors targeting whole of population	Highly walkable neighbourhoods (high pop. density, good land use mix, high connectivity and good provision of walking and cycling facilities) are more likely to encourage walking and cycling for transportation. No difference was found between high and low walkable neighbourhoods for recreation.	Database search with specific search terms and subjective inclusion / exclusion criteria. Quality of sources and studies not reviewed, however, limitations of studies specified	Increase strength of research through quasi-experimental study type.	<ul style="list-style-type: none"> • High density • Good land use mix • High connectivity • Good provision of walking and cycling facilities

Appendix 2: Summary of review articles examining relationship between physical environment and physical activity

Review Details	Review Type	Review Objectives	Review Results and Conclusions	Quality Considerations	Research Recommendations	Promising Interventions
Sallis et al. (2004) Active transportation and physical activity: opportunities for collaboration on transportation and public health research.	Narrative review – examining associations.	<ul style="list-style-type: none"> Summarise transportation & planning studies on community design & active transport & interpret them from a health perspective Summarise health literature on physical environment & leisure-time PA Promote transdisciplinary research 	<ul style="list-style-type: none"> Active transport consistently higher in high walkable neighbourhoods (two times more walking trips) than in low walkable neighbourhoods. However, differences only in utilitarian trips; no differences in walking for exercise Land use mix, density, footpaths, street lighting associated with active transport On national level (US) active transport five times higher in highest versus lowest density areas 	Search terms and databases only partly stated	Transdisciplinary research including experts from public health, transport and urban planning areas	Different zoning regulations that lead to reallocation of growth to regional centres to reduce trip lengths
Trost et al. (2002) Correlates of adults' participation in physical activity: review and update.	Updated review of all correlates of physical activity	Identify correlates of all types [factors associated with PA] ; for the first time, physical environmental correlates were examined as well as individual and social variables	10 studies examined physical environments, and most found associations with access to facilities or conducive environments, aesthetics, observing others being active locally, safety and urban>rural; climate and season tended to be negatively correlated.	All studies included, no assessment of sample representativeness was made [external validity]	Physical environments was a new area for correlates of physical activity, and should be included in determinants research and interventions	All were observational studies

Appendix 3: Characteristics and main findings of original studies examining relationship between physical environment and physical activity

Author, year, title	Sample	Study design	Physical environmental variable(s)	PA behaviour variable(s)	Significant associations with PA	Research recommendations
Addy et al. (2004) Associations of perceived social and physical environmental supports with physical activity and walking behaviour.	N=1,194, 18+, M+F, US	CS	Self-reported measures of footpaths, public recreation facilities, streetlights, traffic volume, unattended dogs, walking/bike trails, swimming pools, parks, playgrounds, sports fields, schools, malls, places of worship, waterways	Self-reported PA and walking	Better street lighting, private recreation facilities, parks, playgrounds, sport fields, schools and worship facilities associated with PA Footpaths available in neighbourhood and using a mall for walking associated with increased walking Neighbourhood variables (0.5-mile radius) stronger predictor for PA and walking than community variables (10-mile radius)	Focus on expanding awareness, safety and access to and use of places for PA
Boarnet et al. (2005) Evaluation of the California Safe Routes to School Legislation – urban form changes and children's active transportation to school.	N=1,244 parents of school students (grade 3-5), California	CS with retrospective questions and t-test between groups of students who pass project construction and who don't	Combined measure of construction projects including footpaths, bicycle paths, traffic lights or crosswalks	Parental proxy measure of active / motorised transport to school	Increase of walking or bicycle travel among students who had environmental improvements on their way to school	Stratification of type of environmental improvement
Cervero and Duncan (2003) Walking, bicycling, and urban landscapes: evidence from the San Francisco Bay Area.	15,066 households, San Francisco Bay area	CS	Subjective measures of Street connectivity, land use mix, employment accessibility, walking quality all measured in area around trip origin and destination	Self-reported walking and bicycling	Street connectivity, small city blocks, mixed land uses and close proximity to shops associated with active transport, but much stronger association of topography, weather or demographic factors with PA	In previous research factors such as topography and weather not controlled for

Appendix 3: Characteristics and main findings of original studies examining relationship between physical environment and physical activity

Author, year, title	Sample	Study design	Physical environmental variable(s)	PA behaviour variable(s)	Significant associations with PA	Research recommendations
Duncan and Mummery (2004) Psychosocial and environmental factors associated with physical activity among city dwellers in regional Queensland.	N=1,215, 18+, M+F, Rockhampton, Queensland	CS	Self-reported measures of safety, aesthetics, accessibility and opportunities for PA GIS measures of distances to nearest parkland, shopping centre, pathway network, busy street and newsagent	Self-reported PA (Active Australia Physical Activity Questionnaire) and recreational walking	GIS measures of street connectivity, proximity to parkland, number of active people in 1-km radius and self-reported perceptions of neighbourhood cleanliness associated with achieving sufficient PA levels GIS derived distance to footpath networks, number of dogs in 0.8-km radius, network distance to newsagent and perceptions of footpath condition significantly associated with recreational walking	
Evenson et al. (2005) Evaluating change in physical activity with the building of a multi-use trail.	N=366, 18+, M+F, Durham, North Carolina	Quasi-experimental non-control pre-post design	Self-reported measures of footpaths, walking, jogging or biking trails and heavy traffic GIS measures of shortest or Euclidian distance from home to trail	Self-reported PA using BRFSS	No significant PA change of those who used the new trail compared with those not using it	Use of objective measures of PA
Foster et al. (2004) Environmental perceptions and walking in English adults.	N=4,265, 16-74 years, M+F, England	CS	Subjective measures of Attractiveness of local area for walking Access to shops, leisure centres and parks Cycle paths Traffic density	Self-reported walking in past four weeks	For women no local shop in neighbourhood negatively associated with walking For men access to local park or open space associated with walking	Using objective instead of perceived measures of physical environment

Appendix 3: Characteristics and main findings of original studies examining relationship between physical environment and physical activity

Author, year, title	Sample	Study design	Physical environmental variable(s)	PA behaviour variable(s)	Significant associations with PA	Research recommendations
Frank et al. (2005) Linking objectively measured physical activity with objectively measured urban form.	N=357, 20-70, M+F, Atlanta	CS	Objective measurement with GIS of land-use mix, residential density and street connectivity	PA measured with accelerometers	Land-use mix, residential density and intersection density associated with moderate PA	Total PA, not only certain kinds should be measured
Giles-Corti et al. (2005) Increasing walking – how important is distance to, attractiveness, and size of public open space?	N=1,803, 18-59, M+F, Perth	CS	Direct observation of access, attractiveness and size of Public Open Space (POS)	Self-reported PA	Access to proximate, attractive and large POS associated with high levels of walking	More research about attributes that make POS attractive
Hoehner et al. (2005) Perceived and objective environmental measures and physical activity among urban adults.	N=1,068, 18-96, M+F, St Louis, Missouri and Savannah, Georgia	CS	Perceived and objective (direct observation) measures of land use, transportation environment, recreational facilities, aesthetics	Self-reported PA using long version of IPAQ	Active transport negatively associated with objective measures of footpath levelness and perceived and objective aesthetics; positively associated with perceived and objectively measured number of destinations and public transit, perceived access to bike lanes and objective counts of active people in neighbourhood Recreational PA positively associated with perceived access to recreational facilities and objective measures of attractive features	Objective measurement of PA Distinguish between transportation and recreational PA

Appendix 3: Characteristics and main findings of original studies examining relationship between physical environment and physical activity

Author, year, title	Sample	Study design	Physical environmental variable(s)	PA behaviour variable(s)	Significant associations with PA	Research recommendations
Merom et al. (2003) An environmental intervention to promote walking and cycling – the impact of a newly constructed rail trail in Western Sydney.	N=450, 18-55, M+F, Western Sydney, people living within 5km of rail trail	Prospective cohort study	Geo-coded measure of distance to new trail Awareness of trail and access to it	Self-reported cycling and walking Observed cycling activity before, during and after opening of trail	Significant increase in trail usage from baseline to follow-up Usage of new trail higher among bike-owners than pedestrians and moderated by proximity to trail Significant increase of mean daily bike counts Significant increase of mean cycling time of NESB inner residents (within 1.5km of trail)	
Morrison et al. (2004) Evaluation of the health effects of a neighbourhood traffic calming scheme.	N=131, M+F, Glasgow	Prospective cohort study	Self-reported measures of perceptions of neighbourhood and perceptions of traffic problems and safety	Self-reported PA and observed measures of pedestrian activity	Traffic calming scheme associated with increases in self-reported walking and observed pedestrian activity and willingness to allow children to play outside	
Patterson and Chapman (2004) Urban form and older residents' service use, walking, driving, quality of life, and neighbourhood satisfaction.	N=133, 70+, females, Portland, Oregon	CS comparison of urban and suburban groups	Direct observation of footpaths, connectivity, distances to destinations, street trees, mixed land use	Self-reported walking	Urban women walk for more reasons and more often to community services than suburban women Presence of footpaths associated with more reasons for walking	Longitudinal studies

Appendix 3: Characteristics and main findings of original studies examining relationship between physical environment and physical activity

Author, year, title	Sample	Study design	Physical environmental variable(s)	PA behaviour variable(s)	Significant associations with PA	Research recommendations
Powell et al. (2003) Places to walk: convenience and regular physical activity.	N=4,532, 18+, M+F, Georgia	CS	Safety, convenience and proximity of places for PA	Self-reported PA	People reporting a place to walk in less than 10 minutes significantly more likely to meet PA recommendations Neighbourhood streets, footpaths and public parks most commonly reported safe and convenient places for walking	
Sharpe et al. (2004) Association of environmental factors to meeting physical activity recommendations in two South Carolina counties.	N=1,936, 18-55+, M+F, South Carolina	CS	Subjective measures of presence of recreational facilities (trails, parks, walking and bicycling routes), condition of side-walks, quality of street lighting	Self-reported PA	Perceived condition of sidewalks, safe areas for walking/jogging, knowledge of routes for bicycling and walking/jogging associated with meeting PA recommendations	Longitudinal studies are needed
Spangler-Murphy et al. (2005) Environmental perceptions related to physical activity in high- and low-risk counties.	N=253, M+F, West Virginia	CS, comparison of perception of environment between high and low risk communities	Existence, safety and usability of footpaths and bicycle paths, street lights, indoor facilities for exercise	Exercise self-efficacy	Residents in low-risk community more likely to report having footpaths and that these are safe and well lit and more recreation facilities	Focus on footpath safety, lighting, accessible exercise facilities Environmental interventions need to be combined with media campaigns

Appendix 4: Characteristics and main findings of original studies examining relationship between physical environment and obesity

Details	Study Design	Research question (RQ) Study Factor (SF) Outcome Factor (OF)	Main findings	Quality Strengths and Limitations	Conclusions/ Recommendations
Burdette and Whitaker (2004) Neighbourhood playgrounds, fast food restaurants and crime: relationships to overweight in low-income preschool children.	Cross-sectional study of urban low-income children aged 3-4 years, enrolled in the WIC program (Special Supplemental Nutrition Program for Women, Infants and Children that provides food and nutritional counselling to low-income mothers and their children) in Cincinnati, OH. N=7,020	RQ: What is the association between the residential proximity of low-income preschool children to playgrounds and fast food restaurants, and the safety of their neighbourhoods, to their risk for being overweight? SF: The proximity of each child's residence to the nearest public playground and fast food restaurant was determined using geographic information systems. Neighbourhood safety was determined by the number of police-reported crimes per year per 1,000 residents, for each 46 city neighbourhoods. OF: Overweight was defined as BMI ≥ 95th percentile, using weight and height data collected at the child's last clinic visit.	No association was found between the residential proximity of low-income preschool children to playgrounds or fast food restaurants and overweight. No association was found between the safety of their neighbourhood and overweight.	Strengths: Objectively measured environmental variables and weight status in a well-defined study population. Limitations: Exclusion of important variables like parental perceptions of safety, and cleanliness or accessibility of playgrounds.	In a low-income urban preschool population, distance to playgrounds and fast food restaurants, along with neighbourhood safety, were not found to be associated with the risk for being overweight. The provision of more playgrounds in low-income areas may not influence the prevalence of overweight in preschool populations. This may reflect that factors other than proximity determine use.

Appendix 4: Characteristics and main findings of original studies examining relationship between physical environment and obesity

Details	Study Design	Research question (RQ) Study Factor (SF) Outcome Factor (OF)	Main findings	Quality Strengths and Limitations	Conclusions/ Recommendations
Catlin et al. (2003) Environmental and policy factors associated with overweight among adults in Missouri.	Cross-sectional study using data from the Missouri CVD telephone survey 1999 to 2000. Sample: adults > 18 years, Missouri. N=2,821	RQ: What is the association between environmental and policy factors and being overweight? SF: Community perceptions (perceived criminal and traffic safety, perceived pleasantness), community infrastructure (sidewalks, exercise facilities) and worksite infrastructure OF: Prevalence of overweight, determined by BMI, calculated using self-reported height and weight	Negative community perceptions of the physical environment (unsafe or unpleasant) and the absence of outdoor exercise facilities were found to be positively associated with being overweight. OR=1.6 (95% CI: 1.1-2.3) and OR=1.2 (95% CI: 1.0-1.5) respectively. The absence of sidewalks and shoulders and negative community perceptions were found to be positively associated with being overweight among the employed. OR=2.8 (95% CI: 1.5-5.2) and OR=1.7 (95% CI: 1.3-2.4) respectively.	Limitations: Potential selection bias due to 16% of responders excluded due to incomplete answers. The excluded subjects were more likely to be older and female. BMI calculated using self-reported height and weight	Environmental and policy interventions that improve community perceptions of safety and pleasantness of the physical environment and improve the availability of sidewalks and outdoor exercise facilities may prove effective in reducing the prevalence of overweight.
Cheadle et al. (1991) Community-level comparisons between the grocery store environment and individual dietary practices.	Cross-sectional study matching dietary data collected via telephone survey with measurement of grocery store environment in the same communities. Analysis at community and zip code levels. N=34	RQ: What is the association between individual dietary practice and grocery store environment at the community level? SF: Grocery store environment including the availability of healthful foods (low fat, high fibre determined by measurements of shelf space) and health education materials. OF: self-reported individual diet	The availability of healthful foods in stores was found to be positively associated with reported healthy diets of individuals living near those stores.	Limitation: The study linked respondents to grocery stores by proximity rather than actual use.	The positive association between availability of healthful foods and individual dietary practices found in this study should be interpreted with caution.

Appendix 4: Characteristics and main findings of original studies examining relationship between physical environment and obesity

Details	Study Design	Research question (RQ) Study Factor (SF) Outcome Factor (OF)	Main findings	Quality Strengths and Limitations	Conclusions/ Recommendations
Frank et al. (2004) Obesity relationships with community design, physical activity, and time spent in cars.	Cross-sectional study using travel survey data from the SMARTRAQ study 2000-2002. Atlanta, Georgia. N=10,878	RQ: What is the association between residential built environment and self-reported travel patterns and obesity? SF: Urban form variables including land-use mix, residential density and street connectivity. Travel patterns including walking distance and time spent in car travel. OF: BMI calculated using self- reported height and weight.	Land-use mix was found to have a negative association with obesity; each quartile increase in land- use mix associated with a 12.2% reduction in obesity. Walking distance showed a negative association, with each additional kilometre walked / day associated with a 4.8% reduction in obesity. Conversely, car travel showed a positive association, with each additional hour in a car / day associated with a 6% increase in obesity.	Strength: Objective measures of urban form around each participant's place of residence. Limitation: BMI calculated using self-reported height and weight.	Interventions that increase land-use mix, increase distance walked and re- duce time spent in cars may reduce the prevalence of overweight and obesity.
Giles-Corti et al. (2003) Environ- mental and lifestyle factors associated with overweight and obesity in Perth, Australia.	Cross-sectional study using data from the Study of Environmental Determinants (SEID1) survey and an environmental scan of recreational facilities. Sample: healthy, sedentary adults aged 18-59 years in Perth, Australia. N=1,803	RQ: What are the associations between environmental and lifestyle factors and overweight and obesity? SF: Lifestyle factors including time spent watching television, recreational physical activity and access to a motor vehicle. One social environmental factor, the amount of physical activity compared with others. Five physical environmental factors including type of street in which the respondent lived, presence of sidewalks, accessibility to recreational facilities and respondents' perceptions of distance to walking/cycling paths and shops. OF: Overweight and obesity determined by BMI, calculated using self-reported height and weight.	Living on a highway, or street with none or only one sidewalk, and perceiving no paths within walking distance, were associated with being overweight. OR=4.24 (95% CI: 1.62-11.09), OR=1.35 (95% CI: 1.03-1.78) and OR=1.42 (95% CI: 1.08-1.86) respectively. Poor access to 4+ recreational facilities and perceiving no shop in walking distance were associated with obesity. OR=1.68 (95% CI: 1.11-2.55) and OR=1.84 (95% CI: 1.01-3.36) respectively. Conversely, easy access to car were less likely to be obese. OR=0.56 (95% CI: 0.32-0.99)	Limitations: Possible selection bias due to low survey response rate (52.9%). The sample had a greater proportion of women than the population. BMI calculated using self-reported height and weight.	Urban planning interven- tions that improve access to sidewalks, recreational facilities, walking paths and shops may be effective in reducing overweight and obesity. Interestingly, access to a motor vehicle "all of the time" was negatively associated with obesity. This result contradicts previous research indicating that greater car use is positively associated with overweight and obesity.

Appendix 4: Characteristics and main findings of original studies examining relationship between physical environment and obesity

Details	Study Design	Research question (RQ) Study Factor (SF) Outcome Factor (OF)	Main findings	Quality Strengths and Limitations	Conclusions/ Recommendations
Lopez (2004) Urban sprawl and risk for being over- weight or obese.	Multi-level cross- sectional study using data from the 2000 Behavioural Risk Factor Surveillance System (BRFSS). N=104,084	RQ: What is the association between urban sprawl and the risk for overweight or obesity in US adults? SF: Urban sprawl measured using the urban sprawl index (0-100 scale), a measure of the population density and distribution in metropolitan areas, derived from the 2000 US Census. OF: Overweight or obesity status determined by BMI, calculated using self-reported height and weight.	Urban sprawl was found to be associated with an increased risk for being overweight and obese. It found an increase in risk of 0.2% and 0.5%, respectively, for each 1- point increase in the urban sprawl index.	Limitations: Urban sprawl index fails to account for variation in urban sprawl within metropolitan areas. BMI calculated using self-reported height and weight.	Urban planning interven- tions that reduce the degree of urban sprawl may reduce the prevalence of overweight and obesity.
Rutt and Coleman (2005) Examining the relationships among the built environment, physical activity, and body mass index in El Paso, TX.	Community-wide cross-sectional study using telephone survey data matched to environmental data. N=452 70% female 73% Hispanic El Paso, TX	RQ: What is the association between the built environment, physical activity and BMI? SF: Sidewalk availability, number and distance to physical activity facilities, intersection number and type and land-use mix. OF: BMI, calculated using self- reported height and weight.	Living in areas of greater land-use mix (less residential) was found to be positively associated with higher BMI ($p=0.03$). Only one other study has found a similar positive association (Reddy 2002). These findings contradict previous studies showing negative associations between greater land-use mix and higher BMI (Saelens et al. 2003 & Ewing et al. 2003)	Limitations: Only 48% of the survey sample was successfully matched to envi- ronmental data. Those included were significantly older than those excluded. BMI calculated using self-reported height and weight	This study showed a positive association between higher land-use mix and BMI in a low-income, predominantly Hispanic community. This result contradicts the established literature which generally shows a negative association between greater land-use mix and higher BMI. These results may be due to differing measures of land-use mix or the in- clusion of individual SES as a confounding variable. Further research is required to confirm these findings.

Appendix 4: Characteristics and main findings of original studies examining relationship between physical environment and obesity

Details	Study Design	Research question (RQ) Study Factor (SF) Outcome Factor (OF)	Main findings	Quality Strengths and Limitations	Conclusions/ Recommendations
Turrell et al. (2004) A multi-level analysis of socioeconomic (small area) differences in household food purchasing behaviour.	Multi-level cross-sectional study using data collected from face-to-face interviews of people responsible for their household's food purchasing, as part of the 2000 Brisbane Food Survey. Brisbane, Australia.	RQ: What is the association between area and individual socioeconomic status (SES) and food purchasing behaviour? SF: SES was measured using a composite area index of disadvantage and household income. OF: Food purchasing behaviour was scored using a scale (0-100) for fruit, vegetable and grocery items, with higher scores for purchasing patterns more consistent with dietary guidelines.	No statistically significant association was found between area level SES and food purchasing behaviour.	Limitation: The study was under-powered and therefore unable to detect any statistically significant association.	Inconclusive results.

Appendix 5: Examples of self-reported and objective measures of physical environments related to physical activity

Instrument	Key reference	Assessment method	Description of items	Potential use
Systematic Pedestrian and Cycling Environmental Scan (SPACES)	Pikora et al. 2002	Direct observation	Walking/cycling surface, streets, permeability, personal safety, traffic safety, aesthetics streetscape, views, destination facilities, subjective assessment	Comprehensive instrument to measure the physical environmental factors that may influence walking and cycling in local neighbourhoods Setting: neighbourhood, community, open space
Neighbourhood Environment Walkability Scale (NEWS)	Saelens et al. 2003	Self-report via mail	Residential density, land use mix-diversity, land use mix-access, street connectivity, walking/cycling facilities, aesthetics, pedestrian/automobile traffic safety, crime safety	Cross-sectional studies to measure neighbourhood characteristics related to lifestyle PA, particularly walking for transport Setting: neighbourhood, open space
Home Environment Scale, Neighbourhood Environment Scale, Convenient Facilities Scale	Sallis et al. 1997, King et al. 2000	Self-report	Exercise equipment at home (e.g., weight lifting equipment, aerobic workout videotapes, audiotapes), neighbourhood characteristics (e.g., sidewalks, hills, enjoyable scenery, crime rate, perceived safety), convenient facilities (e.g., to basketball court, bike lane or trail, spa, gym, public park)	Setting: home, neighbourhood, community, open space
Environmental factors / No name of the scale /	Wilcox et al. 2000	Self-report via telephone interview	Presence or absence of sidewalks, heavy traffic, hills, streetlights, unattended dogs, enjoyable scenery, frequently observe others exercising, high levels of crime, easy access to walking trails/ swimming pools/ recreation centres, bicycle paths	Setting: neighbourhood, community, open space
Perceptions of Environmental Supports Questionnaire Objective measures of the environment	Kirtland et al. 2003, Addy et al. 2004	Self-report via telephone interview GIS	Accessibility, neighbourhood characteristics, barriers to PA, social issues/other people's PA behaviour, use of recreation facilities E.g. connectivity, density of recreation facilities, shops, walking/cycling trails	Setting: neighbourhood, open space

Appendix 5: Examples of self-reported and objective measures of physical environments related to physical activity

Instrument	Key reference	Assessment method	Description of items	Potential use
Perceived environment / No name of the scale	Ball et al. 2001	Self-report via telephone interview	Aesthetics, safety, convenience of facilities, social environment (companionship) for walking	Cross-sectional or intervention studies to assess walking for exercise in the community Setting: community, open space
Perceptions of the neighbourhood environment, perceived access to neighbourhood facilities / No name of the scale	Giles-Corti & Donovan 2002	Self-report	Neighbourhood attractiveness, safety and interest, social support for walking locally, traffic and traffic hazards, availability of sidewalks, convenience of public transport/park/shop	Setting: neighbourhood, open space
Access to recreational facilities		GIS	Indices for recreational facilities (e.g. golf courses, gym/health club/ exercise centre, public open space)	
Awareness of PA facilities / No name of the scale, no scale	Leslie et al. 1999	Self-report via mail	Awareness of PA facilities on a campus	Cross-sectional study Setting: campus
Environmental influences / No name of the scale, no scale provided	Booth et al. 2000	Self-report via face-to-face interview	Exercise equipment at home, safety in neighbourhood, access to PA facilities, social environment: offers of friends/family to jointly be active/ helpful reminders/ encouragement to be active	Cross-sectional study Setting: home, neighbourhood
Personal Environment Scale, Media Environment Scale, External Environment Scale, Local Opportunity Scale	Ståhl et al. 2001	Self-report via telephone interview	Personal Environment Scale: friends/acquaintances, spouse/ family/ relatives, workplace, school support PA Media Environment Scale: journals/newspapers, TV/ radio External Environment Scale: health insurance, doctor, politician, community Local Opportunity Scale: access to PA facilities in the community, awareness of local programs/opportunities for PA, belief of the extend the country's health policy helps to do enough PA	Cross-cultural study conducted in different countries Setting: community, open space

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