# Chapter 8
# Contributions of Natural Environments to Physical Activity

## Theory and Evidence Base

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**Abstract** The idea that nearby nature stimulates people to be more physically active is quite popular. In this chapter the literature regarding the link between physical activity and the residential environment is scrutinized. More specifically, after introducing the main concepts and a theoretical framework the evidence regarding three categories of activity is examined: physical activity in general, walking and cycling (mainly by adults), and outdoor play by children. Overall activity is deemed important because of its link to total energy expenditure, and thereby health. However, the other two categories are more likely to be linked to green aspects of the environment. Also attention is paid to the possibility that activity undertaken in a natural environment is especially beneficial for one's health. At

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the end of the chapter conclusions are summarized, directions for future research are proposed and policy recommendations are given, as far as possible given the current state of affairs.

## 8.1 Introduction

### *8.1.1 What Is Physical Activity and Why Is It Important?*

There are many different definitions of physical activity. The American Centre for Disease Control (CDC) defines it as '*any bodily movement produced by skeletal muscles that results in an expenditure of energy*'. The World Health Organization refines this definition slightly, calling it '*any force exerted by skeletal muscles that results in energy expenditure above resting level*' (Caspersen et al. 1985; Cavill et al. 2006). In simple terms, it is comprised of the physical actions in daily living, in household chores, in leisure time activities (including sports, gardening, cycling, walking, etc.) and in occupational activities (NIH 1996). International minimum recommendations for health-enhancing physical activity recommend 30 min every day (1 h for children) of moderately intense activity, which means getting somewhat out of breath without necessarily sweating (Cavill et al. 2006; WHO Europe 2002).

A great deal of research has shown that physical activity has positive effects on both physical and mental health (Cavill et al. 2006), especially when it occurs regularly and with sufficient intensity (Bauman 2004). Undertaken regularly, physical activity can reduce the risk of heart disease (Berlin and Colditz 1990), some cancers (notably colon (Slattery 2004; Friedenreich et al. 2006) and breast (Monninkhof et al. 2007)) and musculoskeletal problems (Brill et al. 2000). It has been shown to be an effective treatment for depression (Dunn et al. 2001) and can even help recovery from invasive medical treatments (see for example Mutrie et al. 2007). Conversely, health problems can arise when physical activity is not undertaken enough. In particular, when someone does not expend enough of the energy they brought into their body by eating and drinking, they will gain weight (Bull et al. 2004). If a person becomes overweight or obese, they are more likely to develop health problems which can include type II diabetes, heart disease, stroke, certain cancers and musculoskeletal problems (Cavill et al. 2006; Behn 2006).

### *8.1.2 Why Is There Concern About Physical Activity Levels?*

In recent years, in economically developed societies, there has been a fall in the amount of physical activity people undertake (Tudor-Locke et al. 2001; Dollman et al. 2005; Sjöström et al. 2006). The development of densely populated cities, rising car ownership, use of numerous labor saving devices and systems and a fall in physically active employment, coupled with reductions in the availability of

environments dedicated to physical activity, such as playgrounds for children and sports grounds for adults, has acted to reduce both the need and opportunity for people to be physically active. Between 1977 and 1995, for example, there was a 37% decline in the number of trips made by American children by foot or by bicycle (McCann and DeLille 2000). At the same time the calorific value of our food (that is, the amount of energy it provides when consumed) has increased, and food has become more plentiful (Wright et al. 2004; Putnam 1999). The consequences of these changes are that more energy is consumed while less energy is needed, because of the lower levels of physical activity. This has resulted in much higher numbers of overweight people, particularly amongst populations which consume greater quantities of processed food (Lobstein and Millstone 2007).

### *8.1.3 Why Might Natural Environments Be Important for Physical Activity?*

As governments and policy makers have searched for solutions to growing health problems which stem from being sedentary and overweight, they have tried to promote or induce higher levels of physical activity. It seems that this is a very difficult thing to do, and whilst there has been some success for small scale interventions (Marcus et al. 2006) there has been little success in improving physical activity rates across whole populations (Dunn et al. 1998). More recently, attention has turned to the natural environment, sometimes called green space, as a means to help encourage physical activity. The important question for policy makers and for this section of the book is: can natural environments help promote or induce physical activity? There are good reasons to ask this question. Natural environments are perceived as more attractive than built environments (Van den Berg et al. 2003) and because some bodily movement (for example, walking or cycling) is often necessary to experience them, it may be that they do inherently promote physical activity. However, the 'idea' that natural environments are useful for promoting physical activity is not the same as solid evidence for their true effectiveness upon which policy and spending decisions can be made.

### *8.1.4 The Effectiveness of Interventions to Alter Population Level Health-Related Behavior*

Since health and health behaviors in general have numerous complex and multi-factorial influences it can often be immensely difficult to alter or improve them. Even very intense efforts to alter a specific behavior, such as taking exercise, are frequently not successful at securing large scale, long-term behavior change (see for example Hillsdon et al. 2002; Lamb et al. 2002; Harrison et al. 2005). Furthermore, if there is

more success at altering health and behaviors for some groups than for others, health inequalities can be created or exacerbated. In general, interventions which are 'upstream', i.e., structural, environmental or legislative (such as banning smoking, separation of pedestrians and vehicles or compulsory seat-belt wearing) seem to work best in improving health, not increasing inequalities (and perhaps reducing them) (Macintyre 2007). Interventions based on information or education; for example, warning people about the dangers of alcohol or adverts encouraging exercise, seem most prone to exacerbating inequalities (Macintyre 2007). This may be because more advantaged groups pay more attention to and/or find it easier to act on health promotion advice. Furthermore, the health benefits of a successful behavior change intervention might not be equally distributed. An intervention which is successful at encouraging people to use a woodland trail might have more benefits for someone who was previously sedentary than for someone who was already very physically active and has simply shifted the location of their physical activity to the woodland trail from elsewhere.

### *8.1.5 The Success of Environmental Interventions to Improve Physical Activity Rates*

In a systematic review, Kahn et al. (2002) found evidence of effectiveness in a variety of strategies for improving physical activity rates. These included information based, behavior and social based, and environmental and policy based interventions. Whilst it is very difficult to identify which types of interventions were 'most' successful because this depends of the kinds of evidence available, in general environmental interventions such as community-scale urban design and land use policies that support physical activity, appeared more successful. The 12 studies of this kind that qualified for review had a median improvement in some aspect of physical activity (e.g., number of walkers or bicyclists) of 48%. This compares favorably, for example with a median improvement of just 5% from large-scale, intense, highly visible, community-wide campaigns with messages directed to large audiences through different types of media, including television, radio, newspapers. There was no attempt to review impact of these interventions on inequalities, or to differentiate between impacts on those who were previously sedentary and those who were already physically active elsewhere or in other ways. An example of two similar small scale environmental interventions, with very different results, can be seen in Photos 8.1 and 8.2.

### *8.1.6 What Do We Need to Know?*

To help us decide if natural environments can help promote physical activity, it is important to weigh the evidence carefully. To help in this process, we approach the evidence with a set of questions.

**Photo 8.1** Even though this exercise pavilion is close to many people, it is hardly used. The local residents do not seem motivated to use it (Photo: Ulrika Stigsdotter) (*See Color Plates*)

**Photo 8.2** This exercise area is frequently used by users that pass it on their run, walk or cycle tour (Photo: Jasper Schipperijn) (*See Color Plates*)

1. Are people who live near natural environments more physically active?
2. If proximity to natural environments is associated with greater physical activity, is there a dose-response relationship (i.e., does greater proximity equate to greater activity), and how strong is the relationship?

3. Is there evidence that the natural elements are causal in any relationship between natural environments and physical activity?
4. Do these relationships between natural environments and physical activity vary according to population characteristics (e.g., age, sex, socio-economic status, ethnicity, country of origin)?
5. Is there something specifically beneficial about physical activity performed in a natural environment, when compared to that performed elsewhere (e.g., indoor or built environment)?

## 8.2 Conceptual Framework and Structure of the Overview

The attention for the (natural) environment as a factor that may influence the physical activity rates of people has already produced quite a lot of research. Recently several reviews of such studies have been published (Humpel et al. 2002; Owen et al. 2004; Giles-Corti et al. 2005b; Davison and Lawson 2006; Ball et al. 2006; Ferreira et al. 2007). Usually these reviews do not limit themselves to the green or natural aspects of the environment, but are concerned with the environment in general. Rather than seeing this as a disadvantage, we feel that this helps to put the role of natural elements and green areas into perspective. Swinburn et al. (1999) have developed a taxonomy dividing the environment into different categories of relevant characteristics, the so-called ANGELO-framework. ANGELO stands for 'analysis grid for environments linked to obesity'. The framework distinguishes two scale-levels, micro and macro, and four aspects: physical, economical, political and socio-cultural. The micro level refers to the local environment in which the individual lives, works, obtains an education, and performs leisure activities and such. It can be subdivided into different settings: residential neighborhood, school environment, workplace, etc. The macro environment can be divided into different sectors, e.g., the educational system, the healthcare system, different levels of authorities, the food sector. This chapter will have a strong focus on the physical aspect of the micro-environment(s), especially the residential setting. In this paragraph we will present a conceptual framework that helps to structure the overview of research thus far. Later on we will present and discuss the conclusions of these reviews and other studies with regard to the evidence base that they provide.

Starting point is that the physical environment may stimulate or impede physical activity. Several authors (Giles-Corti et al. 2005b; Ball et al. 2006) suggest that it is important to be specific about the type of activity when looking at its environmental correlates. The relevant environmental aspects may vary strongly from activity to activity. Consequently, clearer and stronger relationships may be observed when the environmental aspects under study are tailored to the specific activity at hand. This specification may go beyond the activity as such, and include the motivation or context in which it takes place. Furthermore, because of differences in preferences and/or (personal) constraints, a distinction between population segments might also be helpful.

To focus our overview, we have selected the following three categories of outdoor activity: (a) physical activity and green space in general (Section 8.3); (b) walking and cycling for transport and recreation (Section 8.4); (c) outdoor physical activity by children (Section 8.5)

Finally, we will also devote a section of the chapter to the possible additional benefits of being physically active in a natural environment, compared to being active in another type of environment. That is, benefits other than the amount of energy spent during the physical activity (Section 8.6).

The first category is included because within some studies physical activity has been defined broadly and no subcategories of activity have been distinguished. However, it is also relevant because it focuses on the total amount of activity, which in the end seems what is relevant with regard to energy expenditure. The second category is included because active transport, i.e., to get to a destination by foot or bicycle for other than leisure purposes, nowadays for many people is an important source of physical activity (see e.g., Breedveld and Van den Broek 2002). Furthermore, especially for adults, walking and cycling also constitute the most common active outdoor leisure pursuits. We will concentrate on the role of (nearby) natural elements and green areas in the participation in this type of leisure activity. The third category focuses on children and will be mainly concerned with outdoor play, which is an important way of energy expenditure for this age group (Baranowski et al. 1993; Sallis et al. 1993b; Bakker et al. 2008). Each category of activity will be treated in a separate paragraph. Individual differences will be taken into account within each of these three categories, in as far as the studies being discussed pay attention to such differences, and the paragraph does not already have a clear focus on a specific segment of the population.

The above division into categories of activities has been made because of the different environment aspects that may be relevant for each of the categories. Nevertheless, at a more conceptual level it is still possible to identify a number of factors that are likely to be of importance for (almost) all of the categories, although their physical appearance/preferred levels may vary widely from activity to activity. Pikora et al. (2003) developed a framework of the potential environmental influences on walking and cycling based on available research on this topic. They distinguish four different features, namely *functional*, *safety*, *aesthetic* and *destination*.

The *functional* feature in the framework relates to the physical attributes of the street and path that reflect fundamental structural aspects of the local environment. Namely the specific attributes of the path, the type and width of the street, the volume, the speed and type of traffic, and the directness of routes to destinations. See Photo 8.3 for an example of a high quality recreational path.

The *safety* feature incorporates two elements of safety; personal safety (such as presence of lighting and level of passive surveillance) and traffic safety (such as availability of crossings).

The *aesthetic* feature includes factors which make for an interesting and pleasing environment. Here the presence, condition and size of street trees; the presence of parks and private gardens; the level of pollution; and the diversity and interest of natural sights and architectural designs within the environment are aspects to be considered.

**Photo 8.3** Good trails are essential for many forms of active recreation (Photo: Jasper Schipperijn) (*See Color Plates*)

The *destination* feature relates to the availability of community and commercial facilities in neighborhoods. Where there are appropriate local destinations within easy reach there is an increased chance people will walk. In other literature this is also called proximity or connectivity. Proximity relates to the distance between trip origins and destinations. Connectivity characterizes the ease of moving between origins (e.g., home) and destinations (work, shop, play) within existing street and sidewalk/pathway structure. Connectivity may also be considered an aspect of the functional feature.

The framework of Pikora et al. (2003) deals with the local environment at large. Besides being a part of this environment, green areas can also be considered a specific category of destinations within (or outside) this environment. To a large extent similar features are also relevant at this more specific level: (a) *destination*, accessibility of the area, distance and infrastructure (by mode of transport); (b) *safety*, personal and traffic, with importance of latter depending on modes of transport within the area; (c) *functional*, suitability for the activity at hand, internal infrastructure and required facilities to make the activity physically possible; supplemental facilities

and other amenities (not required, but appreciated); (d) *aesthetic/pleasantness*, scenic beauty, noise level, crowdedness, etc.

The attractiveness of the area as a setting to perform the activity at hand may be considered an overall concept in which the aforementioned aspects are integrated (highly accessible, very safe, very well suited for the activity and pleasant setting as well).

## 8.3 Natural Environments and Physical Activity in General

### *8.3.1 What Do We Mean by Physical Activity in General?*

Many studies of the relationships between natural environment and physical activity are focused on specific types of activity such as walking or cycling. Indeed, an important aspect of natural environments is that they may encourage or favor particular types of activity, over others. However, some of the evidence on associations between natural environments and physical activity is focused on activity 'in general'.

### *8.3.2 Why Record or Measure Physical Activity in General?*

It is sometimes better to record or express all the physical activities which study participants do in a single measure. If overall level of activity is the focus of a study, the specific activities which contribute might not matter too much. This is particularly the case when the study wants to compare activity levels of different groups, each of whom might prefer different kinds of exercise. Men, for example, may be more likely than women to achieve their physical activity in 'formal' activities such as team sport or running, but that does not mean that the activities of women are less important or healthy. This is particularly important in research on children's physical activity. The kinds of play that children may enjoy in green or natural environments can be very hard to describe or capture in terms of a single 'activity'. Furthermore, it might be that a natural environment promotes a particular kind of activity but that this is at the expense of another activity; thus overall amounts of physical activity could be unaltered. For that reason, a simple summary measure of activity can be very useful.

### *8.3.3 How Is Physical Activity Measured?*

There are two principal means of measurement. In the first, a questionnaire or survey will ask the respondent how many minutes of various kinds of physical activities they have taken part in, and at what intensity, over a specified period of time. A summary

measure can then be derived. One commonly used example of such a summary measure is the International Physical Activity Questionnaire, or IPAQ (Craig et al. 2003). Self-reported measures of activity have the advantage of being easy to gather from large numbers of people, but they are limited in their reliability and objectivity (Kohl et al. 2000).

In the second, an objective instrument is used to record the body's movement or energy expenditure. Accelerometers are a popular choice for the objective assessment of physical activity in studies of both adults and children. They are small and unobtrusive, and their information can be validated in a laboratory setting (Chen and Bassett 2005). They can record the body's movements in various directions and are thus suited to measuring physical activity derived from a wide variety of activities. However, they are limited in their ability to measure activity such as cycling, climbing, or other upper body-based exercise.

Identifying the most suitable method of assessing physical activity for a given situation is complex; often a combination of validity, reliability, accuracy and practicality must be considered (Melanson and Freedson 1996; Taylor et al. 1984). Whilst subjective measures may be relatively easy to gather, biases in tendency to over or underestimate the quantity of activity completed have been observed among various population groups (Adams 2005; Durante and Ainsworth 1996). Children in particular, may over or underestimate their activity levels (Sallis et al. 1993a). On the other hand, large scale deployment of objective measuring instruments is rarely possible and studies with large numbers of participants are usually the most powerful.

### *8.3.4 What Does the Published Literature Tell Us About Physical Activity and Green or Natural Environments?*

There are very few studies which report analyses of general levels of physical activity specifically in association with green or natural environments. However, there are a reasonable number of studies concerned with determining 'environmental correlates' of physical activity. These consider various aspects of physical and social environment, often including natural or green spaces. Humpel et al. (2002) reviewed literature on environmental factors associated with adults' participation in physical activity. They reviewed studies which made objective assessments of environment and those in which residents assessed their own environments. Their results, thus drawn from a variety of study designs, show evidence for positive associations between physical activity and the presence of parks within walking distance of home, hills, and 'pleasant scenery'.

Also Ellaway et al. (2005) found in a cross-sectional study that in residential environments containing high levels of green, the residents' likelihood of being frequently physically active was more than three times as high and the likelihood of being obese reduced by 40%. Atkinson et al. (2005) showed that physical activity is favored in neighborhoods characterized by residential density, mixed land use, and street connectivity, but also by proximity to green and open spaces for recreational needs. However,

Wendel-Vos et al. (2007) found in a systematic review of 47 studies that social support, having a companion, and connectivity of trails to be associated with different types of physical activity in the neighborhood (e.g., active commuting). There was less consistent evidence for physical activity and availability, accessibility and attractiveness of green spaces. For example, they identified numerous studies which did not show any positive relation between physical activity and green space (Wendel-Vos et al. 2007).

Others have been more specific in their exploration of the role of parks. Brownson et al. (2001) reported that access to parks in the neighborhood was associated with respondents being nearly twice as likely to meet the recommended level of moderate or vigorous physical activity compared to those without such access. Enjoyable scenery in the neighborhood was also associated with being more likely to meet the recommendations, albeit to a lesser extent. Giles-Corti and Donovan (2002) focused on access to recreational facilities, including parks, and their role in encouraging physical activity. Parks located near to home were used by more respondents than those located elsewhere, and public open space was the second most frequently used recreational 'facility' (28.8% of respondents). Both these studies tried to isolate the significance of parks from other factors known to be associated with variation in physical activity rates. Giles-Corti and Donovan (2002) found the physical environment's direct influence on activity was secondary to individual and social environmental determinants. This suggests that access to a supportive physical environment is useful for encouraging activity but may be insufficient to independently increase the meeting of recommended levels. It should also be noted that variety in park environment was often not controlled for in the studies. There is evidence that the type or design of the park might influence physical activity, with aesthetically pleasing parks containing tree-lined paths being more encouraging to activity than empty open space (Giles-Corti et al. 1996).

Other studies have looked at these relationships for particular subsections of the population. Cohen et al. (2007) studied the use of parks by low income minority groups. Interestingly, two thirds of park users they observed were sedentary. However, interviewees identified the park as the most common place they exercised. In analyses, Cohen et al. determined that both park use and exercise levels of individuals were predicted by proximity of residence to the park. In a more detailed study, Cohen et al. (2006) explored further the significance of access to green space for physical activity rates among adolescent girls. There are more details on studies of children later in the chapter but, briefly, Cohen et al. (2006) suggested that, for the average girl with 3.5 parks within a one-mile radius of home, the presence of parks accounted for 36.5 extra non-school minutes of activity per 6 days. However, their study was unable to determine whether these higher rates of exercise were actually due to park use, or if it was because more attractive neighborhoods, with more parks, tend to contain physically active families, normalizing the behavior. Other studies have focused on older populations (e.g., Chad et al. 2005), or those with a specific illness. Deshpande et al. (2005), for example, found a 'dose-response' relationship between parks and physical activity among diabetics, where higher dose was defined by shorter walking time to the park.

Some studies have explored dose-response relationships using 'accessibility' to natural spaces or paths, instead of a simple measure of distance. Often these measures are of perceived accessibility and it does appear that when accessibility to natural environments is perceived to be greater, physical activity rates are generally more likely to be higher. However, there is insufficient literature to determine the direction of causality. Those who are generally more physically active may regard their park as more accessible because their physical activity makes it easier for them to access the park, rather than because the readily accessed park makes them more physically active.

One problem with studies exploring the relationship between physical activity and access to natural environments is that in general terms, it is often wealthier people who can afford to live in the more pleasant, greener places (Bolitzer and Netusil 2000; Hobden et al. 2004) and research has shown that wealthier populations tend also take more exercise for recreation (Popham and Mitchell 2007; Macintyre and Mutrie 2004; Mutrie and Hannah 2004). Although usually statistical corrections are applied to minimize this problem, establishing whether the natural environment has an independent impact on physical activity can therefore be difficult.

It is also important to note that not all studies find access to natural environments to be associated with physical activity levels. Hillsdon et al. (2006), for example, found no evidence of clear relationships between recreational physical activity and access to green spaces in an urban setting. In fact, in their useful review of evidence for relationships between parks and recreational facilities, and physical activity, Kaczynski and Henderson (2007) found that nine of 37 included studies focused on parks, open space or trails showed non-significant relationships. However, Kaczynski and Henderson concluded that positive associations between natural environments and physical activity were rather more common than those between other types of recreational facilities and physical activity. It should be noted that not all the studies they reviewed concerned 'physical activity in general'.

## 8.4 Walking and Cycling

### *8.4.1 Introduction*

Walking and cycling are forms of physical activity that are accessible to the majority of the population regardless of income, age and location. It is estimated that more than 96% of the people in Europe are able to walk and more than 75% to ride a bicycle (WHO Europe 2002). At the same time there are substantial differences in walking habits and the use of bicycles throughout Europe. According to Eurostat (2005), in Switzerland 40% of all trips still are covered by walking compared to 7% in Denmark (and about 20% in most other countries). Cycling accounts for a sizable share of daily mobility in countries like the Netherlands (26% of all trips) and Denmark (15%), but is of very low impact in the UK (2%), France (3%) and several countries on the Mediterranean shore. In a smaller survey in nine countries, the

time spent for daily travel on foot or bicycle amongst people aged 20–74 varied from 14 min (Finland and Norway) to 29 (Slovenia) (de la Fuente Layos 2005). In the Netherlands and Denmark, the annual mean distance travelled by bicycle was about 1,000 km, in Germany and Sweden about 300 km, and in Spain, Portugal and Luxemburg it was less than 50 km (EC 1999).

The above numbers are regardless of motive and environment. With regard to motive a distinction may be made between leisure (recreational) and transport (e.g., commuting) mobility. The ratios of active leisure and transport mobility, considering and comparing the absolute amounts of trips and the time spent on the activities, vary significantly between age and social groups. Students and senior citizens, possibly due to different life stages, show on the one hand a much higher proportion of leisure mobility than do e.g., commuting middle-ages, but on the other hand the total amount of senior citizens' physical activity tends to be lower compared to children or students. However, since leisure mobility also includes transport (e.g., getting to a leisure or recreational destination), at least 75% of overall active mobility is for transport and much less is for recreation. Bearing this in mind, WHO Europe pointed out that '*walking and cycling for daily transport has greater potential than leisure activities for getting people physically active*' (WHO Europe 2002, p. 4).

In this section we will first focus on walking and cycling as a means of transport. After that we will pay attention to walking and cycling for recreation. However, a strict distinction of potential health effects referring to these two motives for physical activity is sometimes difficult to make.

### *8.4.2 Walking and Cycling for Transport*

Epidemiological studies suggest that there are substantial health benefits to be gained from physical activity as a means of transport (active transport to get to a destination). However, while many studies examined the associations with overall physical activity, only a few were able to study the independent health effects of transport-related physical activity such as walking and cycling (WHO Europe 2002, 2007). Some studies showed that people having the option of walking and cycling for transport reasons, i.e., destinations within reasonable distance have a lower prevalence of overweight and obesity (Saelens et al. 2003; Giles-Corti et al. 2003; Wen et al. 2006). Andersen et al. (2000) found strong protective health effects of cycling. Even after adjusting for different 'risk' factors like the general and leisure physical activity level, socioeconomic background and smoking, the mortality rate of the study subjects cycling to work was 39% lower than for those who did not (Andersen et al. 2000). Matthews et al. (2007) found similar results – among others – for cycling for transport and mortality in Chinese women. For walking for transport the result just failed to reach significance in this study ($p < 0.07$).

Cooper et al. (2006) found that children who cycled to school were 8% fitter than children who used other kinds of transport, including walking, and concluded that a 10–15 min session of cycling twice a day was enough to increase fitness in children.

Furthermore, observational studies have consistently shown that children who walk or cycle to school engage in more additional physical activities than do those who travel using other means (Cooper et al. 2003).

Even though the mentioned studies showed interesting protective effects or increases in physical activity, there are very few studies investigating the potential specific effects of walking or cycling for transport in urban green areas (Wendel-Vos et al. 2007). Nevertheless, Taylor et al. (1998) stated that natural environments are perceived as more attractive than built up environments and that green areas may stimulate residents to undertake physical activity such as walking and cycling, e.g., for transport purposes (Taylor et al. 1998; Bedimo-Rung et al. 2005). Some more recent studies support this statement, but others did not (see e.g., reviews by Kaczynski and Henderson 2007; Wendel-Vos et al. 2007).

Studies on the relationship between environment and active transport primarily come from the US and Australia, and most of them have investigated the environmental characteristics of residential neighborhoods (e.g., Craig et al. 2002; Saelens et al. 2003; Humpel et al. 2004; Powell 2005). Some types of active transport, for example commuting, do however partly take place outside these neighborhoods and therefore, most likely the overall commuting route environments are more important for understanding the relationship between environment and physical activity through commuting.

Studies of active commuting in Stockholm, Sweden, have dealt with the issue of which environmental variables along the commuting routes may stimulate active commuting, and which may inhibit it. Based on correlational studies, perceived levels of exhaust fumes and congestion in mixed traffic environments appear to have the potential to inhibit commuting by bicycle in inner urban environments, whereas for commuting by foot, noise levels have the same inhibiting role. On the other hand, for both these modal choices, aesthetics and green elements, respectively, appear to potentially have a stimulating effect on active commuting (Schantz and Stigell 2006; Schantz and Stigell 2007). The next phase of the study is to see to what extent stimulating and inhibiting environmental factors are associated with actual commuting behavior.

According to a study conducted in Bielefeld (Germany), accessibility of green areas is essential in people deciding to use them as an alternate route of active transport. Urban green areas were used as an alternative route by 56.1% of the Bielefeld residents, and 76% get to these green areas at least once a week staying there median 30–60 min (Frank et al. 2004). The results of this investigation, however, did not show whether the residents use these routes for active transport to avoid densely trafficked streets, or just because these green routes are more time-effective due to fewer traffic lights.

Maas et al. (2008) did not find any significant relationship between the percentage of green space in the living environment and the amount of or time spent with walking trips for commuting purposes. Furthermore, the results showed a negative relationship between the percentage of green space in a one-km radius and the amount of cycling trips for commuting purposes, but a positive relationship concerning the time spent for those that did cycle (Maas et al. 2008). These results are in line with

those from Wendel-Vos et al. (2004). A higher amount of nearby green space can be caused by more agricultural areas, which can be found in the outskirts and suburban parts of cities. People living in these parts that do cycle to work, presumably often located in the city centre, are likely to spend more time commuting. In accordance with these studies, Den Hertog et al. (2006) demonstrated the density of different facilities and parking possibilities – within an urban environment – to be important determinants for the amount of physical activity undertaken. In neighborhoods with a high density of facilities such as shops, and without private parking spaces, people more often choose to walk or cycle. Consequently, there are often higher amounts of physical activity in city centers with hardly any green areas, whereas people with more green space in their living environment less often walk or cycle due to car availability and reduced facility density (Maas et al. 2008).

### *8.4.3 Walking and Cycling for Recreation and Exercise*

In this subsection the literature on walking and cycling especially for recreation is reviewed. With 'for recreation' it is meant that the activity of walking or cycling is undertaken for leisure purposes, for the pleasure they themselves provide. However, we will also include walking and cycling for exercise purposes under this heading. Furthermore, some studies do not distinguish between motives, or include both walking for transport as well as walking for leisure purposes.

As recently once again confirmed in a Dutch study, most recreational walking and cycling trips take place close to home. Even though in this diary study a lower limit of being away from home for at least 1 h was used, about 68% of all recreational walks used no other means of transport first (CVTO 2007, p. 57). For cycling trips this was even higher: 89% (ibid, p. 58). Moreover, especially the habitual behavior and activity pattern will be relevant with regard to overall physical activity levels, more so than the occasional long-distance trip. Although the review in this section is not limited to green areas, they will be given special attention, as will solitary natural elements such as street trees (Lee and Moudon 2006). With regard to green areas within the living environment, we will use a broad definition, for example also including agricultural areas. Finally, walking and cycling for recreation is especially common among adults (in some cases accompanied by young children), and most of the studies seem to be focused on this segment of the population.

As for green areas as specific destinations for walking and cycling for pleasure, it may be noted that especially for walking it is quite common to use a car or other means of transport first to drive to an attractive destination area and to go for a walk there. So, a distinction may be made between trips on which other means of (usually motorized) transport is used first and those on which one starts walking or cycling as soon as one leaves one's dwelling. In the latter case there may be no destination at all; one might be just going for a stroll in the own neighborhood. On the other hand, one might be visiting a nearby green area, such as an urban park. The distinction between taking a walk in the neighborhood and visiting a nearby green area by foot

is not always clear. Furthermore, also when there is no specific destination, natural features may play a role by making the neighborhood environment or the streetscapes more attractive. Cycling, because of its action radius, is always likely to mainly take place outside the own neighborhood.

If another means of transport is used first, the range of destinations within reach tends to become much larger, depending on the mode of transport and on how much time one is willing and able to spend on travelling to and from the destination area. The latter is usually strongly related to the time one wants to or is able to spend in the destination area itself. The total amount of leisure time available is an important consideration (as is one's willingness to spend it on the trip). Usually longer trips take place during the weekend, days off or holidays. The larger choice of destinations is assumed to increase the demands with regard to the attractiveness of the destination area. This includes both functional (e.g., walking facilities or network of cycle paths) and aesthetic features. The safety feature is likely to remain important, although traffic safety may be less important once the destination area has been reached, depending on what modes of transport are allowed within the area, or, more specifically, on the paths. Other safety or health dangers may become more prominent, e.g., tick bites (Lyme's disease).

In a review by Owen et al. (2004), a distinction was made between exercise and walking for pleasure on the one hand and walking for transportation purposes on the other. Eighteen studies were identified. The environmental attributes associated with walking for exercise or pleasure, were different from those associated with walking to get to and from places. Relevant aspects for walking for pleasure appeared to be an aesthetically pleasing environment (e.g., perceived presence of pleasant and attractive natural features), convenience of facilities for walking (e.g., trails); and accessibility of destinations such as parks and beaches. These specific findings appear to be largely based on a study by Ball et al. (2001) among a cross sectional sample of Australian adults. More recently, based on a study among Australian adults living in Perth, Giles-Corti and others (2005a) concluded that access to attractive, large public open spaces was associated with higher levels of walking.

Pikora et al. (2006) have tried to empirically determine the relative importance of the four features they discerned earlier (functional, safety, aesthetic, destination) with regard to neighborhood walking by adults. They concluded that functional features were correlated with both walking for transport and walking for recreation. Destination factors were correlated with walking for transport, but not with walking for recreation. Aesthetic considerations (including green aspects) seemed to be (weakly) linked with walking for recreation only. In their study safety aspects were correlated with neither walking for transport, nor walking for recreation. In an Australian study, Owen et al. (2007) observed a relation between an objectively determined score on a walkability index and walking for transport by adults, but no such relation for walking for recreation. This index did not include the aesthetics of the neighborhood. In a recent Dutch study Maas et al. (2008) even observed a negative relationship between the local amount of green space and walking and cycling for leisure purposes. It should be noted that in the latter study green space often mainly consisted of agricultural land, usually considered a less attractive type of destination for walking (at least in the Dutch context).

Harrison et al. (2005) came to another conclusion regarding safety and fear of crime than Pikora et al. (2006) did. Based on their study among adults in northwest England, they concluded that feeling safe had the potential largest effect on population levels of physical activity. More specifically, Foster et al. (2004) concluded that English men are more likely to walk at least 150 min a week if they report having access to a local park, while their walking is not influenced by concerns about safety. English women, according to them, seem to be more concerned with walking in safety. The presence of green space itself may also have consequences for social safety. Maas et al. (2009) concluded that whereas in general the amount of local green space is positively associated with feelings of social safety, in highly urban areas larger amounts of enclosed green space are associated with reduced feelings of social safety.

As for specific segments of the population, Li et al. (2005) conducted a study among elderly residents of Portland (Oregon, USA). They observed a significant relationship between the area of green and open space for recreation within the neighborhood and the level of neighborhood walking of older adults (over 64 years of age). Perhaps it is especially for elderly adults that walking (and cycling) for pleasure is a suitable or common means of getting exercise. This type of recreational activity seems to be less popular with adolescents, whereas children usually undertake the activity in the company of (one of) their parents or guardians. At the same time, for the elderly safety issues are likely to be relatively important (Loukaitou-Sideris 2006).

Some studies do focus on recreational facilities, but not limit the physical activity to walking and/or cycling. Kaczynski and Henderson (2007) reviewed the evidence specifically with regard to parks and recreation settings, outdoor as well as indoor, as environmental correlates of physical activity. Based on the 50 studies they retrieved, they concluded that proximity to parks or recreation settings was generally associated with increased physical activity. However, not all the reviewed studies are equally relevant for our present purposes, in the sense that the environmental correlate sometimes involved another aspect than natural elements and green areas (indoor recreation settings). In other cases the study that was reviewed looked at a very location-specific activity, such as the use of a new trail (e.g., Evenson et al. 2005). In such cases location substitution may have occurred. Furthermore, in some cases negative relationships were observed with green environmental characteristics.

So far we discussed studies looking specifically at the relationship between the local supply of parks and other green areas and the amount of physical activity, either in total or more specifically in the form of walking and cycling mainly for transport or for pleasure. There are many more studies dealing with the visiting of parks, forests and/or nature areas. Given that walking is the most common activity during a visit to such areas, visitation levels may be considered a crude proxy of physical activity gathered by means of walking. A distinction may be made between studies that look at levels of visitation accumulated over different parks, etc. and studies that look at the visitation of a specific green area. Given the present focus, the former studies are of more interest than the latter.

An example of the first type of study is the one by Grahn and Stigsdotter (2003). Although this study on residents of mid-sized Swedish towns (all ages) focuses on

stress reduction, it also looks at the yearly number of visits to urban open green spaces and the yearly amount of time spent in such areas. Both are clearly related to the (self-reported) distance to the nearest urban open green space. Also other studies show that the accessibility of a certain type of green space (nearness to, amount of) is strongly positively associated with the recreational use a resident makes of this type of green space (see e.g., De Vries 2004). Conversely, people tend to make use of green and natural areas that are nearby, and do not seem very inclined to compensate for the local lack of a specific type of area by visiting natural areas further away, at least not fully (see also Maat and De Vries 2006). So, people with more nearby green space are likely to spend a larger proportion of their outdoor leisure time in a natural environment. This is something that we will come back to in Section 8.6 of this chapter.

## 8.5 Children's Physical Activity in Green Spaces

### *8.5.1 Introduction*

Also for children there is a growing concern that they are becoming more sedentary (Fjørtoft 2004; Sallis et al. 2000). This is partly due to increasing interest of children in watching television and playing computer games. Furthermore, suggestive evidence shows steep declines in the number of destination children reach by walking or cycling, and at the same time, an increase in the reported use of motorized vehicles (Tudor-Locke et al. 2001).

In 2005, less than 10% of the children between 4 and 12 years old in the Netherlands met the Healthy Norm for Physical Activity which states that children should be moderately physical active for 1 h per day (De Vries et al. 2005; Kemper et al. 2000). Australian data suggest that 20–25% of the children are not sufficiently active to confer health gains (Booth et al. 2000). Promotion of children's physical activity is important to combat the international obesity epidemic that extends to childhood and to establish an early habit of lifestyle physical activity that can be sustained into adolescence and adulthood (Tudor-Locke et al. 2001).

Whether or not children are physically active depends on demographic, psychological, social and environmental factors (US DHHS 1996). Concerning the environment, the social, school, home and neighborhood environment can influence children's physical activity. Children can play indoor as well as outdoor. Playing outdoors has been associated with a higher level of PA than playing indoors (Sallis et al. 2000; De Vries et al. 2008). In this paragraph we will focus on a specific type of outdoor environment, namely the natural outdoor environment. The traditional outdoor playground is usually barren, covert with asphalt and has metal playing equipment. Natural environments represent a dynamic environment and a stimulating and challenging playground for children (Photos 8.4 and 8.5). Trees, shrubbery, and broken ground can be important triggers of young children's physical activity. The richness

**Photo 8.4** This stream is a much more popular play area among local children than the playground next to it (Photo: Ulrika Stigsdotter) (*See Color Plates*)

**Photo 8.5** Also this playground is highly popular in summer (Photo: Jasper Schipperijn) (*See Color Plates*)

of forms, colors and materials stimulate not only the imagination of children but also provides movement challenges and a diversity of opportunities for playing and moving (Fjørtoft 2004; Boldemann et al. 2006).

### *8.5.2 Where Do Children Usually Play?*

Studies on where children usually play show that parks are attractive places for children to play in. An Australian study showed that 53% of children's play occurred at home ground, 24% occurred in parks and playgrounds and 6% occurred on the streets (Tandy 1999). A study by Veitch et al. (2006)) showed that children usually play 'in the yard at home or at a friend's house, the street and local parks'. Safety concerns, the child's level of independence, the presence of nearby children, and facilities at parks and playgrounds were considered to have the most impact on playing. A study from Prezza et al. (2001) showed similar results. They showed that environmental factors such as living in an apartment block, living near a park and the age of the neighborhood were important determinants for whether children play independently.

It is however important to note that playing does not necessarily have to be related to the amount of physical activity. In the next section research which investigated whether natural environments promote physical activity is discussed.

### *8.5.3 Does a Natural Environment Promote Children's Physical Activity?*

#### 8.5.3.1 Do Parks in the Neighborhood Promote Children's Physical Activity?

Most studies on the relation between natural environments and children's physical activity investigate whether neighborhood parks promote children's physical activity. Neighborhood parks are easy to access for children because they are often in the vicinity of their homes. Furthermore, neighborhood parks could provide a place for parents with young children to meet and allow their children to play.

In a mixed method study, Hume et al. (2005) explored which aspects of children's home and neighborhood environments were deemed important by them, and found that these did include open spaces and parks, However, when using accelerometers to explore children's physical activity levels, Hume et al. (2005) found that the frequency with which open spaces and parks in the neighborhood were mentioned was not associated with physical activity rates. Yet, in a study which also used accelerometers to measure physical activity in children, but which measured environmental characteristics objectively, Roemmich et al. (2006) found that the quantity of park land in the neighborhood was clearly related to physical activity rates. Roemmich et al.'s (2006)

study is useful because it separates the contribution of park land from other recreational space. Their results suggest that each 1% increase in park area was associated with a 1.4% increase in average physical activity. Other work from this team suggests that for older children access to parks is associated with greater increases in physical activity for boys than for girls, but this was not the case for the younger children (Epstein et al. 2006).

Early results from a study underway in Scotland echo these findings, with time spent in forest environments boosting physical activity rates about equally for younger boys and girls (Lovell 2010). In a study by Hoefer et al. (2001), use of neighborhood parks explained 5.1% of variance for boys' total physical activity, after adjusting for parental transportation. This suggested that active boys found ways to access physical activity locations by walking or cycling, leading the authors to conclude that the availability of neighborhood parks and playgrounds may stimulate physical activity that does not rely on adult transport.

Cohen et al. (2006) further explored the significance of access to a park for physical activity rates among adolescent girls. They found that every additional park in the half-mile around a girl's home was associated with an increase in moderate/vigorous physical activity by 2.8% or 17.2 non-school minutes of activity per 6 days. They suggested that, for the average girl with 3.5 parks within a 1-mile radius of home, the presence of these parks accounted for 36.5 extra non-school minutes of physical activity per 6 days. This would indicate, albeit crudely, a form of 'dose-response' relationship between quantity of green space and physical activity. However, their study was unable to determine whether these higher rates of exercise were actually due to park use, or if it was because more attractive neighborhoods, with more parks, tend to contain more physically active families.

A few other studies explored the relation between reported access to parks nearby and physical activity. These studies concluded that children who did not report limited access to parks nearby engage more in physical activities (Alton et al. 2007; Mota et al. 2005; Kipke et al. 2008). Timperio et al. (2004) examined associations between perceptions of the local neighborhood and walking and cycling among children aged 5–6 years and 10–12 years. Among older girls, parent's belief that there were no parks or sports grounds near home was associated with a lower likelihood of walking or cycling (OR = 0.5, 95% CI = 0.3–0.8). A study of Den Hertog et al. (2006), performed in four different districts in Amsterdam, The Netherlands, showed that the availability of a park of high quality and with a high offer of play areas, rest places and walking routes which was within reach of the residents, was important for children's levels of physical activity. Overall, these studies suggest that (access to) a park in the neighborhood promotes physical activity of children.

#### 8.5.3.2 Do Other Natural Environments in Neighborhoods Promote Children's Physical Activity?

Two studies focused on the relation between neighborhood green space and physical activity. Using a physical activity diary, De Vries et al. (2005) explored the relationships between aspects of environment and physical activity in children aged 6–11. In univariate

analyses, adjusted for age, sex, body mass index, and highest level of maternal education, physical activity was significantly ($p < 0.05$) associated with the proportion of green space in the neighborhood. However, in multivariate analyses, other features of the neighborhood were found to be more strongly associated with activity levels.

Taylor et al. (1998) conducted a study in a deprived neighborhood in Chicago and investigated whether the amount of vegetation in courtyards, mainly consisting of trees and grass, influenced the frequency of playing. They found that in the courtyards with more vegetation, the frequency of playing behavior was higher. Furthermore, children displayed more creative playing behavior and had more contact with adults.

### *8.5.4 Does Green Space in and Around the School Environment Promote Children's Physical Activity*

Two different studies investigated whether green elements in the outdoor (pre) school environment promoted children's physical activity. Boldemann et al. (2006) used pedometry and assessments of the environment to investigate whether outdoor preschool environments with a large outdoor area which was characterized by (a) play structures/areas adjacent to trees and shrubbery or integrated in areas with the character of wild nature and (b) open spaces located in between play structures/areas influenced children's physical activity. Environments with both these two characteristics could yield 1,500–2,000 more steps in a child staying seven hours at preschool and spending half the time outdoors. On the other hand, Cardon et al. (2008) showed that the presences of vegetation or height differences in 39 randomly selected preschools were not significant physical activity predictors in boys or girls (on average 5 years old).

## 8.6 Benefits of Physical Activity in Green Space Versus in Urban and Indoor Settings

The following paragraph will analyze effects and outcomes of physical activity in different environments. Why might physical activity be more beneficial in green space than in urban settings? First, main theories and their relevance for restorative benefits of exercise in green spaces will be discussed, followed by their empirical evidence.

### *8.6.1 Main Theories Explaining the Beneficial Effects of Green Space*

A first theory applicable to the relations between exercise environment and perceptions of physical symptoms, fatigue and health is the *competition of cues model*. According

to this model, internal sensory stimuli and external environmental cues compete for attention (Pennebaker and Brittingham 1982; Pennebaker and Lightner 1980; Watson and Pennebaker 1989). It suggests that being in natural physical environments, for example, may promote physical and psychological well-being by increasing external attention, decreasing the amount of attention directed towards internal states, and thus decreasing, e.g., the number of current health complaints (Watson and Pennebaker 1989).

Two other theories are relevant for additional benefits of physical activity in different environments. Kaplan and Kaplan's (1989) *attention restoration theory (ART)* explains the positive, restorative effects of green spaces on the overuse of directed attention (= mental fatigue). According to the ART an environment has restorative potential (qualities) if four components, being away, fascination (effortless attention), coherence (coherent physical environment of sufficient scope) and compatibility (match between personal purposes and environment), are available in the human-environment interaction. Based on this theory restorative environments contribute to restoration by recovering directed attention and by clarifying and restructuring thoughts, which further leads to reflecting on immediate unresolved problems as well as on life's larger questions such as personal goals and one's place in the overall scheme of things (see also Chapter 5). Compared to the ART, which is focused on cognitive processes, Ulrich (1983), Ulrich et al.'s (1991) *stress reduction theory (SRT)* is more focused on emotional and physiological processes. The SRT is based on the belief that viewing or visiting natural environments after a stress situation rapidly promotes physiological recovery and relaxation (Ulrich 1983).

## *8.6.2 Exercise-Related Empirical Support*

### 8.6.2.1 Running

According to the *competition of cues model* the more interest-commanding external cues there are, the less attention is drawn inwards. For example, joggers exercising in an interesting, natural setting (a wooded cross-country trail) have been found to run faster but report only a similar amount of fatigue and physical symptoms after the run to joggers exercising on a boring lap course (Pennebaker and Lightner 1980). Concurrently, when people have been instructed to produce a certain intensity level while running (e.g., light or hard) they do it differently in field and treadmill conditions. In an experiment with 12 physically active males the subjects ran faster and had higher heart rate as well as blood lactate levels in a field setting (a natural setting by a lake without other people, snow or ice) than in a treadmill condition although they perceived their physical exertion level, that is, the intensity of the exercise, similarly in both conditions (Ceci and Hassmén 1991). One potential theoretical interpretation of these findings suggests that the perception of fatigue and physical symptoms might be reduced or slowed down in natural environments offering interesting and engaging external cues, that is, fascination.

Harte and Eifert (1995) tested ten trained runners during an outdoor run in a campus area (presumably including some green space) and two indoor treadmill running conditions. All subjects participated in all four conditions: three experimental and one control. Subjects ran 12-km on a designated route around James Cook University campus. All subjects completed the course in less than 45 min. In the indoor run-external stimuli setting and the indoor run-internal stimuli setting subjects were advised to run at a similar speed and exertion level as they normally would outdoors for over all 45 min. There was only one difference between the two indoor settings; in one condition subjects wore earphones and listened to a tape cassette with 'outdoor noises' while running (e.g., sounds of wind, cars, people walking past, birds, and so on). In the other condition subjects listened to their own breathing through earphones connected to a sensitive microphone attached to their chests. The control condition was 45 min of quiet inactivity in the laboratory. The study found that after the outdoor run, subjects felt less anxious, less depressed, and less angry and fatigued, and more invigorated than before the run. In contrast, the two indoor runs had less positive effects on mood. After the indoor internal-stimuli run subjects felt tenser, more depressed, angrier, and more fatigued than before the run. Running in a campus area reduced negative emotions whereas running on a treadmill in a laboratory did not. A significant increase in systolic blood pressure and perceived exertion after all three running conditions was found. Noradrenalin and cortisol secretions were higher during the internal-stimuli indoor run, whereas levels of increase in adrenalin secretions were similar over all conditions. The findings support the notion that setting, attention, and cognitive appraisal may alter the emotional experiences associated with physical exercise.

When Bodin and Hartig (2003) conducted a within-subject field experiment with 12 regular runners they did not find statistically significant differences in emotional or attentional outcomes between a park route and an urban route. However, the effect sizes for more tranquility and less anxiety after running in the park route were medium-sized, indicating potential for the hypothesis that the park may promote restoration while running to a greater degree than the urban environment. Moreover, runners significantly preferred the park to the urban environment and judged it to be more psychologically restorative.

Contradictory results with competitive and non-competitive runners were reported by Kerr et al. (2006). They measured changes in emotions and stress (before and after) to compare the psychological effects of exercise in laboratory and natural environments. Significant increases in positive, and decreases in negative emotions pre- to post-exercise were found irrespective of indoor and outdoor conditions. For the recreational (non-competitive) runners, only for emotion pride higher levels were observed in the natural as compared to the laboratory environment. No explanation for this somewhat surprising finding was presented. Competitive runners (i.e., members of a running squad) were more excited and less anxious after running irrespective of the type of environment. More interestingly, stress from tension and effort was higher with natural than with laboratory running, which again was an unexplained finding. The overall conclusion by the authors is that the actual running environment may be somewhat irrelevant to experienced runners. We might speculate

here that stress from tension and effort might well be higher after running in natural settings because the earlier findings suggest that people tend to run faster (Pennebaker and Lightner 1980) and have higher heart rate (Ceci and Hassmén 1991) when jogging in a natural setting. Non-competitive runners seem not to perceive or report these feelings whereas competitive runners as in Kerr et al.'s study (2006) do.

Again, contradictory results with this conclusion are presented by Pretty et al. (2005). An independent panel of 50 people categorized 309 photographs on a five point scale according to how well it represented a rural pleasant, rural unpleasant, urban pleasant or urban unpleasant scene. Four groups of 20 subjects were exposed to a sequence of 30 scenes projected on a wall whilst exercising on a treadmill. A fifth group acted as a control group exercising with a white blank screen. For most of the subjects the intensity of the exercise meant a jogging pace, but for others it was a fast walk. A clear effect of exercise in different outdoor scenes on blood pressure, self-esteem and mood was found. Rural pleasant scenes had the greatest effects in reducing blood pressure. Both rural and urban pleasant scenes produced a significantly greater positive effect on self-esteem than the exercise-only control. This shows that exercise in both rural and urban environments has positive psychological effects. On the other hand, both rural and urban unpleasant scenes reduced the positive effects of exercise on self-esteem. The rural unpleasant scenes had the most dramatic effect, depressing the beneficial effects of exercise on three different measures of mood. Pretty et al. (2005) conclude that threats to the countryside and green space represented in rural unpleasant scenes have a greater negative effect on mood than already urban unpleasant scenes. Note that in general, urban scenes with green, such as urban parks, domestic gardens or allotments, together with water and blue sky, were categorized as pleasant.

A quasi-experimental study by Hug et al. (2008) showed varying results. The study compared the physical and psychological benefits of exercise in self-selected indoor and outdoor environments. The survey was conducted on site in the urban forest and in fitness centers in Zurich. The physical activities performed indoors and outdoors included running, cycling and general fitness training, and were thus to some extent similar. There was a significant interaction effect between exercise environment and the four measures for restoration outcome. Increases in feeling mentally well-balanced and decreases in suffering from everyday hassles were higher outdoors, whereas the stress reduction and increases in physical well-being were more emphasized indoors. Exercise induced a positive effect averaged across the four indicators of well-being which did not differ between the indoor and outdoor locations (indoor versus forest). One further result was that people exercising in the forest judged air quality to be better. Participants exercising in the forest were more excited about exercising again at the present site, were more reluctant to leave the forest and did not think that exercising in the gym would provide better opportunities for restoration.

A prospective study of over 500 middle-aged women showed that the main running area (open countryside runners versus runners in a constructed environment) was not related to the progression from irregular running to regular running. However, those who perceived themselves to be in poor health and had an unattractive

neighborhood were more likely to regress from regular running, compared to those who assessed their neighborhood as attractive (Titze et al. 2005; see also Sproston and Primatesta 2004). The study did not specify the aspects of attractiveness but suggests that green spaces and green streets may have contributed to these assessments.

#### 8.6.2.2 Walking

Results from the study by Hartig et al. (2003) combining ART and SRT theories show that after a stressor condition by the midpoint of a 50-min walk in a nature reserve the participants had 6 mmHg lower systolic blood pressure levels (on average) than participants walking in the urban surroundings, indicating greater stress reduction. Furthermore, positive affect increased and anger decreased in the nature reserve by the end of the walk, whereas the opposite pattern emerged in the urban environment. Performance on an attentional test improved slightly from the pretest to the midpoint of a walk in a nature reserve, while it declined in the urban setting. The natural environment was a 4,000 acre vegetation and wildlife preserve in a canyon of mountains. The urban site was an area of medium-density professional office and retail development in the city (Hartig et al. 2003).

#### 8.6.2.3 Playing in the Green Space and Children

There are only a few studies focusing on whether physical activity or playing in green space has more beneficial health effects for children than in other types of environments. Fjørtoft (2004) investigated whether a natural play environment influenced playing behavior and motor development of Norwegian children aged between five and seven. She concluded that playing in a natural environment improved motor fitness, especially balance and coordination abilities. A study from Van den Berg et al. (2008) examined whether playing in nature is positively related to behavior indicators which indicate a healthy and balanced development of children. With good controlled experimental design this study showed that a brief visit to a natural environment provoked more varied and creative behavior and more exploration of the environment. Furthermore it provoked concentration. Finally, a study from Faber Taylor et al. (2001) performed in the US found a weak but significant positive relation between the naturalness of the playing environment and the seriousness of ADD (Attention-Deficit Disorder) symptoms such as difficulty in completing tasks, listening or following directions.

## 8.7 Summary, Conclusions and Future Directions

In this chapter we have presented and analyzed an expanding body of evidence on the issue of whether there is a relation between green space/green elements and levels of physical activity or not. For this purpose we have been using the following set of five questions that will be reflected on in this summary:

1. Are people who live near natural environments more physically active?
2. If proximity to natural environments is associated with greater physical activity, is there a dose-response relationship (i.e., does greater proximity equate to greater activity), and how strong is the relationship?
3. Is there evidence that the natural elements are causal in any relationship between natural environments and physical activity?
4. Do these relationships between natural environments and physical activity vary according to population characteristics (for example, age, sex, socio-economic status, ethnicity, country of origin)?
5. Is there something specifically beneficial about physical activity performed in a natural environment, when compared to that performed elsewhere (e.g., indoor or built environment)?

We thereafter conclude and point at different potential future research directions to further the understanding of these complex issues.

### *8.7.1 Natural Environments and Physical Activity in General*

Perhaps the strongest conclusion which can be reached is how little quality evidence there is about the association between natural environments and general levels of physical activity. Almost all of the cited studies were in urban settings; few considered results by demographic or social group, by type of green environment or at different spatial scales. Furthermore, adding to the uncertainty on these matters is the fact that sometimes different spatial scales have been used for the determination of physical activity and the environmental correlate, i.e., it is not always known where the measured physical activity has been taken place. Thus, correlations between the levels of physical activity and the amount of green space may be spurious. Much more work is therefore needed to explore these associations.

When the definition of physical activity is a general one, the available evidence suggests that greater proximity to or accessibility of natural environments is frequently associated with elevated physical activity levels. However, findings are mixed, with dose-response relationships sometimes detected and sometimes not. The literature does suggest that perceptions of accessibility might be more important than the physical distance in determining the association with physical activity. However, perceptions of accessibility might well be confounded with physical activity behavior, and it is therefore difficult to determine the true direction of causality. In terms of the size of effect, again the evidence is mixed and dependent on the study setting, measure used and degree to which potential confounders have been controlled for. In general, when an association is observed, its strength is modest.

Relationships between greater access to natural environments and e.g., socio-economic advantage make it difficult to draw firm conclusions as to whether natural or green spaces have an independent and causal association with physical activity rates. At this time, the literature cannot confirm a causal relationship. The few studies which do exist suggest that some forms of natural environment are more encouraging to physical activity than other forms of natural environments.

It does appear that different population subgroups have differing relationships with natural environments and thus to physical activity in them, but it is currently not possible to provide generalizations.

### *8.7.2 Walking and Cycling for Active Transport or for Recreation and Exercise*

A basic prerequisite for active transport is that distances between origin and destinations are suitable. It is therefore not surprising that this type of physical activity appears to be related to residential density and land use mix in the neighborhood environment. Whether green elements affect the levels of active transport therefore needs to be studied while controlling for these other variables. To our knowledge, no such study exists. Correlation studies do however suggest that both walking and bicycling commuters' perceptions of levels of green elements along their individual active commuting routes are related to their perceptions of to what extent their route environments stimulate to active commuting.

The effect of the local supply of green and natural areas on *where* people go for a recreational walk is considerable. There are also some studies indicating that a low local accessibility and/or availability will lead to less walking for pleasure overall. Given the limited focus of most studies, it is not clear whether this also means a lower level of overall physical activity. Lower levels of walking may be compensated by other activities (elsewhere). On the other hand, a lot of greenery in the residential environments often goes together with a spacious design of the neighborhood. Among other things, this may imply good parking facilities and fewer destinations such as shops, banks, etc. nearby, thereby facilitating car use for transport purposes. So, factors promoting recreational activity may be negatively associated with factors promoting active transport, at least for adults (see e.g., Den Hertog et al. 2006). The net result may be negative. Moreover, besides their sheer presence also the attractiveness of the green areas and their (social) safety are of importance for their use.

General conclusions with regard to type and strength of the relationship are hard to draw. We still cannot answer questions such as: is there really a dose-response relationship, and if so, is it linear or is there for example a decrease in the marginal return of ever more nature? A wide variety of green environmental characteristics have been used. Sometimes these characteristic have only two levels, making it impossible to say something about the shape of the relationship. Also for physical activity, a wide variety of measures have been used. Furthermore, in several studies the environmental characteristics are the characteristics as perceived by the respondents that also self-reported their physical activity. This same-source bias may lead to an overestimation of the strength of the relationship between actual physical characteristics of the environment and physical activity.

A related question is how the dose should be defined in this case. Whereas on the effect side the measurement of physical activity has received quite a lot of attention, the development of measurements of environmental doses is still in a very early stage. The question of which green environmental characteristics are relevant

and how they can be assessed objectively and reliably has only begun to be addressed. A next step would be to integrate the individual characteristics into an overall measure of the activity stimulating capacity of the green components of the environment. An early example of this type of study is that by Giles-Corti et al. (2005a), introducing a model in which size, distance and attractiveness of public open spaces are combined.

Given the nature of almost all studies that have been presented (cross-sectional, correlational) no firm conclusions regarding the direction of causality are possible. Intervention studies, when available, usually only deal with a small part of the local supply of green space and natural elements. Besides the resulting problem of location substitution, this makes it unrealistic to expect big effects.

Differences between population segments are also likely to exist. Neighborhood walking may be especially important for the elderly as a type of activity with a low threshold. At the same time, social and physical safety issues are likely to be more prominent for them.

### *8.7.3 Children's Outdoor Physical Activity*

Relatively few studies focus on whether a green environment stimulates physical activity for children. The evidence shown in this chapter suggests that having a park in the neighborhood is often associated with elevated physical activity levels of children. For other types of natural environments the evidence is less convincing or available. This evidence mainly comes from studies outside Europe. Further research is needed to find out whether this relationship also exists in Europe.

Findings are mixed with dose-response relationships sometimes detected, and sometimes not. In terms of the size of effect, again the evidence is mixed and dependent on the study setting, measure used and degree to which potential confounders have been controlled for. In general, the association size is modest.

Because all reviewed studies are cross-sectional it is hard to draw conclusions regarding the causality of the relation. Furthermore, most studies do not investigate whether children are really physically active in the green environments, but investigate whether the availability of green environments is related to children's physical activity.

It does appear that there are differences between boys and girls and between different age groups in whether natural environments promote physical activity, but it is currently not possible to provide generalizations.

### *8.7.4 Benefits of Physical Activity in Green Space Versus Urban and Indoor Settings*

Discussing emotional, cognitive and physiological benefits of physical activity in green space versus in urban and/or indoor settings implies two connotations. First, natural

environments may provide the same benefits as other locations but at a different degree. Second, they may provide qualitatively different benefits. Most of the studies on running show similar benefits in natural and urban/indoor settings, but at a different degree. Obviously, quantity may sometimes turn into quality, and the most reliable result seems to be the presence or increase of positive emotions and absence or decrease of negative emotions after physical activity in natural environments. Less reliably, adults seem to perceive less fatigue and physical symptoms after their physical activities in green space vs. indoors or sports fields. Regarding walking, experiments indicate that natural environments (e.g., nature reserve area) in comparison to urban (e.g., office and retail development) provide lower levels of blood pressure after stress conditions.

In sum, the evidence regarding exercise in green space versus elsewhere seems to be limited, mixed and we note that the effects of the environment may differ according to the intensity of the exercise and level of the runners (e.g., competitive versus non-competitive; experienced versus less experienced runners). There are some studies comparing different types of outdoor environments but only a few studies comparing the effects of indoor and outdoor exercise environments. The contradictory results described above may be due to methodological differences and differing limitations of the studies. More accumulation of research results is needed. For example, because the studies are mostly experimental and the research settings have been selected by the researchers, it is not known whether attachments to particular exercise places or to types of places might influence the effects (cf. Korpela et al. 2001). It is not known whether regular runners choose their environments differently from irregular runners and whether familiarity of and habituation to the route is relevant.

Because the reported studies have used limited sample sizes and population groups, we cannot answer the question of individual and population group differences properly. Individual differences in training or individual exercise preferences and habits can mediate effects of physical activity in green space. It seems that physical activity in green space has beneficial emotional, cognitive, behavioral and physiological benefits effects on both adults and children. For children, the results of controlled experiments suggest more creative and explorative play and greater alleviation of attention deficit disorder (ADD) symptoms in natural settings.

### *8.7.5 Future Directions and Issues*

The overall pattern and the majority of correlations between green elements and levels of physical activity speak in favor of the hypothesis of a connection between green elements and physical activity. However, there are a number of studies showing no relation and even a few showing a negative relationship.

The quality and quantity dimensions of green space need to be explored as separate entities in relation to possibly being determinants of physical activity. For example, the potentially stimulating effect of the green environment in urban settings

may be neutralized by high levels of noise from traffic (cf., Schantz and Stigell 2007; Hornberg et al. 2007). On the other hand, a playground in the park may be the actual cause for higher levels of physical activity in children, rather than the green dimensions of the environment itself. The confounding of aesthetic quality and the greenness versus urbaneness of the setting is an understudied issue. The study by Pretty et al. (2005) suggests that both rural and urban pleasant scenes observed during physical activity may have similar effects on self-esteem. Thus, we have to more carefully differentiate between the aesthetic and natural features in studies comparing natural and non-natural physical activity settings.

Green elements as a destination and/or as part of a transportation route and their effect on physical activity are an important but complex research subject. Thus, future investigations should try to study environments where the physical activity/inactivity is undertaken but also the effects of environments along the route or adjacent to the environment where the activity takes place. For example, a basketball court in a green park versus besides a car park may attract people to physical activity in different ways.

The quantity and the optimal size of green space needs also further research: envision two extremes, both in urban settings, one a local pocket park, the other being a large urban park in center of an urban residential area, e.g., Central Park in New York City. It is immediately apparent that the pocket park will not be used as an arena for physical activity. A slightly larger park can be a destination point for e.g., dog owners and thereby be a determinant of physical activity for this subgroup. But still the park may be too small to attract adult joggers. Thus, the quantitative limits and qualitative features of green space positively effecting physical activity for different user groups are still relatively unknown. Furthermore, the potential substitution effects are not presently known, i.e., whether the total level of physical activity would remain the same if the desired green space did not exist.

Future studies should also conceptually clarify not only the independent variable, i.e., the green space and its dimensions but also the "dependent" variable, physical activity. This refers to types of physical activity as well as to the intensity of activity. If natural environments attract people to engage in physical activity, do we mean overall starting of physical activity (by people who previously were totally sedentary) at whatever frequency and intensity, achievement of recommended levels of physical activity, progression from irregular to regular physical activity, or regression from regular to irregular physical activity, or total regression from physical activity to a sedentary state? Attaining such types of more specific information on the physical activity and the individuals being active would enhance evaluations of health impacts on both the individual and the population level.

It is known that usage of green space for running and walking may vary substantially over the year (see e.g., Kardell 1998). In consequence, the relation between green space and levels of physical activity is rather weak during winter whereas it might play a substantial role in summer. Studies using spot data of physical activity can thereby miss important information depending on when the data is collected. To address these issues we therefore need a basic understanding of how green space is used over the year. It is also of interest to know whether the physical activity takes place at other locations during winter time (e.g., on a treadmill at a gym), i.e., is there a substitution effect regarding

the place where the physical activity is going on, or whether people are less physically active during winter time?

The understanding of the basis for the possible relation between green space and physical activity is today to a great extent relying on psychological and psychophysiological theories and findings. However on top of that basis, we are dealing with a behavior that to a certain extent very likely also is an effect of socialization and learning processes as well as trends that might undergo undulations. Studies in for example Sweden have revealed great secular changes in usage of the same green settings and running trail network (Kardell 1998). This points at the importance of studying these issues in different behavioral and cultural contexts and settings. For example, one might think of different ethnic, parental support and learning environments. Examples are nature-based pre-schools, physical education contents in schools and the influence of NGO's, such as the scout movement and other organizations which promote outdoor recreation.

An important issue for further studies is to increase our knowledge of the effect size. In one study presented in this chapter, the postulated effect of green space was about 6 min of physical activity per day. In relation to the recommended minimum levels of physical activity per day (= 30 min.), the 6 min per day amounts to 20%. Research on the effect size has to take moderating factors into account. For example, despite good environmental conditions physical activity may not occur, e.g., due to factors such as lack of leisure time. In other words, effect sizes might be highly conditional. Green space might be a necessary or optimal ingredient in stimulating to physical activity within the population, but it might not be a sufficient factor. To further the understanding of these matters, it would be favorable if the correlation approach used in many current studies can be supplemented with information on the preferences of different population groups for arenas and qualities of environments for physical activity. Indeed, there is a need for several different and complementary study designs.

The most important concern about the existing results relates to the potential selection effects, i.e., that people select their housing or other general living conditions in order to obtain certain conditions for e.g., physical activity. The results may then be relevant for subgroups of the population, rather than for a majority or the whole population. Longitudinal studies following changes in environment and/or in residence can be one way to circumvent this measurement issue. Experimental research might offer another avenue, when feasible.

### *8.7.6 Recommendations*

In all, it is possible to speculate about some practical recommendations regarding planning and design of open (green) space based on the available empirical evidence. If access and the amount of green space near one's residence can be more reliably than now related to the meeting of recommended levels of moderate or vigorous physical activity, the conclusion could be that we need many but somewhat smaller

parks rather than few large parks within the city structure. The point is that there should be a sufficient amount of green space close to everyone's residence. At the moment, however, there are no studies to show the sufficient size of, for example, a city park for physical activity. The same point would also speak for urban sprawl rather than densification. Studies on the effect of green space in the vicinity of children, disabled and the elderly, whose range of activity is usually more limited than adult 'normal' population support similar conclusions.

In this chapter we have dealt merely with the physical activity dimension in relation to green space. However it is obvious, that in physical planning more dimensions have to be integrated. As pointed out in other chapters in this book, studies showing that viewing green space has relaxing physiological and psychological effects (Chapters 5 and 6). This supports the need for private gardens or green yards in residential areas. Some of these elements may also stimulate physical activity through gardening, but the point is that there are also other merits of green space to be considered. On the basis of existing knowledge a wise policy might be to conserve whatever green space is there as a precaution, because in practice changing built-up areas back to green space has proven to be quite difficult.

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