The Environment And Physical Activity

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Until recently, obesity research has mainly focused on biological and behavioral factors. However, there is growing agreement among researchers that the social and physical environment may play an important role as well. Certain aspects of the environment may promote or discourage physical activity and therefore have an influence on children's body weight. The purpose of this chapter is to give an overview of the current knowledge on the relation between the physical neighborhood environment and physical activity in children.

Ecological model of physical activity

Traditionally, interventions promoting physical activity focused on changing personal and psychosocial factors (e.g. knowledge of health benefits). However, by focusing on personal and psychosocial factors, only small groups of people could be reached. Whereas intervening in the environment could have positive outcomes on large groups of people living in that environment.

Consequently, ecological models of health behavior have gained increased attention. Ecological models posit that multiple levels of influence determine individual behavior (Figure 1). Ecological models include factors at the intrapersonal (e.g. psychological), interpersonal (e.g. social support, modeling), organizational (e.g. sports clubs), community (e.g. school), physical environmental (e.g. neighborhood), and policy (e.g. the law) level [1]. According to ecological models, higher levels of physical activity are expected when environments and policies support physical activity, when social norms and social support for engagement in physical activity are strong and when individuals are motivated and educated to be physically active [1]. Currently, ecological models are frequently used to get insight into the factors that determine physical activity levels. The factors that are related to physical activity are called 'correlates'.

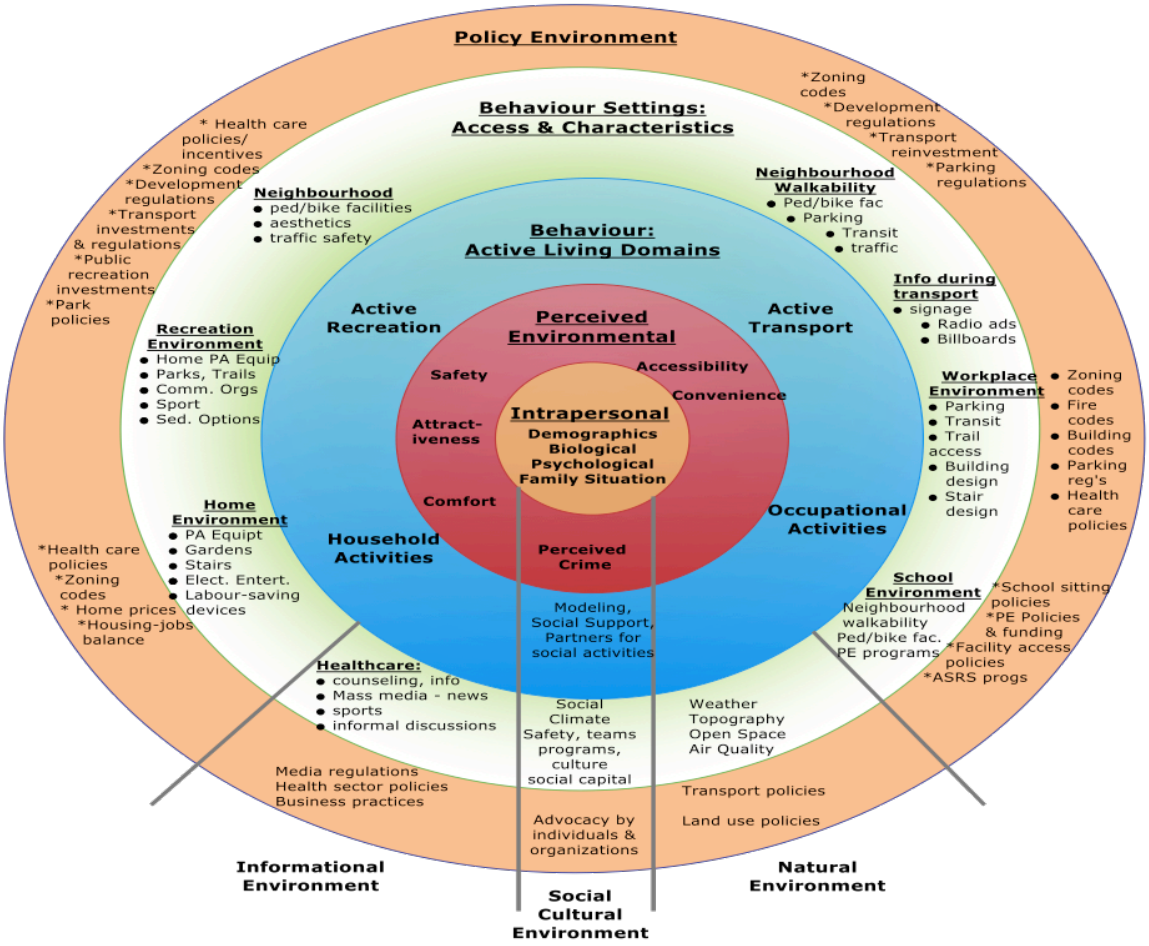

Figure 1: *The ecological model for physical activity. From Sallis J.F., Cervero R.B., Ascher W., Henderson K.A., Kraft M.K., & Kerr J. (2006). An ecological approach to creating active living communities. Annual Review of Public Health, 27 297-322.[53]*

In this chapter we will focus on physical neighborhood environmental correlates of physical activity in children. The physical neighborhood environment is defined as 'objective and perceived characteristics of the physical context in which children spend their time (e.g., home, neighborhood, school) including aspects of urban design (e.g., presence and structure of sidewalks), traffic density and speed, distance to and design of venues for physical activity (e.g., playgrounds, parks and school yards), crime and safety' [2].

Measuring children's physical activity and the neighborhood physical environment

Physical activity

Children's physical activity can be measured in different ways [3]. It can be measured objectively (e.g. by activity monitors, direct observation, heart rate monitoring) or subjectively (e.g. by using self-reported questionnaires, activity logs and activity diaries) [4].

The most frequently used activity monitors in physical activity research are accelerometers. Accelerometers measure acceleration (i.e. the change in velocity over time) of the body or body segments [5]. They are small and light-weight devices that are able to collect data for weeks [6] and are most often worn on the hip during waking hours [7].

Accelerometers have the ability to objectively capture physical activity intensity. Physical activity can be divided in light- (e.g. bicycling less than 5 mph), moderate- (e.g. hiking, aqua aerobics) or vigorous- (e.g. jogging/running) intensity physical activity [8,9].

Another way to determine children's physical activity is the use of subjective measurement methods such as physical activity questionnaires or log books for children and/or their parents. The use of physical activity questionnaires makes it possible to obtain more information about the domain and context in which children's physical activity took place [10]. A possible disadvantage of using questionnaires is that people may misreport their physical activity, due to social desirability or recall problems [11,12].

Neighborhood physical environment

Also the neighborhood physical environment can be assessed using different objective and subjective methods. An audit or observation of the neighborhood by specialists or Geographical Information Systems (=GIS) are used to determine the environment in an objective way. A neighborhood audit can be conducted in person in the neighborhood or by using Google Streetview [13-15]. GIS is 'a computer-based tool for the capture, storage, manipulation, analysis, modeling, retrieval and graphic presentation of spatially referenced information' [16]. A GIS model consists of several layers with different information. For example, when a layer with different neighborhoods in a specific city is combined with a layer containing the street network of that city, it is possible to calculate the street connectivity for each neighborhood in that city.

Besides determining the environment objectively, it is also possible to determine the neighborhood environment subjectively. Subjective environmental perceptions of parents as well as perceptions of children are most frequently used in research investigating the physical environment. The 'Neighborhood Environment Walkability Scale' (=NEWS) is internationally the most frequently used questionnaire to determine the perceptions of the neighborhood physical environment [17,18].

Following aspects of the neighborhood physical environment were thoroughly investigated in relation to children's physical activity by using questionnaires, audits or GIS.

- *Land use mix diversity;* refers to the 'level of integration within an area of different types of uses for physical space, including residential, office, retail/commercial, institutional, industry and public space' [19]. A neighborhood with a high mixture of different land uses (e.g. schools, shops, houses, sport facilities) is a neighborhood with a high land use mix diversity.
- *Street connectivity;* refers to 'the directedness or ease of travel between two points which is directly related to characteristics of street design' [19]. A neighborhood with high street connectivity is characterized by many interconnected streets.
- *Residential density;* refers to 'number of residential units per unit of land area' [19]. A neighborhood with a lot of residential buildings on a small area is a neighborhood with a high residential density.
- *Walkability;* land use mix diversity, street connectivity, and residential density are often combined into a walkability index. A high walkable neighborhood is characterized by high land use mix diversity, high street connectivity and high residential density (Figure 2 [19]).
- *Accessibility;* refers to the ease by which desired places or activities can be reached and refers to the land-use system and transportation system [20]. E.g. easy to walk to a transit stop.
- *Walking and cycling facilities;* refers to the presence and characteristics of facilities for walking and cycling. E.g. presence of sidewalks, crosswalks, bike lanes.

- *Aesthetics;* refers to the aesthetic value of the neighborhood and may include aspects of pleasantness, interesting architecture, environmental upkeep, pollution, natural elements. E.g. beautiful scenery, graffiti.
- *Safety;* is mostly investigated as traffic safety (e.g. presence of traffic lights) or crime safety (e.g. absence of stranger danger).
- *Recreation facilities;* refers to the quality and presence of e.g. parks and playgrounds.
- *Urbanization;* refers to the degree of urbanization in a neighborhood. E.g. rural versus urban area.

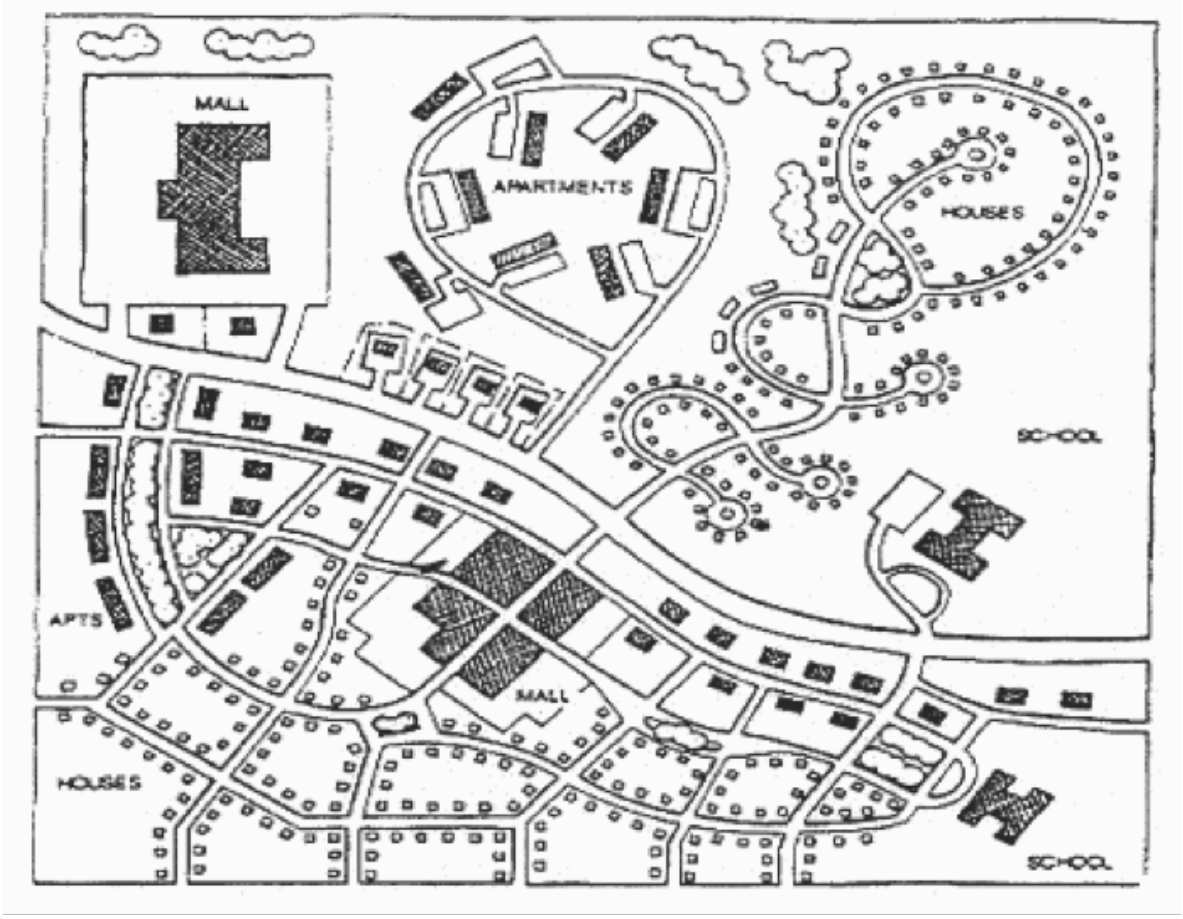

Figure 2: *A high-walkable neighborhood (bottom left) and a low-walkable neighborhood (top right). From Saelens BE, Sallis JF, Frank LD. Environmental correlates of walking and cycling: findings from transportation, urban design, and planning literatures. Annals of Behavioral Medicine 2003; 25: 80-91.[19]*

A more advanced technology recently used in physical activity research is the use of global positioning systems (GPS) [21]. By using GPS in combination with accelerometers and GIS, children's physical activity can be exactly located in the neighborhood. GPS can also be combined with GIS, which makes it possible to determine environmental characteristics of children's activity spots.

Different domains of children's physical activity were investigated in relation to different aspects of the neighborhood physical environment. The relation between the neighborhood physical environment and children's physical activity may vary according to the measurement method that was used to determine children's physical activity and the physical environment [22]. This makes it difficult to draw univocal

conclusions about the relationship between the neighborhood physical environment and children's physical activity. A recent review found that the most consistent associations were found between objectively measured environmental attributes and self-reported physical activity [22].

Direct relationship between the neighborhood physical environment and children's physical activity

The relationship between the neighborhood physical environment and physical activity may vary according to the domain of the activity (e.g. active transport, overall physical activity,…)[23,24]. The neighborhood environment can have a dissimilar impact on different domains of physical activity [2,25]. For example, a highly connected neighborhood can be beneficial for walking for transportation in children, but detrimental for active play in the streets. Therefore, the direct relation between the neighborhood physical environment and children's physical activity is described separately for different activity domains: active transportation to school, walking and cycling during leisure time and overall physical activity and moderate- to vigorous-intensity physical activity.

Active transportation to school

Children's household distance from school seems to be one of the most important correlates of their active transportation to school. Children living further away from school are less likely to actively commute to school [24,26,27]. A feasible distance for children to walk to school is 1.5 km and a feasible distance to cycle to school is 3.0 km [26].

In a recent review (D'Haese et al., under review) significant relations were found between the neighborhood physical environment and children's active transportation to school. Walkability and neighborhood accessibility were positively related to children's active transportation to school. Evidence for a possible positive association with active transportation to school was found for density measures (e.g. residential density, population density, building density), pedestrian crossings and general safety (e.g. feeling safe to walk). Aesthetics, crime safety, traffic safety and recreation facilities were all largely investigated in different studies, but these variables were generally unrelated to children's active transportation to school (D'Haese et al., under review). It seems that walkability, distance to school and accessibility are the most important physical environmental correlates of children's active transportation to school.

Walking and cycling during leisure time

Although physical environmental variables were positively associated with active transportation to school in children, they were not related to walking and cycling during leisure time (D'Haese et al., under review). This can be due to the fact that children walk or cycle to school more frequently than they walk or cycle during leisure time [28] and that children who walk or cycle during leisure time are mostly accompanied by a parent or a friend, making other influences (e.g. parental support, access to a car, or friends living in the neighborhood) more important for walking and cycling during leisure time than the physical environment (D'Haese et al., under review).

Overall physical activity and moderate- to vigorous-intensity physical activity

The physical environment is neither related to total physical activity or to overall moderate- to vigorous-intensity physical activity in children (D'Haese et al., under review), so it is supposed that other influences than the physical environment are more important in order to explain children's total physical

activity and moderate- to vigorous-intensity physical activity. For example, it is possible that when children have a large backyard and enough play space at home, their neighborhood environment is less important [29].

Until now, mainly macro-scale neighborhood environmental factors were investigated in relation to children's physical activity. However, these macro-scale factors are often difficult to change in existing neighborhoods, whereas micro-scale environmental factors (e.g. sidewalk evenness, separation between cycle path and car traffic, speed limitation) might be easier to change. Therefore, future research should also focus on these micro-scale environmental factors.

Relationships between neighborhood physical environment and physical activity differ across continents

The relationship between the physical neighborhood environment and physical activity in children differs across continents. This can be due to differences across continents and countries in the neighborhood physical environment, in design of land use and traffic and crime situations; and the difference in physical activity behaviors across continents and countries (D'Haese et al., under review).

Relationships between the neighborhood physical environment and physical activity in children were mainly found in North-America and Australia. In Europe and Asia only few relationships between the neighborhood physical environment and PA were found in children. In Africa and South-America, the relation between the physical environment and children's physical activity is still understudied (D'Haese et al., under review).

General safety, traffic safety, crime safety, and recreation facilities were more often related to walking and cycling during leisure and children's total physical activity/moderate- to vigorous-intensity physical activity in North-America and Australia compared to Europe (D'Haese et al., under review). This might be due to the fact that it is less safe to walk or cycle in the USA and Australia [30]. As neighborhoods in Europe may be different from neighborhoods in North-America or Australia [31], it is possible that European children are more active at home or in a cul-de-sac whereas Australian or North-American children are more active in recreation facilities.

Indirect relationship between the neighborhood physical environment and children's physical activity

Besides the direct relation that was investigated between the neighborhood physical environment and children's physical activity, it is hypothesized by Kremers et al. in the Environmental Research framework for weight Gain prevention (EnRG), that the physical environment is also indirectly related to children's physical activity [32] (Figure 3). According to Kremers et al. it is possible that the physical environment influences cognitive factors (attitude, subjective norm, perceived behavioral control and intention towards physical activity) which in turn can influence physical activity. Besides, it is also possible that this direct relation between the physical environment and physical activity differs in subgroups with different characteristics (e.g. different socio-economic status).

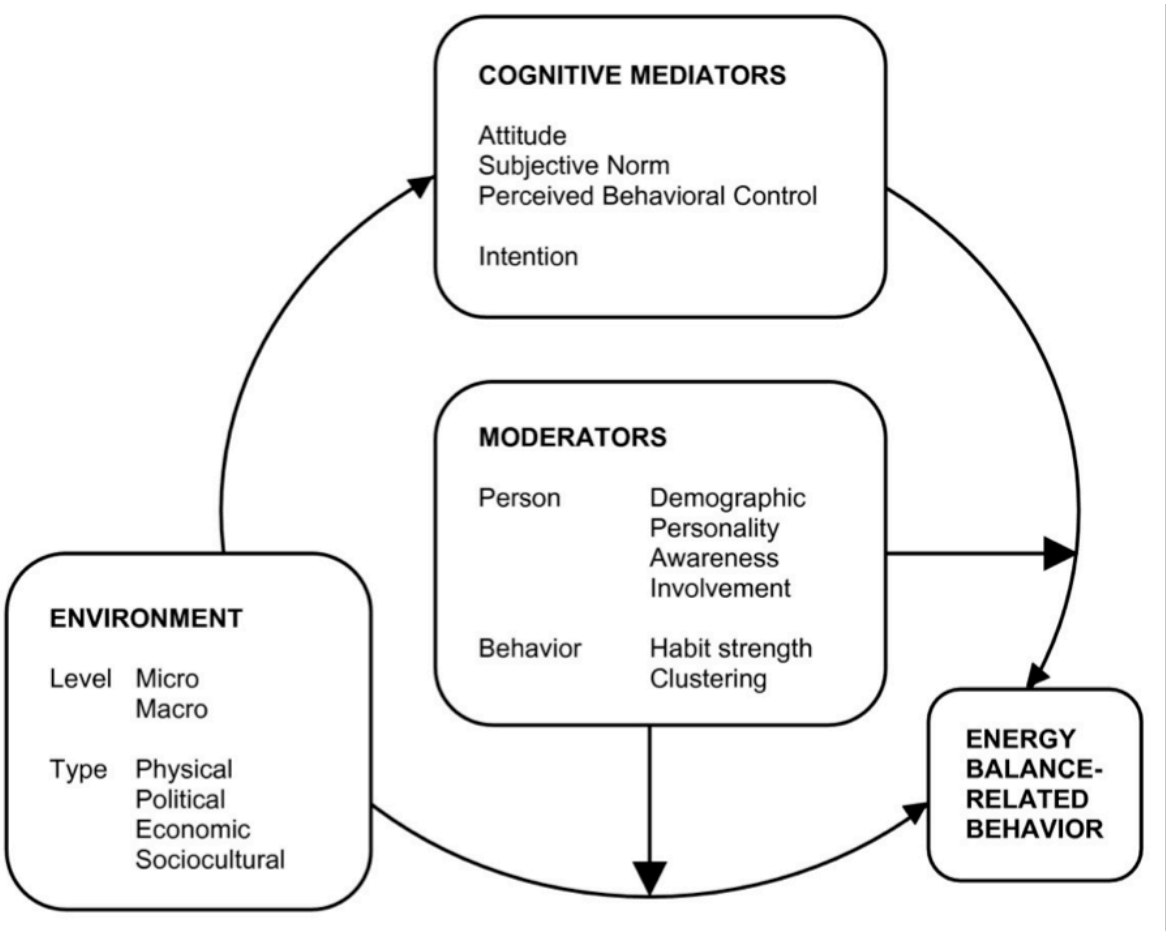

Figure 3: *Environmental Research framework for weight Gain prevention (EnRG).From Kremers SP, de Bruijn GJ, Visscher TL, van MW, de Vries NK, Brug J: Environmental influences on energy balance-related behaviors: a dual-process view. International Journal of Behavioral Nutrition and Physical Activity 2006, 3: 9. [32]*

For example, in a Belgian study in older adolescents perceived safety and access to recreational facilities were only associated with active transportation among adolescents with lower self-efficacy [33]. Another Belgian study found that in low income neighborhoods, walkability was positively related to children's walking for transportation during leisure time and was negatively related to children's sports during leisure time; whereas in high income neighborhoods, walkability was unrelated to children's physical activity (D'Haese et al. submitted).

In an Australian study it was found that parental moderate- to vigorous-intensity physical activity was positively associated with children's moderate- to vigorous-intensity physical activity, but only among children whose parents reported a high presence of sporting venues. Having more restrictive physical activity rules (e.g. 'My child must be supervised while playing outside') was negatively associated with children's weekday moderate- to- vigorous-intensity physical activity in neighborhoods with high perceived stranger danger [34].

These findings show the importance of targeting physical activity interventions to specific subgroups, as different physical environmental factors may have a different influence on the physical activity of different subgroups.

Also the ability of children to walk or cycle around their neighborhood without adult accompaniment (=independent mobility) can indirectly influence physical activity. In the UK, parental perceived lack of appropriate spaces to be active, safety, traffic, the proximity of friends and older children determined children's ability to walk or cycle around without adult supervision [35]. In a review study it was found that children's independent mobility, was positively related to their physical activity [36]. In a Belgian study, independent mobility mediated the relation between the parental perception of the neighborhood and physical activity in adolescent girls (De Meester et al., under review).

Neighborhood interventions can affect different age groups differently

People from different age groups live in the same neighborhood environment. Because neighborhood physical environmental interventions affect all inhabitants of a neighborhood, intervening in the physical environment may have opposite effects on children's and adults' physical activity.

For example, in adult studies it has been consistently shown that a higher street connectivity [37,38] and walkability [39] were associated with more physical activity. On the other hand, it was shown in children that street connectivity was negatively related to physical activity in the neighborhood [40]. As a neighborhood with low connectivity is characterized by few intersections and a lot of dead-end streets that reduce traffic volume, this results in safer streets to play in. Therefore, it seems logical that lower-connected neighborhoods are more activity friendly for children.

In Belgium, a cross-sectional study was conducted to investigate the relation between objectively measured walkability and physical activity in children (10-12 yr) and adults (20-65 yr). In Belgian children, only in low income neighborhoods, higher walkability was related to more walking for transportation during leisure and to less sports during leisure. In high income neighborhoods, walkability was unrelated to children's physical activity (D'Haese et al. submitted). In adults, objectively measured walkability was positively associated with accelerometer-based moderate- to vigorous-intensity physical activity, transport-related walking and cycling and recreational walking in both low and high income neighborhoods [41]. Therefore, the challenge for urban planners, intervention developers and policy makers is to develop neighborhoods that are activity friendly for different age groups. A possible solution is to create neighborhoods with a low connectivity for motorized transport, but with a high connectivity for walking and cycling by providing a lot of walk- and cycle tracks that are prohibited for motorized transport.

Neighborhood physical environmental interventions promoting children's physical activity

Physical environmental interventions in the neighborhood are usually conducted and lead by city councils. This makes it difficult for researchers to evaluate these interventions. Studies investigating the effect of neighborhood environmental changes on children's physical activity are scarce. On the contrary, interventions in the school environment are more frequently studied [42-46]. Until now, most neighborhood intervention studies focused on increasing the availability of play spaces (i.e. parks and playgrounds) for children. An Australian study investigated the effects of park improvements on park activity [47]. Park improvements (including the establishment of a walking track, a barbecue area, a playground,..) were positively associated with the number of park users, the number of people observed walking and being vigorously active [47]. Also in the US, park renovations appeared to increase visitation and overall physical activity in different age groups [48]. In a US study, an urban greenway/trail was retrofitted in a neighborhood to increase connectivity for pedestrians [49]. This study showed that an increase of the pedestrian connectivity lead to greater levels of physical activity in the neighborhood [49]. In the US, schoolyards were made available after school hours on week- and weekend days as a safe play

space for children and this led to an increase in children's physical activity [50]. Also in the US, the impact of playground renovations that were available for children outside school hours on their physical activity was investigated. It was found that children were more active at schools with renovated schoolyards compared to schoolyards in control schools [51,52].

Conclusion

As known from previous research, physical activity may have a positive influence on children's weight status. The physical environment can influence children's physical activity, which may in turn have a positive influence on children's weight status. Urban planners, policy makers and intervention developers should focus on creating activity-friendly environments for all age groups. Further research is necessary to determine which neighborhood environmental interventions might be effective at increasing children's physical activity.

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