Children, physical activity and the environment

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Children, physical activity and the environment: Opportunities for multi-sector policy

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Children, physical activity and the environment: Opportunities for multi-sector policy

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General introduction and study design

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Based on: Aarts MJ, Van de Goor LAM, Van Oers JAM, Schuit AJ. Towards translation of environmental determinants of physical activity in children into multi-sector policy measures: study design of a Dutch project. BMC Public Health 2009; 9:396.

Abstract

Background: Physical inactivity among children is a major health problem in The Netherlands as well as in many other Western countries. In addition to health promotion among parents and children, creating "activity-friendly" neighborhoods can contribute to the solution of this health problem. However, changing environmental characteristics is often the responsibility of policy sectors outside the public health domain. Therefore this project identifies and evaluates the possibilities of multi-sector policy measures to stimulate physical activity among children.

Methods and study design: The project consists of quantitative as well as qualitative research methods and is conducted in four medium-sized Dutch cities. To identify perceived environmental correlates of physical activity among children, a large scale health survey was conducted at 42 primary schools. Written questionnaires including topics on the children's physical activity behavior (i.e. sports participation, outdoor play, active commuting, television watching and computer usage) and physical and social environmental characteristics were completed by 6,601 parents of children aged 4-12 years old and 3,449 children aged 9-12 years old. In addition, 33 neighborhood audits (systematic observations) were conducted to assess objective neighborhood characteristics. Furthermore, a policy analysis was conducted in the four participating municipalities to provide an overview of the current local policy measures directed at stimulation of physical activity in children. Policy plans of six different policy sectors (public health, sports, youth and education, spatial planning, traffic and transportation, and safety) were screened for their content on physical activity in children. In addition, semi-structured interviews were conducted with policy makers of each of these sectors to identify current multi-sector policy initiatives, the role multi-sector collaboration herein and possible facilitators and challenges for multi-sector policy action aimed at stimulating physical activity among children. The results of all these research activities will be discussed with local policy makers during interactive workshop sessions in order to identify clear cut and feasible multi-sector policy measures that stimulate physical activity in children.

Conclusions: This paper describes the study design of a project that focuses on multi-sector policy measures that stimulate physical activity among children. Apart from extensive research into the environmental correlates of physical activity among children, much emphasis is placed on the translation of the research outcomes into concrete and feasible policy plans.

Background

Lack of physical activity among youth: the role of the environment

Although The Netherlands is famous for its pedestrian and bicycle friendly infrastructure, lack of physical activity is a serious problem among the Dutch population. Not only is approximately 50% of all Dutch adults not as physically active as would be desirable for their health [1], also a great percentage of children is relatively inactive. Only a quarter of the Dutch primary school children meets the recommended guidelines for physical activity as stated by the Dutch health authorities, which encompasses at least 60 minutes of moderate physical activity for at least 5 days per week [2]. One study conducted in deprived Dutch neighborhoods even showed that only 3% of the children who lived there met the recommended guidelines [3]. Hence, the vast majority of the Dutch children is not sufficiently involved in regular physical activity, particularly those living in deprived areas.

Besides the increased risk of developing overweight and obesity, an inactive lifestyle during youth increases the risk for the development of cardiovascular disease, hypertension, diabetes, psychosocial problems and a poor development of motor skills [4, 5]. Particularly when the inactivity is maintained on a lifetime basis, the health consequences may be severe. It is therefore of major importance to find appropriate ways to stimulate physical activity in children.

Until recently, most Dutch prevention initiatives have focused on health education among children and their parents, often in a school based setting. Several teaching programs and other school-based physical activity programs for primary and secondary schools have been developed to create awareness among teachers, parents and children for the benefits of an active lifestyle and for the opportunities to be physically active. Some of these interventions are based on behavioral change theories, take into account the school environment and have been evaluated on their effectiveness in getting children more physically active [6-8].

Nowadays, progressively more attention is drawn to the influences of environmental characteristics on children's physical activity level. Numerous studies addressing the role of physical as well as social environmental determinants in physical activity behavior of adults and youth are conducted in North America [9-14] or Australia [15-17]. An overview of potential environmental determinants of physical activity specific for youth is given recently by Ferreira et al. [18]. Next to potential environmental determinants at the home level and at the school level this review includes a limited number of potential determinants at the neighborhood

level. In contrast with some home and school level characteristics such as father's physical activity level and school physical activity policy, there was no clear relationship found between physical and social neighborhood characteristics and children's physical activity level. For example access to or availability of physical activity facilities or programs, neighborhood hazards (such as dangerous traffic situations), and social safety were consistently unrelated to children's physical activity. Due to the limited number of studies addressing other neighborhood characteristics such as distance to destinations, available shelter / food path conditions, neighborhood physical disorder and neighborhood social disorder, no conclusions could be drawn regarding their relationship with physical activity. These findings emphasize the need for more research into the influence of neighborhood characteristics on children's physical activity level.

Moreover, only 13.5% of the studies that were included in the abovementioned review were situated in Europe. Because the European environmental setting may differ drastically from that in North America or Australia (e.g. in terms of street pattern, traffic situation, sports and play facilities, social or societal structure, etc.) it is of great importance to gain more insight in potential environmental determinants of physical activity in children at a national or even local level.

It can be concluded that lack of physical activity among children is a complex problem which needs an integrative approach, aimed at individual as well as environmental characteristics [19]. This research project will focus on the environmental correlates of physical activity and the role of local policy measures herein, which will be expounded below.

The need for evidence based multi-sector policy actions

The importance of environmental determinants of healthy behavior in general, and more specifically physical activity among children, is recognized by the national government in The Netherlands. In the National Memorandum on Overweight from the Ministry of Health, Welfare and Sport [20] it is stated that a healthy local environment is essential for long-lasting successful prevention of obesity. According to the Memorandum, local governments (such as municipalities), play a crucial role in creating a healthy environment i.e. "making the healthy choice the easy choice".

Effectively addressing physical as well as social environmental determinants of physical activity in children, is for a large part dependent on policy measures outside the public health domain. For example sports, youth and education, spatial planning, traffic and transportation and safety can all contribute to a more activity-

friendly environment for children [21, 22]. Working across sectors towards a coherent policy plan for stimulating physical activity in children, is therefore considered necessary.

In The Netherlands, most municipalities do recognize the benefits of such an approach, but local policy makers still find it challenging to develop and implement such multi-sector policy plans. Information about facilitators and challenges in multi-sector collaboration is particularly found in so-called "grey literature" [23]. Effectiveness of multi-sector policies is hard to measure [24] and is for instance dependent on which sector takes the initiative, the point in time or policy process in which the collaboration is started, the basis of support for the multi-sector initiative, the amount of resources and manpower available, the existence of shared (policy) goals and the availability of (scientific) information regarding the potential effectiveness of multi-sector policies [25]. Multi-sector policy plans are more effective when the actors involved share common interests and conflicts of interests are absent. The presence of key figures or "policy entrepreneurs" and structural and long term multi-sector collaboration can also increase the potential success of multi-sector policies [26].

Little scientific publications however are available about facilitators and challenges in multi-sector policy development and implementation. Better understanding of success factors and barriers in multi-sector policy development can contribute to an integral and long term approach in tackling physical inactivity among youth.

Although highly potent in improving children's physical activity level in large populations, redesigning neighborhoods and structurally improving opportunities and facilities for active living, can be very costly. It is therefore utterly important to have scientific evidence underpinning possible multi-sector policy measures, i.e. to develop evidence based policy plans at the local level. Several studies however show that scientific knowledge only plays a modest role in the policy development process and governmental decision making [27]. This project therefore specifically focuses on the translation of scientific research results into feasible and concrete multi-sector policy measures.

Aim of the project

The aim of the project is to identify, describe and test the feasibility of concrete multi-sector policy measures to stimulate physical activity in children in a concerted

action between researchers and policy makers. The data collection of the project consists of four major parts:

1. A health survey among primary school children and their parents to identify perceived environmental correlates of physical activity among children;
2. Neighborhood audits to identify objective environmental correlates of physical activity among children by means of systematic observations;
3. Policy analysis of the current local policy situation regarding environmental correlates of physical activity among children in four municipalities to identify promising possibilities for a multi-sector approach;
4. Interactive workshop sessions with local policy makers to identify clear cut and feasible multi-sector policy measures that stimulate physical activity among children.

The goal of the first two parts is to identify the environmental determinants of children's physical activity behavior and to map the current policy situation. The last two parts of the project is aimed at translation of the data collected in the first two parts into concrete multi-sector policy actions at the local level. The ultimate goal of the research project is to provide scientific support for local policy makers in developing multi-sector policy measures to stimulate physical activity among children. Quantitative as well as qualitative methods are combined in this project and the different parts of the project will be described in more detail below.

Methods and study design

Study setting

At the start of the project in October 2006, five municipalities were approached for participation in the project by letter and were given more detailed information during a personal meeting. The municipalities were selected based on their similarities in population size and composition. Moreover, these cities were chosen from the service domain of the Regional Public Health Services which in turn are cooperating in the Academic Collaborative Center Public Health of Tilburg University. Academic Collaborative Centers are proposed to contribute to bridging the gap between science, practice and policy in public health [28]. The Regional Public Health Services are the regular advisors of municipalities in public health affairs and their expertise and contacts in the field were utilized to recruit the municipalities

for the research project. Due to lack of time and interest in the topic, one municipality decided not to participate. Hence, the research project was conducted in four medium-sized cities in The Netherlands (to guarantee complete anonymity, city names are blinded). Although the project was not initiated by the municipalities themselves, they declared to be interested in the topic and willing to cooperate in the project. No financial or other obligations or compensations were asked from or given to the municipalities in order to participate in the project.

Table 1.1 summarizes the main characteristics of the four cities that were enrolled in the study. This table indicates that, although there are some differences between the cities, the four municipalities show much resemblance regarding size and composition of their population.

Table 1.1: Population characteristics of municipalities included in the study [a]

Municipality	A	B	C	D	The Netherlands
Total number of inhabitants	201,259	170,349	135,648	77,450	16,357,992
Degree of urbanization (number of inhabitants per km^2)	1,716	1,344	1,606	727	394
Percentage of inhabitants aged 0 - 14 years (%)	16.7	17.3	17.2	17.6	18.1
Percentage Western immigrants [b] (%)	8.2	10.0	8.6	8.7	8.8
Percentage non-Western immigrants [c] (%)	13.4	10.2	9.9	11.9	10.6
Number of municipal employees	1,915	2,189	1,430	679	NA

[a] Characteristics per 01-01-2007. All data derived from CBS Statline [2], or the municipal organization (for number of employees); [b] Immigrants are defined as persons with at least one parent born in a foreign country. Western immigrants are all immigrants from Europe (with exception of Turkey), North-America, Oceania or Indonesia or Japan; [c] Immigrants are defined as persons with at least one parent born in a foreign country. Non-Western immigrants are all immigrants from Turkey, Africa, Latin-America or Asia (with exception of Indonesia and Japan); NA = Not applicable.

Target population

The project is targeted at primary school children age 4-12 years. The influence of environmental characteristics may be especially important for younger children, who have less autonomy to travel long distances by themselves and therefore are more dependent on their direct environment [29, 30]. Secondly, because childhood obesity is shown to track into adulthood [31] the benefits of an active life style are greater when physical activity is introduced at an early age and is maintained throughout the entire life span.

Health survey

To identify the correlates of physical activity among children, a large scale health survey was conducted among primary school children (age 4-12) and their parents. With exception of those schools that were known to be already participating in another (research) project aimed at physical activity in children (n = 34), all regular primary schools (n = 149) of the four municipalities were invited by letter and thereupon by telephone to participate in the survey. Approximately one third of all invited schools (n = 42) agreed on participation. Table 1.2 shows the distribution of the participating schools among the four cities and the average number of pupils per school. Average school size was 255 pupils per school, which was somewhat higher in municipality A due to inclusion of 2 schools with more than 500 pupils.

Table 1.2: School recruitment and school size in the four participating cities

Municipality	A	B	C	D	Total
Total number of schools	49	35	43	22	149
Number of schools included in the survey	13	13	8	8	42
Percentage of schools included in the survey (%)	26.5	37.1	18.6	36.4	28.2
Average school size of schools enrolled in the survey (number of pupils)	310	252	248	231	255

The schools were scattered geographically among the four cities, varying in location from mid-centre to the periphery. As indicator for physical (or "built") environment, a measure of the Ministry of Housing, Spatial Planning and the Environment was used, which categorizes postal code areas as either "city centre", "city non-centre", "city green", "town centre", "rural area" or "work area" [32]. From table 1.3 it can be concluded that the study sample is a good reflection of the total population of schools in the four cities. Although more than 50% of the included schools are classified as "city non-centre", this does not imply that these neighborhoods are very similar with regard to their physical environmental characteristics. In fact, there are large differences in for example, type of buildings, traffic situation and sports facilities.

As an indicator for social environment, we used a measure from The Netherlands Institute for Social Research which is called "status score" and is based on percentage immigrants, percentage people with low education and percentage low income households per postal code area [33]. Low status scores correspond with high socio-economic status. As shown in table 1.4, there is great variety in socio-economic status of the schools' neighborhoods, as indicated by status score. Schools from lower socio-economic neighborhoods (as indicated by a high status score) were somewhat underrepresented in our study sample, because these

schools were relatively often involved in other projects aimed at promotion of physical activity in children, and therefore less willing to participate. Nonetheless, we succeeded to include almost 10% of the total number of schools in the lower socio-economic neighborhoods in our health survey.

At each school willing to participate, all grades and classes were included in the study. As indicated in figure 1.1, the children of all grades (grade 1 to 8, corresponding with age 4-12 years old) were given a questionnaire to take home for their parents. The children of the highest grades (grade 6, 7 and 8, corresponding with age 9-12 years old) were also asked to fill in a questionnaire themselves during class hours.

Table 1.3: School's characteristics: built environment

	Number of participating schools	Percentage (%)	Total number of schools	Percentage (%)
City centre	3	7.1	10	6.7
City non-centre	24	57.1	82	55.0
City green	14	33.3	53	35.6
Town centre	0	0.0	0	0.0
Rural area	1	2.4	4	2.7
Work area	0	0.0	0	0.0
Total	42	100.0	149	100.0

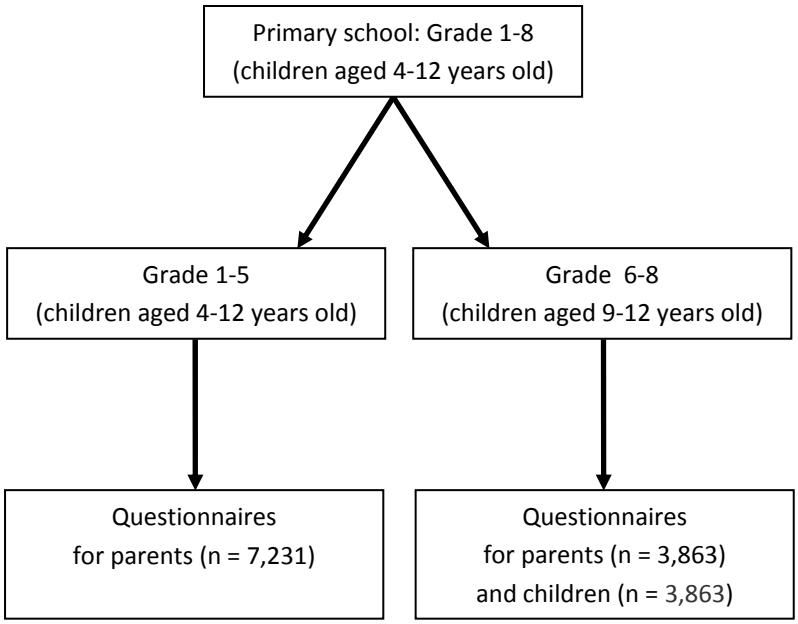
Table 1.4: School's characteristics: socio-economic status [a]

	Number of participating schools	Percentage (%)	Total number of schools	Percentage (%)
Schools with status score < -2	5	11.9	14	9.4
Schools with status score from -2 till -1	10	23.8	32	21.5
Schools with status score from -1 till 1	12	28.6	40	26.8
Schools with status score from 1 till 2	11	26.2	40	26.8
Schools with status score > 2	4	9.5	23	15.4
Total	42	100.0	149	100.0

[a] High status score values represent low socio-economic status.

The health survey was conducted between September 2007 and January 2008. In total, 3,863 children (age 9-13 years old) and 11,094 parents of children aged 4-12 years old of 42 schools, were asked to fill out a questionnaire. Assuming a response rate of 50% and ICC = 0.06 representing the clustering of the data within schools, the effective sample sizes reduce to 522 children and 626 parents [34]. The power to detect a small effect f2 = 0.02 in a multiple regression analysis at $\alpha = 0.05$ with 35 predictors, given these sample sizes, equals 0.90 and 0.94 for the children's and parent's data, respectively. The power analyses were performed using G*Power 3 [35].

Figure 1.1: Survey design at primary schools



Because no medical or physical measurements were conducted and considering the negligible (psychological) burden for children to fill in the questionnaire, no ethics approval was required (according to the Dutch Central Committee on Research investigating Human Subjects). Children were given written and verbal information about the survey in class and were free to renounce from participation without giving any reason. Parents were given written information about the study and by returning the completed questionnaires, parents gave their consent for inclusion of their data in the data base. Parents were offered the opportunity to object to the inclusion of their child's questionnaire as well by a pre-printed objection letter. Parents of 71 children objected against the inclusion of their child's questionnaire in the data base, in those cases the child's questionnaire was destructed. All questionnaires were distributed and collected completely anonymous.

Separate questionnaires were developed for parents and children. The questionnaires were based on questionnaires that were used in other large scale research projects in the Netherlands (results not yet published at the start of this research project) but refined to fit the specific research questions of this project. The questionnaires were pre-tested in a pilot sample of parents and children which lead to some small adjustments with respect to the formulation of the questions.

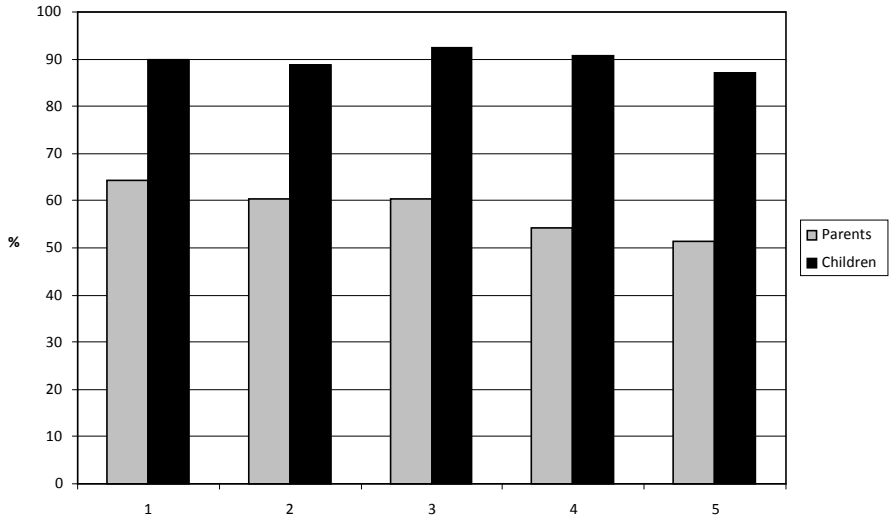
The questionnaire for the parents included questions on the child's physical activity habits (e.g. sports participation, active commuting to and from school, outdoor play and inactive leisure time activities such as television watching and computer usage), topics on the physical environment (e.g. outdoor play opportunities, sports facilities, distance to other facilities, public space design, traffic safety, street pattern, type of buildings) as well as the social environment (e.g. social cohesion, area deprivation, social safety, financial barriers for sports participation). In addition to these environmental characteristics there were also questions about the home environment (household composition, family customs and norms, number of electronic devices and cars in household, support by parents / siblings / peers). Individual factors (such as income, education level and work situation of the parents, ethnicity, age, gender and body mass index (BMI) of parents and children and overall health of the child) as well as some additional questions about eating and sleeping habits were also included.

The questionnaire for the children covered roughly the same topics, but was less elaborate and did not include questions on the socio-economic status of the parents. Especially for older children, who are less parent dependent for their mobility, the views and opinions about environmental characteristics that enhance or hamper physical activity may deviate from their parent's viewpoints. By administering questionnaires among both parents and children, the perception of the neighborhood characteristics of parents can be compared with that of their children. To prevent parental influences on the answers given, children completed the questionnaire during school time.

Finally, the survey also included a questionnaire that was filled in by the management of each of the 42 participating schools. This questionnaire included topics on the physical education program at school, the physical activity policy program, schoolyard play opportunities and traffic situation around the school. This questionnaire will be used to assess school environmental characteristics and school policies related to children's physical activity level.

The overall response on the questionnaires was high: on average 60% of the parents completed and returned the questionnaire and 90% of the children completed the questionnaire. Also, the management of each participating school completed the questionnaire. Figure 1.2 shows that the response of parents was somewhat lower in the lower socio-economic schools, most probably partly due to language difficulties.

Figure 1.2: Response rates of parents and children by school's socio-economic status [a]



1 = Schools with status score < -2; 2 = Schools with status score from -2 till -1; 3 = Schools with status score from -1 till 1; 4 = Schools with status score from 1 till 2; 5 = Schools with status score > 2; [a] High status score represents low socio-economic status.

Neighborhood audits

In addition to the perceived environmental characteristics as measured in the health survey, neighborhood characteristics were also objectively measured by means of neighborhood audits consisting of standardized observations. Previous studies show that perceived environmental characteristics can deviate from objectively measured environmental characteristics [9]. It is therefore important to gain insight in both the objective as well as the perceived environmental characteristics.

During the audits, neighborhoods were observed systematically by two research assistants with a standardized scoring form that was developed specifically for screening Dutch neighborhoods on environmental characteristics relating to children's physical activity behavior [3]. The scoring form included the following topics: type of residences, outdoor play opportunities, sports facilities, public spaces, green and water, street pattern, traffic safety and area deprivation.

Although the scoring form was used and described before [36], this was the first time the measurement tool was used on a larger scale (33 neighborhoods) and some improvements in the operation instructions were carried through to enhance reproducibility of the measurement tool. Firstly, the neighborhood's boundaries were identified more explicitly and based on municipal information, which makes

the outcomes of the observations easier to interpret and implemented by the local policy makers. Secondly, in stead of just walking through the neighborhoods according to a route chosen by the observers during the audit, a random sample of 10% of all of the streets in one neighborhood was selected for observation in advance (according to another Dutch neighborhood observation protocol developed by Van Lenthe et al.[37]). All remaining streets were observed whenever possible, considering that the mean duration of one neighborhood observation was approximately 3 hours. Lastly, all observations were carried out during normal school days after school time and before dark, to mimic best the real conditions under which children are generally physically active in their neighborhood.

In total, 33 neighborhoods were selected for observation, covering a large part of the total study population (39% of parents and 38% of the children that filled in a questionnaire were living in one of the observed neighborhoods, neighborhoods were selected for audit only in case their residents were also included in the health survey). Because the neighborhood observations were conducted between October and December 2008 (autumn), weather conditions were also monitored.

Policy analysis

To map the local policy conditions in the four participating municipalities, a qualitative policy analysis was conducted between February and May 2009. The aim of this policy analysis was to map the current multi-sector initiatives aimed at physical activity in children and to identify facilitators and challenges in multi-sector policy action to stimulate physical activity in children. Although collaborations with private parties outside the municipal organization (such as sports clubs or housing corporations) are very common and can also have beneficial effects on the integrated approach of stimulating physical activity, this was not taken into account; the policy analysis merely focuses on policy initiatives that involved more than one municipal policy sector.

Six policy sectors that have a potential influence on children's physical activity behavior were selected: public health, sports, youth and education, spatial planning, traffic and transportation, and safety. From each of the sectors, official policy documents (such as memoranda) were collected and screened on their content relating to the prevention of overweight or obesity, stimulation of physical activity, or influence on possible environmental correlates related to physical activity. Moreover, it was examined if the documents referred explicitly to physical activity in children and if the policy plans for promoting physical activity were mentioned to

be from a multi-sector point of view (in other words, if other municipal sectors were involved in the development or realization of the policy plans). In total 29 policy documents were screened on their content.

In addition to the document analysis, one policy maker of each sector per city was interviewed using a semi-structured interview protocol including the following topics: multi-sector policy initiatives aimed at creating activity-friendly environments for children, network participants, collaboration structure and relations, and facilitators and challenges for multi-sector policy action. This yields more insight into the actual realization of policy plans described in policy documents, the role of multi-sector collaboration herein, and facilitators and challenges in multi-sector policy development as perceived by the actors. Because respondents were interviewed independently of each other, viewpoints of different sectors could be identified.

Interactive workshop session with local policy makers

In the development and implementation of policy plans and measures, scientific knowledge is only one source of information. Other sources of influence, such as experience and expertise, judgment, resources, values and political context, habits and tradition, lobbyists and pressure groups, may also play an important role in the policy development process [27]. Moreover, Armstrong et al. suggest that the utilization of scientific knowledge is sector-specific and that the use of scientific research results is more common in the public health sector than in other sectors. Because this research project specifically addresses the opportunities for multi-sector policy measures, much emphasis is placed on the translation of the results of the first part of the project into concrete and feasible policy measures during workshop sessions with policy makers.

The research described above will yield valuable insight into the environmental correlates of physical activity among children and into the current policy plans addressing these determinants. Also, insight is acquired regarding the facilitators and challenges in the development and realization of multi-sector policy plans on a local level. In order to translate these research outcomes into concrete and feasible policy measures, each municipality is offered an semi-structured workshop session (in the form of a Delphi study) in which policy makers of different sectors participate.

Outline of this thesis

Table 1.5 gives an overview of the data collection in the project and the corresponding chapters in this thesis. The first part of this thesis will focus on the environmental correlates of physical activity among children. In **Chapter 2**, the relation between environmental determinants and outdoor play among children is described and **Chapter 3** focuses on the environmental correlates of active commuting to school among children. Both chapters are based on environmental characteristics as perceived and reported by parents (health survey data). **Chapter 4** addresses the relation between objectively measured neighborhood characteristics and outdoor play among children based on the neighborhood audits. The second part of the thesis will focus on multi-sector policy opportunities to create activity-friendly environments for children. **Chapter 5** gives a description of the current policy situation in four Dutch municipalities regarding the multi-sector approach to create activity-friendly environments for children. **Chapter 6** elaborates on the feasibility on local multi-sector policy measures to stimulate physical activity among children, based on the data derived from the interactive workshop sessions with local policy makers (Delphi study). Finally, the major findings of the project and the possible implications for research and policy are discussed in the general discussion **(Chapter 7)**.

Table 1.5: Overview of data collection

	Setting / Subjects	Period	Goal	Methods	Corresponding chapter in thesis
Health survey	6,601 parents and 3,449 children of 42 primary schools in four cities	Sept 2007 – Jan 2008	Obtain information about perceived environmental characteristics in relation to children's physical activity level.	- Questionnaires for parents - Questionnaires for children [a] - Questionnaires for school management[a]	Chapter 2 and 3
Neighborhood audits	33 neighborhoods in four cities	Oct 2008 – Dec 2008	Obtain objective data on neighborhood characteristics in relation to children's physical activity level.	- Neighborhood audits using a standardized observation protocol	Chapter 4
Policy analysis	29 policy documents and interviews with policy makers from six different policy sectors in four cities	Feb 2009 – May 2009	Obtain an overview of current policy situation and facilitators and challenges in multi-sector policy action.	- Document analysis of six different policy sectors [a] - Interviews with local policy makers of six different policy sectors	Chapter 5
Workshop sessions	policy makers from six different policy sectors in four cities	April 2010	Assess feasibility of concrete multi-sector policy measures on an local level that en-hance physical activity among children	- Delphi study among local policy makers of six different policy sectors	Chapter 6

[a] These parts of the research project will not be described in this thesis.

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PART 1:

ENVIRONMENTAL CORRELATES OF PHYSICAL ACTIVITY AMONG CHILDREN

CHAPTER 2

Environmental correlates of outdoor play among children

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Abstract

Background: Outdoor play is a cheap and natural way for children to be physically active. This study aims to identify physical as well as social correlates of outdoor play in the home and neighborhood environment among children of different age groups.

Methods: Cross-sectional data were derived from 6,470 parents of children from 42 primary schools in four Dutch cities by means of questionnaires (2007–2008). Multivariate sequential Poisson GEE analyses were conducted (2010) to quantify the correlation between physical and social home and neighborhood characteristics and outdoor play among boys and girls aged 4–6, 7–9 and 10–12 years old.

Results: This study showed that next to proximal (home) environmental characteristics such as parental education (RR 0.93–0.97), the importance parents pay to outdoor play (RR 1.32–1.75) and the presence of electronic devices in the child's own room (RR 1.04–1.15,), several neighborhood characteristics were significantly associated with children's outdoor play. Neighborhood social cohesion was related to outdoor play in five out of six subgroups (RR 1.01–1.02), whereas physical neighborhood characteristics (e.g. green neighborhood type, presence of water, diversity of routes) were associated with outdoor play in specific subgroups only.

Conclusions: Neighborhood social cohesion was related to outdoor play among children of different age and gender, which makes it a promising point of action for policy development. Policies aimed at improving physical neighborhood characteristics in relation to outdoor play, should take into account age and gender of the target population.

Background

As in many other Western countries, the majority of primary school children in the Netherlands does not meet the recommended health guidelines for physical activity [1]. Because of the health risks related to physical inactivity [2, 3], it is important to find appropriate ways to stimulate physical activity in children. A natural way for children to be physically active is by means of outdoor play. Time spent outdoors is consistently related to children's physical activity level [4-10] which is increased during outdoor play [11]. Moreover, in contrast to organized sports participation, outdoor play is cheap, informal and easily accessible [12].

Social cognitive theories state that, next to individual characteristics, environmental characteristics play a role in health behavior such as children's physical activity [13-15]. For example the neighborhood area available for recreation is positively related to physical activity in children aged 4 to 7 years [16]. Low-walkable lollipop-style neighborhoods tend to be beneficial for outdoor play among children aged 6–12 [17]. Conversely, road safety and "stranger danger" are two major sources of parental concern that may inhibit children's outdoor play [18]. Furthermore, social factors are even more important predictors of time spent outdoors among children aged 5–6 and 10–12 years, then the built environment [9].

Most studies on the abovementioned topics are conducted in the USA or Australia and cannot be easily extrapolated to Europe. One Dutch study showed that physical activity was related to the built environment among children aged 6 to 11 years [19], but this study did not address social environmental characteristics. Furthermore, different environmental characteristics may be related to physical activity behavior in children of different age groups. Younger children for example, have less autonomy to travel long distances by themselves and they may experience other environmental barriers or impetuses to be physically active than older children [20, 21]. Special attention should therefore be given to the role of different environmental correlates of outdoor play among children of different age groups.

The aim of this study is to identify physical as well as social correlates of outdoor play in the home and neighborhood environment of children of different age groups (4–6, 7–9 and 10–12 years).

Methods

Study Setting

Cross-sectional data were collected between September 2007 and January 2008 from parents of children of 42 primary schools in four medium sized Dutch cities in the Southern part of the Netherlands, which were comparable regarding the number of inhabitants (77,450–201,259), degree of urbanization (727–1,716 citizens per km2) and composition of their population (e.g. percentage of non-Western immigrants 9.9–13.4%). The selection procedures and characteristics of the participating cities are described in more detail in the first Chapter of this thesis [22].

Study Population

Data were collected among parents of children aged 4–12 years. In the Netherlands, children in this age group attend primary school, which in most cases is close to or within the area of residence. With exception of those schools that were already participating in other (research) projects aimed at physical activity in children (n=34), all regular primary schools (n=149) in the four cities were invited by letter, followed up by telephone to participate in the survey. Approximately one third of all invited schools agreed to participate (n=42). As outlined in Chapter 1 of this thesis [22], the schools in our study were representative of the total population of schools in the participating municipalities in terms of school size, socioeconomic status and the type of neighborhood.

In total 11,094 parents were provided with a questionnaire. Because no medical or physical measurements were conducted and considering the negligible (psychological) burden to fill in the questionnaire, no ethics approval was required according to the Dutch Central Committee on Research investigating Human Subjects. Parents were given written information about the study and by returning the questionnaire they gave consent for the inclusion of their data in the study. Response rate was 60%, resulting in 6,624 completed and returned questionnaires. During data entry, 12 questionnaires could not be read and 11 questionnaires were removed because they were completely empty. Questionnaires were excluded from further analyses because of missing values on age or gender of the child (n=14) or outdoor play (n=82). Furthermore, questionnaires of children living more than three days per week on another address than the address described in the

questionnaire were removed (n=35). The final data base thus encompassed 6,470 respondents. Based on our power analysis described in the first Chapter of this thesis [22], our study provided adequate power to detect small effects (f 2 = 0.02).

Questionnaire

The questionnaire for parents was based on questionnaires used in previous Dutch research [23] and included the following topics: time spent by the child on outdoor play and several physical and social environmental characteristics in the home and neighborhood environment. In addition, parental socio-economic status (education, income, ethnicity) and height and weight of the child were reported by parents. Throughout the questionnaire "neighborhood" was defined as the area that could be reached by parents in 10 to 15 minutes by foot or in 5 to 8 minutes by bike from the respondent's residence (street network distance). This matches the general perception of a typical Dutch neighborhood and -in comparison with distances in meters- distances in minutes are more easily interpreted by the respondents [24, 25]. Furthermore, these distances are reasonable for parents to accompany their children for the purpose of outdoor play.

Measures

In all analyses, the dependent variable outdoor play (minutes per week) was calculated by multiplying the number of days per week the child was involved in outdoor play (considering a typical week in the past month) by the minutes per day the child was involved in outdoor play (exact formulation is given in appendix A). Besides the type of neighborhood and neighborhood socio-economic status which were based upon pre-existing data bases linked to the respondent's postal code [26, 27], all independent variables were reported by parents (exact formulation / calculation is given in appendix A). BMI of the children was calculated and percentage of children with overweight and obesity (as determined by age and gender specific cut off points [28]) was determined.

Statistical Analyses

Analyses were conducted in 2010 and were reported separately for boys and girls in age groups 4–6, 7–9 and 10–12 years. Descriptive analyses were conducted with

SPSS 16.0 (Chicago, Illinois). Conceptually related items were summed when internal consistency was acceptable (Cronbach's alpha > 0.6), otherwise items were treated separately. Missing values were not imputed, unless it concerned a missing value on one of the items of a sum score consisting of more than four items. In that case, the missing value was replaced by the mean of the other values. If more than one item was missing within one sum score, the sum score was not calculated. ANOVA and χ^2 tests with Bonferroni post hoc correction were performed to assess differences ($p < 0.05$) in subjects' characteristics between boys and girls within each age group. Multivariate regression analyses were conducted with SAS 9.1 (Cary, North Carolina). In order to correct for non-normality of the dependent variable and its error terms and since the outcome measure was a count variable, Poisson distribution was applied [29, 30]. As a consequence, exponents of the original regression coefficient estimates were calculated and interpreted as relative rates (RR). The relative rate is interpreted as the decrease or increase in the amount of time children spend on outdoor play, as the independent variable increases with one unit. Hence, a RR of 1.10 indicates an increase of 10% in outdoor play as the environmental characteristic increases with 1 unit. A RR of 0.90 likewise indicates a decrease of 10%. Due to the Poisson analysis, the proportion of explained variance could not be reported. All analyses were adjusted for parental education as indicated by highest completed education of the parent who filled in the questionnaire, in the majority of cases this was either the biological mother (81.5%) or father (11.3 %). Parental education is considered a good indicator for socio-economic status in The Netherlands [31, 32]. Because data were collected via primary schools, and outdoor play shows clustering within schools (intraclass correlation = 0.06, F-value = 14.66, p-value < 0.001), Generalized Estimating Equations (GEE) analysis with school as clustering variable was applied in order to correct for the multilevel structure of the data [33, 34].

In order to quantify the association between the environmental determinants and outdoor play when adjusted for the other environmental determinants, a forward sequential GEE analysis was performed. In a sequential analysis, variables enter the equation in a theory-based order [35]. It was assumed that the proximal (home) environment is more closely related to children's physical activity than distal (neighborhood) environment. Based on previous research it was assumed that social environmental characteristics are more important than physical environmental characteristics [9]. Hence, the first step of the sequential analysis focused on parental education as a covariate. During the second step, a block of proximal (home) social variables was added to the model, followed by the third step introducing of a block of proximal (home) physical variables. Subsequently,

during the fourth step, a block of distal (neighborhood) social variables was added to the model, followed by the fifth step comprising the introduction of a block of distal (neighborhood) physical environmental characteristics. In order to prevent important variables to be excluded from the model in a forward analysis too easily, a more liberal probability level of $p > 0.15$ was chosen to decide upon deletion of variables from the model [35, 36]. The sequential GEE analysis ended when all variables in the model reached statistical significance. In the final multivariate models, only those variables with a p-value < 0.05 are shown. Prior to entry into the multivariate models, correlations between independent variables were computed and variables with a correlation of $r > 0.5$ were excluded from the analyses in order to prevent collinearity.

Results

The characteristics of the study population are summarized in table 2.1. There were no significant differences in characteristics between boys and girls of the same age groups, except for time spent on outdoor play, which was higher for boys compared to girls in the age groups 7–9 and 10–12 years (p-value = 0.0000).

The results of the forward sequential GEE analyses are summarized in table 2.2. Parental education was negatively associated with outdoor play in all subgroups (relative rates ranging from 0.93 to 0.97).

Proximal Social Variables

Importance parents pay to outdoor play was positively associated with outdoor play in all subgroups (relative rates ranging from 1.32 to 1.75), but the presence of rules in the household and the number of siblings were not significantly associated with outdoor play.

Proximal Physical Variables

Living in a semi-detached or duplex residence was positively associated with outdoor play among boys aged 4–6 years (RR = 1.18 and living in a detached residence was negatively associated with outdoor play in girls aged 4-6 (RR = 0.86). Living in a flat or apartment was negatively associated with outdoor play among girls aged 4–

6 (RR = 0.73) and boys aged 10–12 (RR = 0.77). Living in a rental property was positively associated with outdoor play among boys aged 4–6 (RR = 1.15) and absence of a garden was positively associated with outdoor play in girls aged 4-6 (RR = 1.13) but negatively related to outdoor play in girls age 7–9 (RR = 0.75). Presence of an electronic device in the child's own room was positively related to outdoor play in the highest age groups among boys (RR = 1.15 and 1.12 for boys aged 7-9 and 10-12 respectively) and girls in all age groups (RR = 1.04, 1.13 and 1.14 for girls aged 4-6, 7–9 and 10–12 respectively).

Distal Social Variables

Neighborhood socio-economic status was significantly related to outdoor play in boys aged 4–6 (RR = 1.05), girls aged 4–6 (RR = 1.07) and girls aged 7–9 (RR = 1.07) indicating that a higher socio-economic status was related to less outdoor play. The degree of unoccupied houses was positively associated with outdoor play in boys aged 10–12, and the presence of dog dirt was positively associated with outdoor play in girls aged 4–6 (RR = 1.03). Social safety was positively related to outdoor play in boys and girls aged 4–6 (RR = 1.02 and 1.01 respectively) and social cohesion was positively related to outdoor play in five out of six subgroups (relative rates ranging from 1.01 to 1.02). Satisfaction with social contacts was not related to outdoor play in any of the subgroups.

Table 2.1: Characteristics of the study population [a]

	Age 4-6 years [h]		Age 7-9 years		Age 10-12 years [h]	
	Boys (n=1,067)	Girls (n=1,106)	Boys (n=1,239)	Girls (n=1,144)	Boys (n=937)	Girls (n=977)
Age in years	5.0 (0.83)	5.0 (0.81)	8.0 (0.81)	8.1 (0.82)	10.7 (0.71)	10.7 (0.71)
BMI [b] in (kg / m^2)	15.4 (1.98)	15.3 (2.07)	16.2 (2.68)	16.2 (2.58)	17.5 (3.05)	17.4 (2.82)
Percentage overweight (%) [c]	7.5	9.2	9.4	12.6	9.9	9.9
Percentage obesity (%) [c]	3.7	3.5	3.1	3.2	2.2	2.2
Ethnicity (% immigrants) [d]	23.3	21.7	22.1	26.1	23.6	24.6
Parental education:						
- Low (%) [e]	25.8	24.8	27.3	28.9	33.1	33.6
- Intermediate (%) [f]	35.8	38.1	34.8	35.1	34.1	33.5
- High (%) [g]	38.4	37.0	38.0	35.9	32.9	32.9
Net household income (Euros per month)	2,780 (1,291)	2,882 (1,391)	2,839 (1,327)	2,734 (1,395)	2,727 (1,386)	2,642 (1,335)
Outdoor play in minutes per week	417 (271)	390 (260)	449 (287) *	396 (272) *	443 (294) *	373 (291) *

[a] Values are mean (SD), unless otherwise specified; [b] Based on parental self report of height and weight of their child; [c] Based on age and gender specific cut off points as provided by Cole et al. [28]; [d] Percentage of children with at least one biological parent not born in The Netherlands; [e] No education, primary education, lower general secondary education or lower vocational education; [f] Higher general secondary education, pre-university education or intermediate vocational education; [g] Higher vocational education or university; [h] In the Netherlands, children aged 4-12 years are educated together at the same primary school. In our study sample, 3 children in the lowest grade were 3 years and 14 children in the highest grade were 13 years. We included these children in the lowest (4-6) and highest (10-12) age group respectively; * $p < 0.05$ in ANOVA (continuous variables) or $\chi 2$ tests (categorical variables) with Bonferroni correction comparing means / percentages between boys and girls of the same age groups; SD = Standard deviation.

Table 2.2: Association between environmental characteristics and outdoor play for boys and girls: multivariate analyses [a]

	Age 4-6 years [e]		Age 7-9 years		Age 10-12 years [e]	
	Boys	Girls	Boys	Girls	Boys	Girls
Covariate						
Parental education	0.96 (0.95-0.98)	0.97 (0.94-0.99)	0.94 (0.92-0.96)	0.95 (0.92-0.97)	0.94 (0.91-0.97)	0.93 (0.90-0.96)
Proximal social variables						
Presence of rules in the household	-	-	-	-	-	-
Importance parents pay to outdoor play	1.44 (1.12-1.48)	1.75 (1.42-2.16)	1.75 (1.49-2.06)	1.34 (1.12-1.60)	1.32 (1.09-1.61)	1.51 (1.26-1.80)
Number of siblings	-	-	-	-	-	-
Proximal physical variables						
Type of residence: detached	-	0.86 (0.76-0.98)		-	-	-
Type of residence: semi-detached / duplex	1.18 (1.07-1.29)	-	-	-	-	-
Type of residence: corner house	-	-	-	-	-	-
Type of residence: flat / apartment	-	0.73 (0.59-0.89)	-	-	0.77 (0.59-0.99)	-
Type of residence: other [b]	-	-	-	-	-	0.70 (0.50-0.97)
Rental property	1.15 (1.03-1.28)	-	-	-	-	-
Absence of a garden	-	1.13 (1.01-1.26)	-	0.75 (0.59-0.95)	-	-
Number of electronic devices (TVs / computers) in the household	-	-	-	-	-	-
Electronic device (TV / computers) in child's own room	-	1.04 (1.01-1.07)	1.15 (1.07-1.23)	1.13 (1.04-1.23)	1.12 (1.04-1.21)	1.14 (1.04-1.26)
Distal social variables						
Neighborhood socio-economic status [c]	1.05 (1.01-1.09)	1.07 (1.03-1.11)	-	1.07 (1.03-1.11)	-	-
Degree of unoccupied houses	-	-	-	-	1.05 (1.02-1.08)	-
Presence of trash and litter	-	-	-	-	-	-
Presence of dog dirt	-	1.03 (1.00-1.05)	-	-	-	-
Social safety	1.02 (1.01-1.03)	1.01 (1.00-1.03)	-	-	-	-
Social cohesion	1.01 (1.00-1.02)	1.01 (1.00-1.02)	1.02 (1.01-1.03)	1.01 (1.00-1.02)	-	1.02 (1.01-1.04)
Satisfaction with social contacts	-	-	-	-	-	-

Table 2.2: Association between environmental characteristics and outdoor play for boys and girls: multivariate analyses [a]

	Age 4-6 years [e]		Age 7-9 years		Age 10-12 years [e]	
	Boys	Girls	Boys	Girls	Boys	Girls
Distal physical variables						
Type of neighborhood: city centre	-	-	0.79 (0.66-0.94)	-	-	-
Type of neighborhood: city green	-	1.16 (1.02-1.31)	-		-	-
Type of neighborhood: town centre [d]	-	2.08 (1.59-2.72)	1.41 (1.08 (1.86)	1.73 (1.21-2.46)	-	-
Type of neighborhood: rural area	-	1.39 (1.15-1.67)	-	-	-	-
Degree of high- vs. low-rise buildings	-	-	-	-	-	-
Presence of green in the neighborhood	-	-	-	-	-	-
Presence of water in the neighborhood	1.04 (1.01-1.07)	-	-	-	-	-
Traffic situation	-	-	-	-	-	-
Quality of sidewalks and bike lanes	-	-	-	-	-	-
Diversity of routes	-	-	-	1.03 (0.99-1.06)	1.08 (1.03-1.13)	-
Distance to facilities	-	-	-	-	-	-
Satisfaction with play facilities	-	-	-	-	-	-
Satisfaction with public space and green space	-	-	-	-	-	-

[a] Sequential Poisson GEE analysis (forward), p-value < 0.15 was considered statistically significant for entry into the model, but in the final model, only those variables with a p-value < 0.05 are shown. Values are Realtive Rates (95% CI); [b] Other type of residence was a rest category containing all types of residences not included in the pre-printed answer categories (n = 79); [c] Higher scores represent lower socio-economic status; [d] Town centre is a neighborhood type that was underrepresented in this study (n = 29) and results should be interpreted with caution. Results for work area type of neighborhood are as not shown because of extreme low number of respondents living in this type of neighborhood (n = 10); [e] In the Netherlands, children aged 4-12 years are educated together at the same primary school. In our study sample, 3 children in the lowest grade were 3 years and 14 children in the highest grade were 13 years. We included these children in the lowest (4-6) and highest (10-12) age group respectively; CI = Confidence interval.

Distal Physical Variables

Living in a city centre was negatively associated with outdoor play among boys aged 7–9 (RR = 0.79) and living in a city green area showed a positive association among girls aged 4–6 (RR = 1.16). The other neighborhood types also showed an association with outdoor play in some subgroups, but these results should be interpreted with caution, because of the low numbers. The degree of low- vs high-rise buildings, the presence of green and water in the neighborhood, traffic situation, quality of sidewalks and bike lanes, the diversity of routes, and satisfaction with play facilities and public green space were unrelated to outdoor play in most subgroups. The presence of water did however show a positive association for boys aged 4–6 (RR = 1.04) and the diversity of routes was positively associated with outdoor play in girls aged 7-9 (RR = 1.03) boys aged 10–12 (RR = 1.08).

Discussion

This study showed that next to proximal environmental characteristics such as parental education, the importance parents pay to outdoor play and the presence of electronic devices in the child's own room, several neighborhood characteristics were associated with children's outdoor play. Neighborhood social cohesion was positively associated with outdoor play in five out of six subgroups. With an increase of 1–2% in outdoor play per unit increase in social cohesion on a scale ranging from 6 to 30, and the fact that this variable is related to outdoor play among boys and girls of different age groups makes it a potential interesting point of action for policy development. Because (combinations of) environmental characteristics can influence activity behavior of large populations for a prolonged period of time, they are promising strategies to promote active living. With respect to the physical neighborhood characteristics, this study showed different characteristics to be related to outdoor play among the different subgroups of age and gender. This warrants caution when generalizing associations between physical neighborhood characteristics and outdoor play from studies conducted within a specific age group of children to the general youth population.

Previous research in the USA and Australia has shown that access to parks and recreational facilities, walkability of the neighborhood and safety (either social or physical) can determine physical activity in children [16-18]. This study however did not show a consistent association between outdoor play and the presence of water

or green in the neighborhood, or the distance to woodlands or parks. Also, parental satisfaction with public space and green space was not consistently associated with outdoor play. These contradictory findings could be due to the specific spatial planning structure in the Netherlands, which - in general - already provides for green space and play facilities. Diversity of routes (related to the walkability concept) was only related to outdoor play among girls aged 7-9 and boys aged 10–12 years, which indicates that the role of walkability in the Netherlands is especially important for older children. This may be explained by the fact that older children gain more independence in getting around their neighborhood by foot or bike, which is also supported by other research [17, 37]. Apart from social safety, which was reported earlier [38], this study showed that social cohesion was related to children's outdoor play. The importance of social cohesion in relation to physical activity was shown before among children aged 11–15 years [39]. Likewise, children aged 12–14 years are more likely to report more intense physical activity when in the company of peers [40], stressing the importance of the social environment as well. The presence of electronic devices in the child's own room showed a positive association with outdoor play in children in this study.. Although this finding appears contra-intuitive, sedentary behavior is a conceptually different construct that does not necessarily replace physically activity behavior [41-47]. Furthermore, from the current analyses it cannot be concluded whether the presence of electronic devices leads to an actual increase in the time spent using them.

The present study is not without limitations. Firstly, due to the cross-sectional design, no causal relations could be demonstrated. Since parents reported both the amount of time their child spends on outdoor play and the importance they pay to it, this association could be biased. Although the questions on physical activity were not validated, they were derived from the standard questionnaire for monitoring in the Netherlands, which enhances comparison of the results with other Dutch research. The study did not include objective measurement of physical activity (accelerometry) because this cannot quantify the amount of time spent on specific types of physical activity (such as outdoor play, sports participation, active commuting), whereas these different types of physical activity are associated with different environmental characteristics [48]. Because objective measurement of social environmental characteristics is problematic, and (social) neighborhood perceptions of parents may be of overriding importance in relation to their child's outdoor play, this study relies on subjective measurement of environmental characteristics.

Analyses were not adjusted for household income because of collinearity with parental education ($r = 0.511$, $p < 0.001$) and the high number of missing values

(21.4%) on this variable. Additional correction for household income however did not drastically modify the results (data not shown). Analyses were not adjusted for ethnicity and BMI because this would have drastically lowered the numbers due to missing values and may have caused selective drop out. Lastly, because data were collected in four medium sized cities in the South of The Netherlands, results can only be generalized to other cities with a comparable size and population.

In conclusion, this study showed that children's outdoor play was associated with several physical and social environmental characteristics. Neighborhood social cohesion was related to outdoor play among children of different age and gender, which makes it a promising point of action for policy development. Policies aimed at improving physical neighborhood characteristics in relation to outdoor play, should take into account age and gender of the target population.

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CHAPTER 3

Environmental correlates of active commuting among children

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Based on: Aarts MJ, Mathijssen JJP, Van Oers JAM, Schuit AJ. Association between environmental characteristics and active commuting to school among children: a large scale cross-sectional study. (submitted for publication).

Abstract

Background: Active commuting to school can contribute to increased physical activity levels among children and research indicates that environmental characteristics are related to the mode of transportation to school. The aim of this study is to quantify the correlation between (perceived) physical and social environmental characteristics and walking and cycling to school among children.

Methods: Cross-sectional data were collected among parents (n = 5,963) of children aged 4-12 years of 42 primary schools in four Dutch cities. Parents reported mode of transportation to school of their child, individual, home environmental, social and physical neighborhood, and school environmental characteristics. Multilevel multinomial logistic regression analyses were conducted to quantify the association between environmental characteristics and walking and bicycling to school.

Results: Three-quarter of all children usually commuted to school by means of active transportation. Age of the child (years) was positively related to walking (OR = 1.31) and bicycling (OR = 1.71) and distance from home to school (km) was negatively related to walking (OR = 0.18) and bicycling (OR = 0.70). Number of siblings was positively related to walking (OR = 1.44) and bicycling (OR = 1.24), as was number of days per week the child goes home after school (OR = 1.18 and 1.13 for walking and bicycling respectively). Number of cars in the household showed a negative association (OR = 0.58 and 0.49 for walking and bicycling respectively). Lower neighborhood SES was negatively associated with walking (OR = 0.51) and cycling (OR = 0.86). Social safety was positively related to walking and cycling (OR = 1.04 for both), as was social cohesion (OR = 1.04 and 1.02 for walking and cycling respectively). Living in a city centre neighborhood was positively associated with walking (OR = 1.91), whereas living in a city green neighborhood was negatively associated with walking (OR = 0.48) and cycling (OR = 0.76). Traffic safety around school as perceived by the school board was positively associated with bicycling (OR = 1.25).

Conclusions: While social environmental characteristics were consistently related to walking and bicycling to school, the relations for built environmental characteristics were less clear.

Background

As in many other Western countries, the majority of primary school children in The Netherlands does not meet the recommended health guidelines for physical activity [1]. Because of the health risks related to this lack of physical activity [2, 3], it is important to find appropriate ways to stimulate physical activity among children. Active commuting to and from school is a cheap, natural and sustainable way for children to be physically active on a regular basis. Accelerometer data have shown that children that go to school by means of active commuting, are more physically active when compared to children that use motorized travel, both during the journey from home to school itself [4], as well as during other time periods [5]. Maximizing the number of children that actively commute to school can therefore be seen as a promising public health strategy, to which also policy sectors outside the public health domain may contribute [6, 7]. Research indicates that apart from individual characteristics of the child and the parents, environmental characteristics are related to the mode of transportation to school among children [8, 9] and hence optimizing these (perceived) environmental characteristics may be a valuable policy approach to increase the number of children involved in active commuting.

As parents act as gatekeepers for their children's commuting behavior [10], both objective environmental characteristics and parents' perception of their living environment may play an important role in the choice for transportation mode to school [11, 12]. Moreover, not only the physical (built) environmental characteristics, but also social environmental characteristics may be related to active commuting to school [12]. Panter and colleagues further indicate that three components of the living environment should be considered in relation to children's commuting behavior: the neighborhood around the home, the route from home to school and the school environment [13]. Furthermore, specific environmental characteristics may be related to different forms of active commuting, i.e. walking or bicycling [14, 15].

For policy makers to optimize the revenues of their environmental policies aimed at stimulating active commuting among children, it is important to have insight into the obviously complex relation between environmental characteristics and active commuting to school. Much research addressing the abovementioned themes has been traditionally conducted in the USA [8, 9] and Australia [16-19]. European countries and cities however have a different social and physical infrastructure, and therefore European studies addressing this theme [13, 20-22] are specifically important as well. In order to assist local policy makers in designing

policies that stimulate active commuting among children, country-specific results are warranted.

The specific aim of this study is to quantify the correlation between (perceived) environmental characteristics related to active commuting to school among Dutch primary school children. This study includes physical as well as social environmental characteristics in the home, neighborhood and school environment and examines the association with walking and bicycling separately.

Methods

Study setting

Cross-sectional data were collected between September 2007 and January 2008 from parents of children of 42 primary schools in four medium sized Dutch cities in the Southern part of The Netherlands. The number of inhabitants ranges from 77,450 to 201,259 and the degree of urbanization ranges from 727 - 1,716 citizens per km^2. Although Roosendaal is somewhat smaller and less urbanized compared to the other cities, the municipalities are comparable regarding the composition of their population such as the percentage of non-Western immigrants (9.9 - 13.4%) and percentage of inhabitants aged 0-14 years (16.7-17.6%). The selection procedures and characteristics of the participating cities are described in more detail elsewhere [23].

Study population

Data were collected among parents of children aged 4-12 years. In the Netherlands, children in this age group attend primary school, which, in most cases, is close to or within the area of residence. Initially, all regular primary schools in the four cities (n = 149), except those already participating in other (research) projects aimed at physical activity among children (n = 34) were invited by letter, followed up by telephone to participate in the survey. Of the invited schools (n = 115), approximately one third agreed to participate (n = 42). As outlined elsewhere [23], the schools in our study were representative of the total population of schools in the participating municipalities in terms of school size, socioeconomic status and the

type of neighborhood. Because no medical or physical measurements were conducted and considering the negligible (psychological) burden to fill in the questionnaire, no ethics approval was required according to the Dutch Central Committee on Research Investigating Human Subjects. Parents were given written information about the study and by returning the questionnaire they gave consent for the inclusion of their data in the study. In total 11,094 parents were provided with a questionnaire. Response rate was 60%, resulting in 6,624 returned questionnaires. During data entry, 12 questionnaires could not be read and 11 questionnaires were removed because they were completely empty, leaving 6,601 questionnaires for analysis.

Questionnaires and measures

This study encompassed a questionnaire for parents and a questionnaire for the school board. The questionnaire for parents was based on questionnaires used in previous Dutch research [24] and included the following topics: mode of transportation to school, individual factors (gender and age of the child, parental report of height and weight of their child), home environmental factors, social neighborhood characteristics, physical neighborhood characteristics, and characteristics of the school environment. The exact formulation of the items in the questionnaire, the calculation of all variables in the analysis en the descriptive data for each variable (such as mean or frequencies) are summarized in Appendix 1. Conceptually related items were summed when internal consistency was acceptable (Cronbach's alpha > 0.6), otherwise items were treated separately. Missing values were not imputed, unless it concerned a missing value on one of the items of a sum score consisting of more than four items. In that case, the missing value was replaced by the mean of the other values. If more than one item was missing within one sum score, the sum score was not calculated. The following independent variables (not listed in Appendix 1) were excluded for further analysis, due to lack of variance among respondents: usual parking location for car (99.4% of the respondents that have a car usually parks their car close to their home or in their own garage), availability of bicycle shed at home (95.8% of the respondents has a bicycle shed at home). With exception of the type of neighborhood and neighborhood socio-economic status (SES), which were based on pre-existing databases linked to the respondent's postal code [25, 26] and the variables derived from the questionnaire for the school's board, all independent variables were reported by parents. In addition, school environmental characteristics (traffic safety around school and sufficiency of bicy-

cle shed at school) were derived from a questionnaire provided to the board of the participating schools. Throughout the questionnaire for parents, "neighborhood" was defined as the area that could be reached by parents in 10 to 15 minutes by foot or in 5 to 8 minutes by bike from the respondent's residence (street network distance). This matches the general perception of a typical Dutch neighborhood and, in comparison with distances in meters, distances in minutes are more easily interpreted by the respondents [27, 28].

In all analyses, the multinomial outcome measure is usual mode of transportation to school encompassing the following categories: 1) walking, 2) bicycling, and 3) the reference category inactive transportation (on the back of parent's bike or in a buggy, on the back of parent's moped / scooter, brought by car, or by bus).

Statistical analyses

Questionnaires were excluded from further analyses because of missing values on the outcome measure transport modality (n = 366), and three important potential confounders: age of the child (n = 2), distance from home to school (n = 113) and parental education (n = 154). Furthermore, questionnaires of children living more than three days per week on another address than the address described in the questionnaire (n = 35) and questionnaires of children with severe disabilities that could hamper active commuting (n = 60) were removed. Some questionnaires had to be removed because of more than one exclusion criterion, and the final data base thus encompassed 5,963 respondents. Based on our power analysis described elsewhere [23], our study provided adequate power to detect small effects (f^2 = 0.02).

Descriptive analyses were conducted with SPSS, version 17.0. T-tests and chi-square tests were performed to assess differences ($p < 0.05$) in characteristics between boys and girls for continuous and categorical variables respectively. Multilevel multinomial logistic regression analyses were conducted with SAS version 9.2, using PROC GLIMMIX. Inactive transportation was regarded as the reference category in all analyses. Random intercepts were allowed to correct for the clustering of the data within schools in all analyses. After crude bivariate analyses in which the association of each individual independent variable with mode of transportation was calculated, the association between each individual independent variable with mode of transportation was calculated adjusted for age of the child and distance from home to school (which were considered as important preconditions for active commuting to school) and parental education (which is considered as a good indi-

cator for SES in the Netherlands [29, 30] and was seen as an important possible confounder). In all analyses, parental education was indicated by highest completed level of education of the parent who filled in the questionnaire; in the majority of cases, this was either the biological mother (86.4%) or biological father (12.5%).

Finally, in order to quantify the association between environmental characteristics and active commuting to school adjusted for the other environmental characteristics, a multilevel forward sequential multinomial logistic regression analysis was performed. In a sequential analysis, variables enter the equation in a theory-based order [31]. It was assumed that proximal variables (individual characteristics and home environmental characteristics) are more closely related to children's active commuting behavior than distal characteristics (neighborhood and school environment). Based on previous results from this research project [32] it was assumed that social neighborhood characteristics were more closely related to active commuting than physical neighborhood characteristics. Hence, the first step of the sequential analysis consisted of a block of proximal variables (individual and home environmental variables), followed by the second step which introduced a block of distal (neighborhood) social variables to the model. During the third step, a block of distal (neighborhood) physical variables was added to the model. The last step comprised the introduction of a block of school environmental variables to the model. All steps in the sequential analysis were adjusted for age of the child, distance from home to school and parental education. In order to prevent important variables to be excluded from the model in a forward analysis too easily, a more liberal probability level of $p > 0.15$ was chosen to decide on deletion of variables from the model [31, 33]. The sequential analyses ended when all variables in the model reached significance. In the final multivariate models, only those variables with a p-value < 0.05 are shown. Prior to entry into the multivariate models, correlations between (continuous) independent variables were checked for collinearity, but none of the correlations exceeded the exclusion criterion of $r > 0.5$ [31].

Results

Table 3.1 shows that there were no significant differences between boys and girls in population characteristics except for the percentage overweight and obese children (as determined by age and gender specific cut off points as provided by Cole et al. [34]). The data also show that approximately three-quarter of all children usually commute to school by means of active transportation (walking or cycling).

Table 3.1: Characteristics of the study population [a]

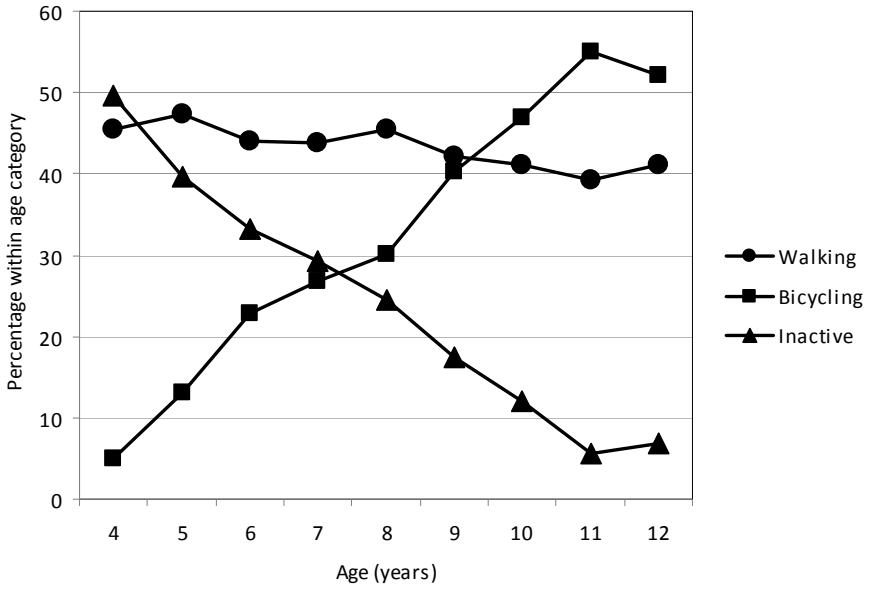
	Boys (n = 3,001)	Girls (n = 2,950)
Age (years)	7.8 (2.4)	7.8 (2.4)
BMI [b] (kg/m^2)	16.3 (2.7)	16.2 (2.6)
Overweight [c] (%)	8.5 *	11.3 *
Obesity [c] (%)	3.1 *	2.4 *
Parental education (%)		
- Low [d]	28.3	28.2
- Intermediate [e]	35.0	35.7
- High [f]	36.7	35.1
Net household income (Euros per month)	2,797 (1,326)	2,781 (1,376)
Usual mode of transportation to school		
- Walking (%)	43.5	43.2
- Bicycling (%)	32.2	31.4
- Inactive (%)	24.3	25.4

[a] Values are mean (SD), unless otherwise specified. 12 respondents had a missing value on the gender of their child and were excluded for the analyses described in this table; [b] Based on parental self report of height and weight of their child; [c] Based on age and gender specific cut off points as provided by Cole et al. [34]; [d] No education, primary education, lower general secondary education or lower vocational education; [e] Higher general secondary education, pre-university education or intermediate vocational education; [f] Higher vocational education or university; *Significant differences between boys and girls ($p < 0.05$).

The descriptive data in Figure 3.1 show that with increasing age, fewer children are going to school by means of inactive transportation (brought to school by car or on the back of parent's bike, moped or in a buggy), in favor of children commuting to school by bike. Figure 3.2 depicts that within a distance of one km between home and school, the majority of children (approximately 70%) commutes to school by foot. With increasing distance up to five km from home to school, fewer children go to school by foot, in favor of children going to school by bike or by inactive transportation. From the children living more than five km from school, the majority is going to school by means of inactive transportation.

Table 3.2a and 3.2b summarize the results of the adjusted and multivariate multilevel analyses and show the association between several environmental characteristics and active commuting to school. The results from the bivariate analyses are not shown, but can be obtained from the corresponding author on request. The results of the final multivariate analyses will be addressed per block of variables below.

Figure 3.1: Usual mode of transportation to school by age [a]



[a] In The Netherlands, children aged 4–12 years are educated together at the same primary school. In the current study sample, 3 children in the lowest grade were aged 3 years and 12 children in the highest grade were aged 13 years. For this figure, these children were included in the lowest (4 years) and highest (12 years) age groups, respectively.

Figure 3.2: Usual mode of transportation to school by distance from home to school

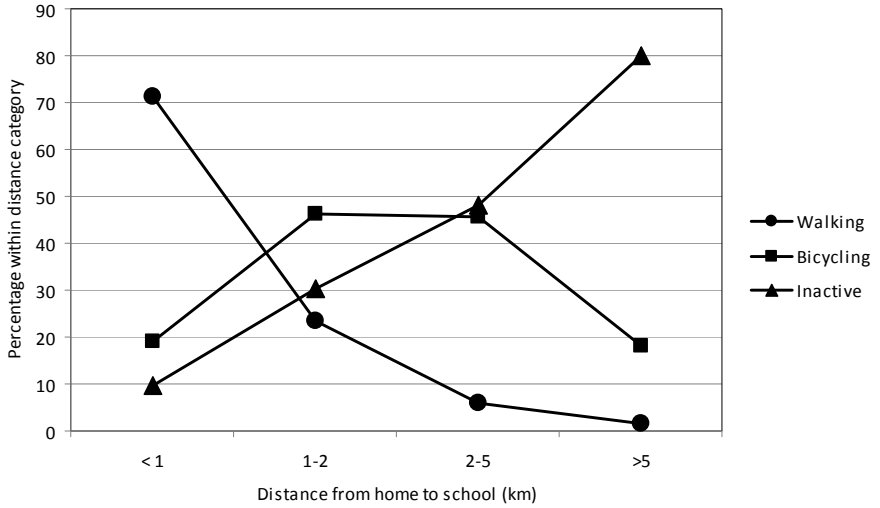


Table 3.2a: Association between environmental characteristics and walking to school [a]

Variable	Range / coding	Adjusted [b] analyses: OR (CI)	Multivariate [c] analyses: OR (CI)
Individual and home environmental characteristics			
Gender	0-1 (0 = boy, 1 = girl)		
Age of the child (years)	3-13 [d]	1.33 (1.29-1.38)	1.31 (1.26-1.37)
Parental education	1-8	0.95 (0.90-1.00)	
Parental ethnic background	0-1 (0 = Dutch, 1 = non-Dutch)	1.63 (1.24-2.14)	
Working situation of parents [e]	Dummy coded: two-parent family, one parent works 36 hours per week or more, one parent works 12-36 hours per week is reference	0.58 (0.39-0.85) (single-parent family, parent works 12-36 hours per week) 1.44 (1.16-1.79) (two-parent family, one parent works 36 hours per week or more, one parent works less than 12 hours per week)	0.61 (0.40-0.94) (single-parent family, parent works 12-36 hours per week)
Number of siblings	0-5	1.47 (1.33-1.63)	1.44 (1.29-1.61)
Distance from home to school (km)	0.5-6.0	0.19 (0.17-0.21)	0.18 (0.16-0.21)
Number of days child goes home after school	0-5	1.21 (1.13-1.30)	1.18 (1.09-1.27)
Number of cars in the household	0-2	0.69 (0.59-0.81)	0.58 (0.48-0.69)
Social neighborhood characteristics			
Neighborhood SES	-4 – 4 (higher scores represent lower SES)	0.58 (0.51-0.67)	0.51 (0.44-0.60)
Social safety	5-25	1.04 (1.02-1.07)	1.04 (1.01-1.07)
Social cohesion	6-30	1.04 (1.02-1.06)	1.04 (1.02-1.07)
Degree of unoccupied houses	1-5		
Presence of trash and litter	1-5		
Presence of dog dirt	1-5	1.15 (1.09-1.22)	1.19 (1.12-1.27)

Table 3.2a: Association between environmental characteristics and walking to school [a]

Variable	Range / coding	Adjusted [b] analyses: OR (CI)	Multivariate [c] analyses: OR (CI)
Physical neighborhood characteristics			
Type of neighborhood [e]	Dummy coded: city non-centre is reference [f]		1.91 (1.06-3.47) (city centre) 0.48 (0.34-0.68) (city green)
Degree of high- vs low-rise buildings	2-10 (higher score represent more high-rise buildings)		
Presence of green	1-5		0.89 (0.82-0.98)
Presence of water	1-5		
Traffic situation	5-25 (higher scores represent less favorable traffic situation)		
Quality of sidewalks and bike lanes	4-20		
Diversity of routes	1-5	1.09 (1.01-1.17)	
School environment			
Traffic safety around school (as perceived by parents)	0-1 (0 = unsafe, 1 = safe)	0.73 (0.61-0.88)	0.70 (0.58-0.85)
Traffic safety around school (as perceived by school board)	1-5 (higher scores represent higher perceived safety)		
Sufficiency of bicycle shed at school (as perceived by school board)	1-4	1.44 (1.12-1.84)	1.91 (1.28-2.87)

[a] All analyses are multilevel (random intercepts were allowed) to correct for the clustering of the data within schools. Only statistically significant associations (p-value < 0.05) are shown; [b] Adjusted for age of the child, distance from home to school and parental education; [c] Adjusted for age of the child, distance from home to school and parental education. Moreover, the final multivariate model included the following independent variables: working situation of parents, number of siblings, number of days child goes home after school, number of cars in the household, neighborhood SES, social safety, social cohesion, presence of dog dirt, type of neighborhood, presence of green, traffic safety around school (as perceived by parents), sufficiency of bicycle shed at school (as perceived by school board); [d] In The Netherlands, children aged 4–12 years are educated together at the same primary school. In the current study sample, 3 children in the lowest grade were aged three years and 12 children in the highest grade were aged 13 years; [e] Only the dummy categories that show significant associations (p-value < 0.05) with walking to school are displayed (dummy categories that did not show a significant association with walking to school were omitted); [f] Results of for work area type of neighborhood are as not shown because of extreme low number of respondents living in this type of neighborhood (n = 9); OR = Odds ratio; CI = Confidence interval.

Table 3.2b: Association between environmental characteristics and bicycling to school [a]

Variable	Range / coding	Adjusted [b] analyses: OR (CI)	Multivariate [c] analyses: OR (CI)
Individual and home environmental characteristics			
Gender	0-1 (0 = boy, 1 = girl)		
Age of the child (years)	3-13 [d]	1.73 (1.67-1.80)	1.71 (1.64-1.78)
Parental education	1-8	1.07 (1.02-1.13)	1.10 (1.04-1.16)
Parental ethnic background	0-1 (0 = Dutch, 1 = non-Dutch)		
Working situation of parents [e]	Dummy coded: two-parent family, one parent works 36 hours per week or more, one parent works 12-36 hours per week is reference	1.48 (1.07-2.05) (two-parent family, both parents work 12-36 hours per week) 1.33 (1.07-1.65) (two-parent family, one parent works 36 hours per week or more, one parent works less than 12 hours per week)	
Number of siblings	0-5	1.26 (1.14-1.39)	1.24 (1.12-1.38)
Distance from home to school (km)	0.5-6.0	0.68 (0.64-0.72)	0.70 (0.66-0.75)
Number of days child goes home after school	0-5	1.14 (1.06-1.22)	1.13 (1.05-1.22)
Number of cars in the household	0-2	0.56 (0.48-0.65)	0.49 (0.41-0.58)
Social neighborhood characteristics			
Neighborhood SES	-4 – 4 (higher scores represent lower SES)	0.91 (0.83-0.99)	0.86 (0.77-0.95)
Social safety	5-25	1.04 (1.03-1.08)	1.04 (1.01-1.07)
Social cohesion	6-30	1.03 (1.01-1.04)	1.02 (1.00-1.04)
Degree of unoccupied houses	1-5		
Presence of trash and litter	1-5		
Presence of dog dirt	1-5		

Table 3.2b: Association between environmental characteristics and bicycling to school [a]

Variable	Range / coding	Adjusted [b] analyses: OR (CI)	Multivariate [c] analyses: OR (CI)
Physical neighborhood characteristics			
Type of neighborhood [e]	Dummy coded: city non-centre is reference [f]		0.76 (0.58-0.99) (city green)
Degree of high- vs low-rise buildings	2-10 (higher score represent more high-rise buildings)	0.95 (0.91-0.99)	
Presence of green	1-5		
Presence of water	1-5		
Traffic situation	5-25 (higher scores represent less favorable traffic situation)	0.98 (0.96-0.99)	
Quality of sidewalks and bike lanes	4-20		
Diversity of routes	1-5	1.16 (1.09-1.25)	1.12 (1.04-1.21)
School environment			
Traffic safety around school (as perceived by parents)	0-1 (0 = unsafe, 1 = safe)	0.76 (0.64-0.91)	0.72 (0.60-0.87)
Traffic safety around school (as perceived by school board)	1-5 (higher scores represent higher perceived safety)	1.22 (0.99-1.50)	1.25 (1.03-1.53)
Sufficiency of bicycle shed at school (as perceived by school board)	1-4	0.73 (0.57-0.93)	0.69 (0.54-0.90)

[a] All analyses are multilevel (random intercepts were allowed) to correct for the clustering of the data within schools. Only statistically significant associations (p-value < 0.05) are shown; [b] Adjusted for age of the child, distance from home to school and parental education; [c] Adjusted for age of the child, distance from home to school and parental education. Moreover, the final multivariate model included the following independent variables: age of the child, number of siblings, number of days the child goes home after school, number of cars in the household, neighborhood SES, social safety, social cohesion, type of neighborhood, diversity of routes, traffic safety around school (as perceived by parents), traffic safety around school (as perceived by school board), sufficiency of bicycle shed at school (as perceived by school board); [d] In The Netherlands, children aged 4–12 years are educated together at the same primary school. In the current study sample, 3 children in the lowest grade were aged three years and 12 children in the highest grade were aged 13 years; [e] Only the dummy categories that show significant associations (p-value < 0.05) with bicycling to school are displayed (dummy categories that did not show a significant association with bicycling to school were omitted); [f] Results of for work area type of neighborhood are as not shown because of extreme low number of respondents living in this type of neighborhood (n = 9); OR = Odds ratio; CI = Confidence interval.

Individual and home environmental characteristics

Age of the child (years) was positively related to walking (OR = 1.31) and bicycling (OR = 1.71) to school, whereas parental education was positively related to bicycling only (OR = 1.10). Living in a single-parent family with the parent working 12-36 hours per week was negatively associated with walking to school (OR = 0.61). The number of siblings was positively related to walking (OR = 1.44) and bicycling (OR = 1.24), as well as the number of days per week the child goes directly to home after school (OR = 1.18 and 1.13 for walking and bicycling respectively). The distance from home to school (km) was negatively related to walking (OR = 0.18) and bicycling (OR = 0.70) to school, as well as the number of cars in the household (OR = 0.58 and 0.49 for walking and bicycling respectively).

Social neighborhood characteristics

A lower neighborhood SES was negatively associated with walking (OR = 0.51) and cycling (OR = 0.86) to school. Perceived social safety was positively related to walking and cycling to school (OR = 1.04 for both walking and cycling), as was perceived social cohesion (OR = 1.04 and 1.02 for walking and cycling respectively). The perceived presence of dog dirt was positively associated with walking to school (OR = 1.19).

Physical neighborhood characteristics

Living in a city centre type of neighborhood was positively associated with walking to school (OR = 1.91), whereas living in a city green type of neighborhood was negatively associated with walking (OR = 0.48) and cycling (OR = 0.76) to school. The perceived presence of green was negatively associated with walking to school (OR = 0.89), whereas the perceived diversity of routes was positively associated with bicycling to school (OR = 1.12).

School environment

The traffic safety around school as perceived by parents was negatively associated with walking and bicycling to school (OR = 0.70 and 0.72 respectively) indicating that children from parents that perceive the school environment as safe, are less

likely to walk or bicycle to school. Conversely, the traffic safety around school as perceived by the school board was positively associated with bicycling to school (OR = 1.25). The sufficiency of the school's bicycle shed (as perceived by the school board) was positively associated with walking to school (OR = 1.91) and negatively associated with cycling to school (OR = 0.69).

Discussion

Discussion of main findings and comparison with previous research

This study confirmed that short distance from home to school and a higher age of the child are factors related to active commuting to school, a finding already known from previous studies [4, 18, 21]. Van Sluijs et al. however have shown that with greater distances between home and school, the physical activity accumulated during active transportation to and from school is higher when compared to smaller distances [4].

With regard to the home environmental characteristics, this study showed that the number of siblings was positively related to walking and cycling to school. This might be explained by the fact that siblings walk together to school, but as data from other studies are somewhat inconsistent [17, 18], this topic requires further study. In contrary to the general idea that parents that are working (nearly) full time are more likely to drive their children to school by car [11, 21, 35], this study did not show a consistent relation between the working hours of the parents and their children's mode of transportation to school. This may be partly explained by the low number of respondents in some of the working situation categories. However, we did find a positive association between the number of days a child goes home after school and walking and cycling to school. This might indicate that not the total number of working hours by parents, but the opportunity to supervise the child during the journey from school to home or a parent being present at home after school time may be an important factor related to active commuting. The importance of social support from parents in stimulating active school transportation was shown in other studies as well [22] and data from Switzerland likewise show a positive association between daycare attendance and regular car trips to school [21]. Comparable with other studies [14, 17, 21], the number of cars in the household was negatively associated with active transportation to school.

Regarding the social neighborhood characteristics, children in lower SES neighborhoods were less likely to go to school by means of active transportation. Previous research has shown a negative association between the likelihood of walking / cycling home from school in deprived neighborhoods as well [13, 20]. Moreover, the current study underlined the importance of social neighborhood characteristics such as social safety and social cohesion, which were consistently related to walking and cycling to school. Social contacts that facilitate collectively commuting to school and parents' perceptions of social neighborhood characteristics were shown to be particularly important for primary school children and adolescents in other studies as well [36, 37]. Together, these findings suggest an important role for social neighborhood characteristics in relation to walking and bicycling to school. The rather contra-intuitive finding that the presence of dog dirt was positively related to walking to school might reflect the walkability of those areas, which attracts both dog walkers and active commuters to school.

With regard to the physical (or built) neighborhood characteristics, living in a city centre type of neighborhood was positively related to walking to school, whereas living in a city green type of neighborhood was negatively associated with walking and bicycling to school. In general, city centre neighborhoods are considered more walkable, due to the proximity of facilities. Together with a discouraging parking environment for cars in city centre neighborhoods, this might be an explanation for the abovementioned findings. Moreover, the presence of green was negatively associated with walking to school in the present study, which indicates that although living in a green environment may stimulate active commuting among adults [38], for children this might not be the case. Although we did include items on traffic situation and quality of sidewalks and bike lanes in our study, these were not significantly related to either walking or cycling to school, which is in contrast with many other studies showing the possible associations of for example major road crossings [21], road safety [12], road density [13], and the presence of walk and bike paths [17] with active commuting among children. In the UK study from Panter et al. it was concluded that both attitudinal and environmental perceptions of parents were associated with children's active commuting behavior [22]. Possibly, the overall neighborhood type included as a variable in the present study, already accounted for much of the differences in the built environmental characteristics. An alternative explanation for the lack of a clear association between physical neighborhood characteristics and active commuting might be found in the specific Dutch infrastructure, which possibly already provides children with a facilitating built environment with regard to walking and bicycling.

While the traffic safety around school as perceived by the school board showed a positive association with bicycling to school, children of parents reporting that the traffic situation around school was safe, were less likely to walk or bicycle to school. As this study has a cross-sectional design and causality cannot be demonstrated, a possible explanation for this finding might be that parents who do walk or bicycle with their children to school, have more experience with the (unsafe) traffic situation around school. The fact that only 23.8% of the school boards in this study perceive the traffic situation around their school as safe, indicated that there is room for improvement of traffic situation around primary schools. Furthermore, the capacity of bicycle sheds at primary schools was positively related to walking to school, and negatively related to bicycling to school. Although this finding may seem awkward at first, this might reflect reverse causality, as schools where many children walk and few children bicycle to school, perceive to have enough bicycle shed capacity and vise versa.

Strengths and limitations of this study

This large-scale study addresses a broad spectrum of physical as well as social environmental correlates of walking and bicycling to school. However, because of the cross-sectional design, no causal relationships can be demonstrated and this hampers the interpretation of some the findings. Moreover, this study relied mostly on parental perceptions of the neighborhood characteristics. Although the environmental characteristics as perceived by parents may be of crucial importance [39], and social neighborhood characteristics are also difficult to measure objectively, measurement of environmental characteristics by means of neighborhood audits or geographical information systems may be a valuable tool in future research. Although accelerometers provide a more objective way to measure physical activity patterns among children, they are less practical in use with large study samples. Moreover, accelerometer data are often less suitable to measure bicycling, and therefore for the specific purpose of determining transportation, parent reporting may be more accurate. Further, this study only asked parents to report the usual mode of transportation *to* school, and we implicitly assumed that this was also the usual mode of transportation back from school to home in the afternoon. Although it is possible that there are temporal differences in transport mode (i.e. between morning and afternoon trips) [35], UK data show that travel mode to and from school are highly correlated [4].

With regard to the analyses of this study, a sequential regression analysis was applied, so that variables enter the model in a theory-driven manner. Additional analyses (which can be obtained from the corresponding author on request) have shown that altering the sequence of entry of blocks of variables (i.e. reverse the order of entry of social and physical neighborhood variables into the model) did not modify the results of the study. Because there were hardly any differences in characteristics between boys and girls and because there was no significant association between gender and mode of transportation to school, data for boys and girls were combined in the regression analyses. Lastly, because the study was conducted in four medium-sized Dutch cities, caution is warranted in generalizing the findings of this study to other areas.

Conclusions

This study shows the relation between several social and physical characteristics in the home, neighborhood and school environment and to walking and bicycling to school. This study suggests an important role for social characteristics at the home and neighborhood level in relation to walking and bicycling to school. With regard to the physical environmental characteristics, the results were less clear. In order to facilitate active transportation to school, policy makers should therefore take into account the importance of the social environment and think of policy measures that address this theme.

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CHAPTER 4

Objectively measured neighborhood characteristics and outdoor play

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Based on: Aarts MJ, De Vries SI, Van Oers JAM, Schuit AJ. Outdoor play among children in relation to objectively measured neighborhood characteristics. (submitted for publication).

Abstract

Background: Environmental characteristics are related to children's outdoor play, but differences exist in correlates of physical activity when measured subjectively or when measured objectively. The aim of this study was to identify quantitative as well as qualitative neighborhood characteristics related to outdoor play among children when measured objectively.

Methods: Neighborhood observations were conducted in 33 Dutch neighborhoods and coupled to survey data of 3,651 parents of primary school children (aged 4-12 years), which included parental reporting of the child's outdoor play behavior. The neighborhood observations included the following topics: buildings, formal outdoor play facilities, public space, street pattern, traffic safety, social neighborhood characteristics, and general impression of the activity-friendliness of the neighborhood for children. Multivariate multilevel Poisson GEE analyses were performed to quantify the association between neighborhood characteristics and children's outdoor play in three age groups (4-6, 7-9, and 10-12 years) and for boys and girls separately.

Results: Parental education was negatively associated with outdoor play in the two highest age groups (RR ranged from 0.94 to 0.96). Neither the presence nor the quality of formal outdoor play facilities were (positively) related to outdoor play in this study. Rather, informal play areas such as the presence of sidewalks were related to children's outdoor play (RR ranged from 1.44 to 1.66). Also, traffic safety was an important characteristic associated with outdoor play, especially for boys. In general, the presence of roundabouts was positively associated with outdoor play (RR ranged from 1.10 to 1.15 in four out of six subgroups), whereas the presence of intersections was negatively associated with outdoor play (RR ranged from 0.78 to 0.87 in five out of six subgroups).

Conclusions: This study showed that, apart from individual factors such as parental education level, certain modifiable characteristics in the neighborhood environment (as measured by neighborhood observations) were associated with outdoor play among boys and girls of different age groups in The Netherlands. Local policy makers from different sectors can use these research findings in creating more activity-friendly neighborhoods for children.

Introduction

As in many other Western countries, the majority of primary school children in The Netherlands does not meet the recommended guidelines for health enhancing physical activity [1] . It is therefore important to find appropriate ways to stimulate physical activity among children, for example by stimulating outdoor play [2]. Time spent outdoors is consistently related to children's physical activity level [3-7]. Research has shown that environmental characteristics can play a role in children's physical activity [5, 8]. More specifically, in a previous study we have shown that both the perceived physical environment and the perceived social environment were related to children's outdoor play [9].

Research among adults [10-12] and adolescents [13, 14] has shown that differences exist in correlates of physical activity when measured subjectively (i.e. perceived environmental characteristics as measured with questionnaires) or when measured objectively (i.e. by neighborhood observations or geographical information systems). As a consequence, for policy makers it is unclear to decide whether they should improve the actual environment (e.g. construct play grounds or bike lanes), or whether they should improve the perception of the existing environment (e.g. by providing parents with information about sports facilities in their neighborhood).

However, most studies addressing the environmental correlates of physical activity among children have focused on parental perception of environmental characteristics [5]. Although environmental characteristics as perceived by parents indeed seem to be related to children's outdoor play behavior, less is known about the relation between objectively measured neighborhood characteristics and outdoor play among children.

A previous Dutch study has investigated the role of objectively measured physical environmental characteristics in disadvantaged neighborhoods on physical activity among children aged 6 to 11 years by means of neighborhood observations [15]. The authors conclude that children's physical activity is indeed associated with certain modifiable factors of the built environment, such as parking spaces in the neighborhood. The authors further stress the specificity of environmental characteristics in relation to different behavioral components (e.g. moderate-to-vigorous physical activity, walking, bicycling etc.) [16], a point also mentioned by others [17].

While the abovementioned Dutch study mainly described the quantitative aspects of the built environment (i.e. the absence, presence or amount of neighborhood facilities), it is assumed that the quality of neighborhood facilities (e.g. the accessibility and state of maintenance) may be important in relation to children's

physical activity level as well. Therefore, the aim of the present study was to identify quantitative as well as qualitative neighborhood characteristics related to outdoor play among primary school children (aged 4 to 12 years) by means of neighborhood observations.

Methods

Study design and setting

This cross-sectional study was situated in four medium-sized cities in the Southern part of The Netherlands. The number of inhabitants ranged from 77,450 to 201,259 and the degree of urbanization ranged from 727 to 1,716 citizens per km^2. Although one city was somewhat smaller and less urbanized compared to the other cities, they were comparable regarding the demography of their population such as the percentage of non-Western immigrants (range: 9.9 - 13.4%) and the percentage of inhabitants aged 0-14 years (range: 16.7-17.6%). The selection procedures and characteristics of the participating cities are described in more detail elsewhere [18].

Data on physical activity behavior of the children was obtained by means of a cross-sectional survey consisting of a written questionnaire among parents between September 2007 and January 2008. The data on neighborhood characteristics were collected approximately one year later (between October and December 2008) by means of standardized neighborhood observations (audits) by trained observers. Based on postal code, the data from these two study parts were combined for the analyses of this paper. Both study parts will be described in more detail below.

Survey among parents

The study was targeted at primary school children aged 4-12 years. In the Netherlands, children in this age group attend primary school, which, in most cases, is close to or within the area of residence. Initially, all regular primary schools in the four cities (n = 149), except those already participating in other (research) projects aimed at physical activity among children (n = 34) were invited by letter, followed up by a telephone call to participate in the survey. Of the invited schools (n = 115),

approximately one third agreed to participate (n = 42). As outlined elsewhere [18], the schools in our study were representative for the total population of schools in the participating cities in terms of school size, socioeconomic status and type of neighborhood.

At each school enrolled in the study, all grades and classes were included in the survey. Because no medical or physical measurements were conducted and considering the negligible (psychological) burden to fill in the questionnaire, no ethics approval was required according to the Dutch Central Committee on Research Investigating Human Subjects. Parents were given written information about the study and by returning the questionnaire they gave consent for the inclusion of their data in the study. In total parents of 11,094 children were provided with a questionnaire. Parents that had more than one child attending the same school, were provided with a questionnaire for each individual child. Response rate was 60%, resulting in 6,624 returned questionnaires. During data entry, 12 questionnaires could not be read and 11 questionnaires were removed because they were completely empty, leaving 6,601 completed and returned questionnaires.

Parents were asked to report the frequency (number of school days and number of days per weekend) their child was involved in outdoor play, considering a typical week in the past month. Parents were also asked to report the duration of outdoor play during week and weekend days (less than 30 minutes per day, 30 minutes to one hour per day, one to two hours per day, more than two hours per day). Furthermore, the questionnaire included items on age and gender of the child and parental education level and net household income per month. Based on parental report of weight and height of their child, BMI was calculated and percentage overweight and obesity (as determined by age and gender specific cut off points provided by Cole et al. [19]) was determined. Because parents were also asked to report their postal code in the questionnaire, the survey data could be coupled to the neighborhood observation data described in the next paragraph.

Neighborhood observations

Data on neighborhood characteristics (the independent variables) were collected by two trained research assistants by means of neighborhood observations in 33 neighborhoods. The observers were not part of the research team to enhance unbiased collection of the data. The two research assistants observed the neighborhoods using a checklist which they completed by mutual agreement. The checklist was based on the Neighborhood Walkability Scale [20], but was specifically

adapted for screening Dutch neighborhoods on environmental characteristics related to children's physical activity [15]. The inter-rater reliability of the checklist was evaluated as good (percentage of agreement = 77%) in previous Dutch research [16]. The scoring form included the following seven main topics: 1) buildings (residential density, land use mix, presence of unoccupied houses and maintenance of buildings), 2) formal outdoor play facilities (number and quality of play grounds, school yards, paved play grounds, and half pipe or skating track), 3) public space (presence and quality of green space and water), 4) street pattern (presence and quality of sidewalks and bike lanes) 5) traffic safety (traffic infrastructure and traffic volume and speed), 6) social neighborhood characteristics (street hygiene, area deprivation and social safety) and 7) general impression of the activity-friendliness of the neighborhood for children.

Neighborhood boundaries were defined by postal code data from the municipal organization, so that the results of the study could be easily interpreted by local policy makers. Similar to another Dutch neighborhood observation protocol developed by Van Lenthe et al. [21], before the start of the actual data collection, a random sample of 10% of the streets within each neighborhood was selected for observation, based on a list of all streets per neighborhood. During the neighborhood observations, after observing the selected streets per foot, all remaining streets were observed per bicycle, within the time limits given (approximately three hours) for each neighborhood observation, i.e. all observations were carried out during normal school days after school time and before dark, to mimic best the real conditions under which children are usually involved in outdoor play in their neighborhood. This was usually enough time to observe the majority of streets in the neighborhoods per bicycle (in addition to the selected streets that were observed by foot).

Neighborhoods were selected for observation based on 1) the number of respondents included in the survey living in the neighborhood in order to maximize the number of respondents in the analyses and, 2) physical and social neighborhood characteristics (based on a neighborhood typology score from the Ministry of Housing, Spatial Planning and the Environment [22] and a status score from the Netherlands Institute for Social Research respectively [23]) in order to maximize the variance in neighborhood characteristics included in the analyses. In total, 57.6% of the parents that filled in a questionnaire during the survey (n = 6,601), were living in one of the 33 observed neighborhoods. Hence, combining the data from the survey among parents and the data from the neighborhood observations, resulted in 3,805 individual respondents for the analyses described in this paper.

Measures

The dependent variable in all analyses was outdoor play in minutes per week which was calculated by multiplying the number of school days and weekend days the parents reported their child was involved in outdoor play by the average minutes per day the child was involved in outdoor play during school days and weekend days (which was recoded as follows: less than 30 minutes per day = 15 minutes per day, 30 minutes to one hour per day = 45 minutes per day, one to two hours per day = 90 minutes per day, more than two hours per day = 150 minutes per day). Finally, to calculate the total minutes of outdoor play per week, minutes spent on outdoor play during school days and during weekend days were summed.

As stated in the previous paragraph, the neighborhood observation checklist included seven main topics, which yielded in total 33 independent variables which will be described briefly here. A detailed description of all variables included in the analyses is given in Appendix A. Residential density was estimated by weighing and summing nine items on type of residences in the neighborhood, with a higher sum score representing higher residential density. Land use mix was defined as the proportion of enterprises to residences (range 0-100%). Presence of unoccupied houses was measured on a five-point scale and maintenance of buildings was measured on a three-point scale. The total number of playgrounds, school yards, paved playgrounds, and half pipe or skating track per km2 was calculated and summed for each neighborhood, resulting in one score for number of formal outdoor play facilities per km2 per neighborhood. Quality of playgrounds, school yards, paved playgrounds, and half pipe or skating track was defined on a scale from 0.00 to 1.00 (see Appendix A for specification of quality aspects). Presence of green space, water, sidewalks and bike lanes were each measured on a four-point scale. Quality of green space, water, sidewalks and bike lanes were defined on a scale from 0.00 to 1.00 (see Appendix A for specification of quality aspects). Traffic infrastructure included the following single-item variables each measured on a four-point scale: pedestrian crossings *without* traffic lights, pedestrian crossings *with* traffic lights, traffic lights, refuges / safety islands, parallel parking places, parking lots (grouped), speed bumps, home zones, 30 km/ hour zones, roundabouts, and intersections. Traffic volume and speed was calculated as a sum score of 6 items each measured on a four-point scale (Cronbach's alpha = 0.898), with a higher score representing higher traffic volume and speed. Presence of a dog walking area was a dichotomous item, as was the presence of a litter basket for dog waste and the presence of street lighting. The presence of graffiti, vandalism and dark spaces were each measured on a four-point scale. General impression of the

activity-friendliness of the neighborhood for children was estimated by a score ranging from 1-10, with a higher score representing a more favorable impression. Two items were removed from the analyses due to lack of variation among neighborhoods: the presence of parking garages and the presence of low-traffic / car-free zones.

Statistical analyses

From the 3,805 individual respondents in this study, 52 questionnaires were excluded from further analyses because of missing values on the outcome measure outdoor play, and 91 additional questionnaires were removed because of missing values on potential confounders: age or gender of the child (n = 6) and parental education (n = 85). Furthermore, questionnaires of children living more than three days per week on another address than the address described in the questionnaire (n = 18) were removed. Since some questionnaires had to be removed because of more than one exclusion criterion, the final data base for the analyses on outdoor play encompassed 3,651 respondents.

Because different environmental characteristics are expected to be associated with outdoor play between boys and girls and children of different age groups [4], analyses were conducted separately for boys and girls and in age groups 4-6, 7-9, and 10-12 years. Descriptive analyses were conducted with SPSS 17.0 (Chicago, Illinois). ANOVA and chi-square tests were performed to assess differences ($p < 0.05$) in characteristics between boys and girls in each age group for continuous and categorical variables respectively. Likewise, t-tests and chi-square tests were performed to asses differences ($p < 0.05$) between respondents that were included in a neighborhood observation and respondents that were not living in one of the observed neighborhoods (based on the original sample derived from the questionnaire).

To quantify the association between neighborhood characteristics and children's outdoor play, multilevel GEE analyses were conducted with SAS 9.1 (Cary, North Carolina). Because most of the independent variables were collected at the neighborhood level, but the dependent variable was collected at the individual level, multi-level analyses were applied in order to correct for the multi-level structure of the data.

Because of the non-normal distribution of the dependent variable outdoor play and its error terms (as assessed by histograms and normal probability plots, data not shown) and since this outcome measure is a count variable, a Poisson

distribution was applied [24, 25]. As a consequence, exponents of the original regression coefficient estimates were calculated and interpreted as relative rates (RR). The RR is interpreted as the decrease or increase (in percentage) in the amount of time children spend on outdoor play, as the independent variable increases with 1 unit. Hence, a RR of 1.10 indicates an increase of 10% in outdoor play as the environmental characteristic increases with 1 unit. A RR of 0.90 likewise indicates a decrease of 10%. Due to the Poisson analysis, the proportion of explained variance cannot be reported.

The first step in the analyses focused on environmental characteristics within each of the seven main topics included in the neighborhood observations: buildings, formal outdoor play facilities, public spaces, street pattern, traffic safety, social characteristics and general impression of the activity-friendliness of the neighborhood for children. All independent variables of one topic were entered simultaneously into a separate model (so one model per topic), which was adjusted for age of the child and parental education level, as indicated by highest completed education of the parent who filled in the questionnaire (it was assumed that this person was the primary caregiver, in the majority of cases this was either the biological mother or the biological father, 81.8% and 11.6 % respectively). Parental education level is considered a good indicator for socio-economic status in The Netherlands [26] and is preferred when statistically controlling for socio-economic status in a regression model [27]. Quantitative (i.e. presence or amount) and qualitative aspects of neighborhood characteristics were entered simultaneously in each step of the analyses.

In order to quantify the association between the environmental characteristics and outdoor play when adjusted for the environmental characteristics from other topics, multivariate regression analyses were also performed. In these analyses, all significant (p-value < 0.05) variables from the analyses per topic were entered into a multivariate model, which was also adjusted for age of the child and parental education level. Non-significant variables were removed one-by-one from the multivariate models, until all variables were statistically significant (p-value < 0.05, except for the potential confounders age of the child and parental education level which were forced into the multivariate model irrespective of significance). All analyses were re-run with a more liberal p-value of 0.10 to prevent that potentially important variables were excluded too easily from the multivariate models.

CHAPTER 4

Results

Characteristics of the study population

The characteristics of the study population are summarized in Table 4.1. The study included 1,849 boys and 1,802 girls with an average age of 7.8 years. The average time spent on outdoor play was 411 minutes per week. There were no significant differences in characteristics between boys and girls of the same age groups, except for time spent on outdoor play, which was significantly higher for boys compared to girls in the age groups 7–9 and 10–12 years (p-value = 0.002 and 0.003 respectively).

Respondents included in this study were not different compared to respondents living outside the observed neighborhoods (based on the original sample derived from the questionnaire) with respect to gender, age, and BMI of the child, percentage of overweight and obese children, and amount of time spent on outdoor play, except for parental education level and net household income, which were significantly lower among the respondents included in the neighborhood observations.

Environmental correlates of outdoor play

Table 4.2 shows the association between neighborhood characteristics and outdoor play as derived from the multivariate analyses for each subgroup of the study population. Due to space limitations, the analyses per topic are not shown, but these can be retrieved from the corresponding author on request.

In the multivariate models, parental education level was negatively associated with outdoor play in the two highest age groups. The relative rates ranged from 0.94 to 0.96 between boys and girls in these two age groups.

With regard to the topic “buildings”, the maintenance of houses in the neighborhood was negatively related to outdoor play among boys aged 10-12 years (RR = 0.88). Within the topic “formal outdoor play facilities” the number of formal outdoor play facilities per km^2 was negatively related to outdoor play in four out of six subgroups (RR = 0.99 in each subgroup), whereas the quality of formal outdoor play facilities was unrelated to outdoor play in all subgroups.

Table 4.1: Characteristics of the study population [a]

	Age 4-6 years [b]		Age 7-9 years		Age 10-12 years [b]		Total
	Boys (n = 637)	Girls(n = 611)	Boys (n = 692)	Girls (n = 665)	Boys (n = 520)	Girls (n = 526)	(n = 3,651)
Age (years)	5.0 (0.8)	5.0 (0.8)	8.0 (0.8)	8.0 (0.8)	10.7 (0.7)	10.7 (0.7)	7.8 (2.4)
BMI [c] (kg/m^2)	15.4 (2.0)	15.2 (2.2)	16.3 (2.7)	16.4 (2.7)	17.5 (3.2)	17.4 (2.8)	16.3 (2.7)
Overweight [d] (%)	6.5	10.2	11.2	12.9	10.6	11.7	10.5
Obesity [d] (%)	3.4	3.8	3.1	4.3	2.7	1.3	3.2
Parental education level (%)							
- Low [e]	25.3	26.4	29.5	28.1	35.0	35.6	29.6
- Intermediate [f]	36.6	40.6	36.4	37.4	33.3	31.9	36.2
- High [g]	38.1	33.1	34.1	34.4	31.7	32.5	34.1
Net household income (Euros per month)	2,754 (1,230)	2,818 (1,277)	2,814 (1,303)	2,761 (1,326)	2,720 (1,345)	2,596 (1,289)	2,751 (1,295)
Outdoor play (minutes per week)	408 (266)	378 (256)	455 (289)*	398 (272)*	444 (284)*	381 (285)*	411 (277)

[a] Values are mean (SD), unless otherwise specified; [b] In The Netherlands, children aged 4-12 years are educated at the same primary school. In the current study sample, two children in the lowest age groups were aged 3 years and 8 children in the highest age groups were aged 13 years. These children were included in the lowest (4-6 years) and highest (10-12 years) age groups, respectively; [c] Based on parental self report of height and weight of their child; [d] Based on age and gender specific cut off points as provided by Cole et al. [19]; [e] No education, primary education, lower general secondary education or lower vocational education; [f] Higher general secondary education, pre-university education or intermediate vocational education; [g] Higher vocational education or university; * Significant differences between boys and girls of the same age group ($p < 0.05$).

Table 4.2: Association between neighborhood characteristics and outdoor play: multivariate analyses [a]

		Age 4-6 years [b]		Age 7-9 years		Age 10-12 years [b]	
	Possible range	Boys	Girls	Boys	Girls	Boys	Girls
Confounders							
Age (years)	3-13 [b]	-	-	-	-	-	-
Parental education level	1-8	-	-	0.95 (0.93-0.98)	0.94 (0.91-0.97)	0.94 (0.92-0.96)	0.96 (0.93-1.00)
Buildings							
Residential density	198-368 [c]	-	-	-	-	-	-
Land use mix	0-100%	-	-	-	-	-	-
Presence of unoccupied houses	0-4	-	-	-	-	-	-
Maintenance of houses	1-3	-	-	-	-	0.88 (0.83-0.93)	
Outdoor play facilities							
Number of formal outdoor play facilities per km^2	1,99 - 51,85 [c]	-	-	0.99 (0.99-1.00)	0.99 (0.98-0.99)	0.99 (0.99-1.00)	0.99 (0.98-1.00)
Quality of formal outdoor play facilities	0.00-1.00	-	-	-	-	-	-
Public space							
Presence of green space	0-3	-	-	-	-	-	-
Quality of green space	0.00-1.00	-	-	-	-	-	-
Presence of water	0-3	-	-	-	-	-	-
Quality of water	0.00-1.00	-	-	-	-	-	-
Street pattern							
Presence of sidewalks	0-3	1.44 (1.16-1.18)	1.66 (1.39-1.99)	-	-	-	1.45 (1.05-2.01)
Quality of sidewalks	0.00-1.00	-	-	-	-	-	-
Presence of bike lanes	0-3	-	-	-	-	-	-
Quality of bike lanes	0.25-1.00	-	-	-	-	-	-
Traffic safety							
Presence of pedestrian crossings without traffic lights	0-3	-	1.14 (1.01-1.28)	1.20 (1.11-1.29)	-	-	-

Table 4.2: Association between neighborhood characteristics and outdoor play: multivariate analyses [a]

		Age 4-6 years [b]		Age 7-9 years		Age 10-12 years [b]	
	Possible range	Boys	Girls	Boys	Girls	Boys	Girls
Presence of pedestrian crossings with traffic lights	0-3	1.13 (1.08-1.19)	-		0.79 (0.67-0.92)	-	-
Presence of traffic lights	0-3	-	-	-	1.48 (1.28-1.72)	-	-
Presence of refuges / safety islands	0-3	-	-	0.89 (0.85-0.93)	-	0.96 (0.93-1.00)	-
Presence of parallel parking places	0-3	-	-	-	-	1.17 (1.07-1.28)	-
Presence of parking lots (grouped)	0-3	-	-	1.28 (1.18-1.38)	-	-	-
Presence of speed bumps	0-3	-	-	1.25 (1.13-1.37)	-	-	-
Presence of home zones	0-3	1.06 (1.02-1.11)	-	-	-	-	-
Presence of 30 km/ hour zones	0-3	-	-	0.82 (0.76-0.89)	-	0.91 (0.86-0.97)	-
Presence of roundabouts	0-3	1.14 (1.07-1.22)	-	1.15 (1.06-1.24)	1.12 (1.01-1.25)	1.10 (1.04-1.16)	-
Presence of intersections	0-3	0.82 (0.74-0.91)	0.78 (0.66-0.91)	0.81 (0.73-0.90)	0.78 (0.69-0.88)	0.87 (0.79-0.97)	-
Traffic volume and speed	0-18	-	-	-	-	-	-
Social characteristics							
Presence of dog walking area	0-1	-	-	-	-	-	-
Presence of litter basket for dog waste	0-1	-	-	-	-	-	-
Presence of graffiti	0-3	-	-	-	-	-	-
Presence of vandalism	0-3	-	-	-	-	-	-
Presence of street lighting	0-1	0.78 (0.97-0.86)	-	-	-	-	-
Presence of dark spaces	0-3	-	-	-	-	-	-
General impression							
General impression	1-10	-	-	-	-	-	-

[a] Values are relative rates (95% CI). Only significant associations are shown (p-value < 0.05), if the confidence interval contains the value 1.00, this was due to rounding off; [b] In The Netherlands, children aged 4-12 years are educated at the same primary school. In the current study sample, two children in the lowest age groups were aged 3 years and 8 children in the highest age groups were aged 13 years. These children were included in the lowest (4-6 years) and highest (10-12 years) age groups, respectively; [c] For the variables residential density and number of outdoor play facilities per km2, the actual range instead of the possible range is shown; CI = Confidence interval.

None of the variables included in the topic "public space" were significantly related to outdoor play in any of the subgroups.

Within the topic "street pattern" the presence of sidewalks showed a positive association with outdoor play among boys aged 4-6 years (RR = 1.44), girls aged 4-6 years (RR = 1.66) and girls aged 10-12 years (RR = 1.45).

Several variables within the topic "traffic safety" were positively related to outdoor play in the different subgroups included in this study: the presence of pedestrian crossings *without* traffic lights (e.g. zebra crossings) among girls aged 4-6 years (RR = 1.14) and boys aged 7-9 years (RR = 1.20), the presence of pedestrian crossings *with* traffic lights among boys aged 4-6 years (RR = 1.13), the presence of traffic lights among girls aged 7-9 years (RR = 1.48), the presence of parallel parking spaces among boys aged 10-12 years (RR = 1.17), the presence of grouped parking lots among boys aged 7-9 (RR = 1.28), the presence of speed bumps among boys aged 7-9 years (RR = 1.25), and the presence of home zones among boys aged 4-6 years (RR = 1.06) Other traffic safety items were negatively associated with outdoor play: the presence of pedestrian crossings *with* traffic lights, the presence of refuges or safety islands among boys aged 7-9 years and boys aged 10-12 years (RR = 0.89 and RR = 0.96 respectively), and the presence of 30 km / hour zones among boys in the highest two age groups (RR = 0.82 and 0.91 for boys aged 7-9 and 10-12 years respectively). In general, the presence of roundabouts was positively associated with outdoor play (RR ranged from 1.10 to 1.15 in four out of six subgroups), whereas the presence of intersections was negatively associated with outdoor play (RR ranged from 0.78 to 0.87 in five out of six subgroups). Traffic volume and speed was not significantly related to outdoor play in any of the subgroups.

None of the variables included in the topic "social neighborhood characteristics" were significantly related to outdoor play in any of the subgroups, except for street lighting, which showed a negative association with outdoor play among boys age 4-6 years (RR = 0.78) .

Likewise, the general impression of activity-friendliness of the neighborhood for children was not significantly related to outdoor play. Rerunning the analyses with a p-value of 0.10 did not drastically alter the results (data not shown).

Discussion

This study showed that, apart from individual factors such as parental education level, certain modifiable characteristics in the neighborhood environment (as measured by neighborhood observations) were associated with outdoor play

among boys and girls of different age groups in The Netherlands. The finding that parental education level was negatively associated with outdoor play, might be explained by the fact that higher educated parents have more financial resources for organized sports activities, and that this substitutes time spent on outdoor play [28]. Moreover, as lower educated parents might live in smaller houses, this makes it more likely for children to play outdoors. Another explanation might be found in the finding that parents living in more socio-economic deprived areas are more likely to allow their children to take part in outdoor activities independently [29]. Veitch et al. recently have shown that the correlation between parental education level and the time spent on outdoor play, is different for different outdoor play locations, i.e. children of higher educated parents are more likely to play in the private yard at home, but are less likely to play in their own street, in a park or on a play ground [30].

In contrast with the expectation, the number of formal outdoor play facilities showed a small, but significant, negative association with outdoor play among four out of six subgroups whereas the quality of formal outdoor play facilities was unrelated to outdoor play. On the other hand, the presence of sidewalks and parallel or grouped parking places was positively associated with outdoor play in three subgroups. This might indicate that in The Netherlands “informal” play areas such as sidewalks might be more important in relation to outdoor play than the formal play facilities such as playgrounds or school yards. This hypothesis is in line with other Dutch research using neighborhood observations, which suggests that the presence of parallel parking places might serve as an informal place to play, or could function as a barrier between children playing on the sidewalks and cars on the road [15]. The fact that the positive association between sidewalks and outdoor play was found in the lowest age group (both boys and girls) suggests that especially for younger children, sidewalks provide for an informal play space close to their home, suitable for outdoor play activities such as rope skipping, hopscotch or skating.

Features of the public space (i.e. presence and quality of green space and water), characteristics of the buildings in the neighborhood, social neighborhood characteristics and the general impression of activity-friendliness of the neighborhood for children were mostly unrelated to outdoor play. USA accelerometer and GIS data among overweight children however, did find a positive association between parks in the neighborhood and children’s physical activity [31]. This might be due to the absence of sidewalks in such areas. UK data on the other hand showed that most of children’s outdoor physical activity occurs in non-green urban environments [32], which is in line with the finding from the present study that sidewalks may provide for an important outdoor play opportunity. These discrepancies

underline the difficult comparison between research results from the USA vs. Europe. Although the walkability concept (including land-use mix and residential density) has shown to be of importance in relation to active commuting to school [33], the results of the current study do not point to an important role for walkability of the neighborhood in relation to a specific component (namely outdoor play) of physical activity among Dutch children, except for the presence of sidewalks, which might be part of the walkability concept as well. Holt et al. even suggest that low-walkable neighborhoods (with for example many cul-de-sacs) are more beneficial for younger children to get involved in outdoor play [34]. Moreover, in comparison with cities in for example the USA, neighborhoods in medium-sized Dutch cities are already very walkable, which could also explain why the traditional walkability items do not relate to outdoor play in our study. Taken together, these findings suggest that walkability is a different concept than "playability" and that these concepts should be considered in relation to the specific environmental context.

Furthermore, Giles-Corti et al. argue that traffic safety should be included into the walkability concept when applied to children's physical activity behavior [33]. Items within the topic traffic safety indeed did show significant associations with outdoor play in the current study, although there was some variation across subgroups (more specifically, traffic safety items were related to outdoor play particularly among boys). The presence of pedestrian crossings or traffic lights was positively associated with outdoor play as was the presence of parking places. The fact that some traffic items such as the presence of refuges / safety islands were negatively associated with outdoor play, may reflect the fact that these infrastructural facilities are usually present at busy streets. Quite consistently among all subgroups, we found a negative association between the presence of intersections and outdoor play on the one hand, and a positive association between the presence of roundabouts and outdoor play on the other hand. Together with results from other studies that demonstrate the importance of parental (traffic) safety concerns [35], this might be a valuable finding for policy makers within sectors such as spatial planning and traffic and transportation, when (re)designing neighborhoods that are activity-friendly for children. Because the influence of road safety on children's physical activity level is dependent on age, gender and type of physical activity [36-38] it remains important to pay attention to these differences and the local neighborhood context.

Social neighborhood characteristics were not related to children's outdoor play behavior in this study. This is in contrary to a previous study among the same study population using subjective methods (i.e. written questionnaires for parents) to quantify the environmental characteristics related to outdoor play among chil-

dren [9]. In the previous study, perceived social neighborhood characteristics such as social cohesion were consistently (and positively) related to outdoor play. Social cohesion however, is a different concept than the social neighborhood characteristics as measured with the observation protocol in this study, which might be an explanation for the discrepancies between the two studies. For example, the social cohesion measure in our previous study included items about the values, norms, and trust prevailing among neighborhood residents, and those concepts are difficult to measure by means of neighborhood observations.

Regarding the study design, some limitations should be mentioned. Due to the cross-sectional design of the study, no causal relations can be demonstrated. However, because we derived the outcome measure and the neighborhood characteristics from different data sources, same source bias was prevented [39]. Although the questionnaires were administered one year earlier than the neighborhood observations, it is unlikely that the neighborhood characteristics have changed within the time span of one year.

Although the questions on physical activity were not validated, the questions were derived from a standard questionnaire used for monitoring purposes in the Netherlands [40]. Because of the large scale set up of the study, it was not possible to measure children's physical activity level more objectively (e.g. by use of accelerometers). Moreover, accelerometers cannot give information about the amount of time spent on specific types of physical activity (such as outdoor play, sports participation or active commuting), whereas these different types of physical activity are presumably associated with different environmental characteristics [17].

Lastly, because data were collected in four medium sized cities in the South of The Netherlands, results can only be generalized to other cities with a comparable size and population. The results are particularly suitable for underpinning local policy measures in the four participating cities.

In conclusion, this study shows that the quantity and quality of formal outdoor play facilities were not positively related to outdoor play among children in The Netherlands. Rather, informal play areas such as the presence of sidewalks were related to children's outdoor play. Also, traffic safety was an important characteristic associated with outdoor play. Local policy makers from different sectors can use these research findings in creating more activity-friendly neighborhoods for children.

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PART 2:

MULTI-SECTOR POLICY APPROACH TO CREATE ACTIVITY-FRIENDLY ENVIRONMENTS FOR CHILDREN

CHAPTER 5

Multi-sector policy approach at the local level

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Based on: Aarts MJ, Jeurissen MPJ, Van Oers JAM, Schuit AJ, Van de Goor LAM. Multi-sector policy action to create activity-friendly environments for children: A multiple-case study. Health Policy 2011, 101: 11-19.

Abstract

Background: The aim of this study is 1) to gain insight into current multi-sector policy initiatives that contribute to activity-friendly environments for children in four Dutch municipalities, 2) to investigate the role of multi-sector collaboration in multi-sector policy action, and 3) to gain insight into critical facilitators and possible challenges for multi-sector policy action aimed at creating activity-friendly environments for children.

Methods: A policy analysis was conducted in four Dutch municipalities by means of semi-structured interviews with 25 policy officers from different policy sectors. Interviews were transcribed ad verbatim and analyzed using qualitative data coding software.

Results: Each policy sector carried out policy measures related to (the environmental determinants of) physical activity among children, but most respondents were not aware of the potential effectiveness of their policy measures regarding this topic. In two municipalities structural collaboration between policy sectors was present, but the number of sectors involved was limited. Awareness and support among all policy sectors, a stimulating political environment, and knowing each other and being informed about other sectors' policies were mentioned as facilitators for multi-sector policy action. The main challenge for multi-sector policy action was lack of time and resources.

Conclusions: This study shows that multi-sector policy action aimed at activity-friendly environments could be stimulated by raising awareness and defining problem ownership, enhancing multi-sector collaboration and paying attention to facilitators and challenges.

Background

Lack of physical activity among children is a serious problem in many affluent countries and has several unfavorable health consequences such as an increased risk of development of overweight and obesity, cardiovascular disease, hypertension, diabetes, psychosocial problems and a poor development of motor skills [1-3]. Nowadays, there is growing attention for the role of environmental characteristics in determining children's physical activity level. Next to individual characteristics, physical and social environmental characteristics such as access to recreational facilities, traffic situation, social safety and social cohesion are suggested to be related to children's physical activity behavior such as outdoor play, sports participation or active commuting to school [4-7]. Creating environments that are attractive and stimulating for children to be physically active, in other words creating "activity-friendly environments" is seen as a promising strategy to stimulate an active life style among children [7].

In their report on promotion of active living in urban environments, The European division of the World Health Organization highlights the role of local governments in creating activity-friendly environments [8]. Furthermore, policy measures from policy sectors outside the public health domain, for example the policy sectors spatial planning, traffic and transportation, safety and social affairs, are warranted to create activity-friendly environments for children [9-11]. Recently, several Dutch advisory boards conclude that there is a large potential health gain, if national and local governments adopt a multi-sector approach in tackling health problems such as physical inactivity [12].

Nevertheless, Dutch semi-scientific (grey) literature indicates that multi-sector health policy initiatives (sometimes referred to as Health in All Policies) at the local level are limited and local policy makers may experience various barriers for conducting multi-sector policies [13, 14]. A possible and promising strategy to promote multi-sector policy action, is by stimulating multi-sector collaboration 15, 16. Empirical research addressing multi-sector policy action (including multi-sector collaboration) however is scarce and facilitators and challenges for multi-sector policy action at the municipal level are poorly documented.

Therefore the aim of this study is threefold:

1. To gain insight into current multi-sector policy initiatives that contribute to activity-friendly environments for children in four Dutch municipalities;
2. To investigate the role of multi-sector collaboration in multi-sector policy action;

3. To gain insight into critical facilitators and possible challenges for multi-sector policy action aimed at creating activity-friendly environments for children.

Methods

Complex organizational phenomena, such as multi-sector policy action, are best studied with qualitative research methods, especially when the research field is still in its infancy and no clear cut hypotheses are available in advance [17]. Case study research is particularly suitable, because it pays attention to the contemporary and contextual conditions in relation to the topic under research [18].

Case selection

The cities selected for this study were participating in a large scale research project described in more detail elsewhere [19]. At the start of this project in October 2006, five municipalities were approached by letter for participation in the project and were given more detailed information during a personal meeting. The municipalities were chosen from the service domain of the Regional Public Health Services associated with the Academic Collaborative Centre Public Health of Tilburg University. Due to lack of time and lack of interest in the topic, one municipality decided not to participate. Hence, the research project was conducted in four medium sized cities in The Netherlands (to guarantee complete anonymity of the respondents in the study, city names are blinded throughout the text). Table 1.1 (Chapter 1) summarizes the main characteristics of the cities that were enrolled. Despite the fact that one municipality (municipality D) is somewhat smaller compared to the other three municipalities, the four municipalities show much resemblance regarding the composition of their population.

In each municipality, six policy sectors (public health, sports, youth and education, spatial planning / public space, traffic and transportation, and safety) were included in the study because of their potential influence on the environmental determinants of children's physical activity behavior [20]. In two municipalities, an additional policy sector was included (environmental affairs and play facilities for municipalities B and D respectively). Although collaborations with (semi)public or private parties outside the municipal organization (such as sports clubs or housing corporations) are very common [21] and can also have beneficial effects on the integrated approach of stimulating physical activity, these collaboration initiatives

were beyond the scope of this study, which merely focused on multi-sector policy collaboration within the municipal organization.

Data collection

Semi-structured face-to-face interviews were conducted with policy officers of the different policy sectors in each municipality between February and May 2009. The Dutch municipal government consists of a (rather extensive) bureaucratic level staffed by policy officers, which supports the political level (aldermen and mayor) in administrating the municipality. The members of the municipal council supervise the alderman and mayor and hold power of decision. Whereas the alderman and municipal council members are re-elected every four years, the pool of policy officers remains more stable over time. Therefore, respondents in this study were deliberately chosen from the municipal bureaucratic system, because it was supposed that the policy officers were best informed regarding the content of the policies within their sector and because this would yield a homogenous group of respondents. Respondents were recruited by means of "snowball sampling", starting with existing contacts with policy officers in the public health domain within each municipality, who referred to their colleagues from other policy sectors. Except for one policy officer youth and education (municipality D), all invited policy officers were willing to participate in the study. In total, 25 respondents (policy officers) were interviewed, resulting in an average of six interviews per municipality.

A semi-structured interview protocol was developed specifically for the purpose of this study. The interview protocol was submitted for evaluation to three Dutch academic experts in the field of public health policies, which led to some minor changes in the protocol. The final interview protocol included the following topics: (a) policy initiatives (policy plans, policy measures or policy actions) that are undertaken to stimulate physical activity in children or that address the environmental determinants of physical activity in children, (b) collaboration with other policy sectors (collaboration network) regarding these policy initiatives, (c) collaborating strategy, (d) interrelatedness of the actors in the collaboration network and (e) facilitators and challenges in multi-sector policy action. In addition to the preset topics, respondents were explicitly asked to bring in other relevant topics when considered needful.

Interviews were conducted by one of the authors and had an average duration of 45 minutes. On request of two respondents, two interviews were conducted by

telephone. With permission of the respondents, all interviews were audio-taped with a digital recording device. After completion of the 25 interviews, the interviewer felt that a saturation point was reached, as no new information was gathered anymore during the last interviews. To ensure that respondent could speak freely, complete anonymity in all external reports was guaranteed.

Data analysis

All interviews were overheard afterwards by two authors and transcribed ad verbatim by research assistants. The transcripts were coded and analyzed using the qualitative data analysis software package Atlas.ti version 6.0 (Atlas.ti, Berlin, Germany). Coding interview transcripts with analytical software contributes to a more systematic analysis of qualitative data and prevents information-processing bias [22]. Based on the interview protocol, a list of coding constructs was compiled and all interview transcripts were coded by one author. When necessary, extra codes were added to the coding list during the coding process. Two other authors independently coded a subset of four interviews and these results were compared with the codes of the first coder. By comparison and discussion of the results, some small adjustments were made to the coding protocol (particularly, some codes were merged, because they had too few distinguishable characteristics). Finally, all interviews were coded once again with the renewed protocol by one author. Data were analyzed case by case and whenever appropriate, data were pooled for the four municipalities or per policy sector. Cross-case analyses were performed to identify similarities and differences between cases in perceived facilitators and challenges for multi-sector policy action.

Results

Policy initiatives related to activity-friendly environments

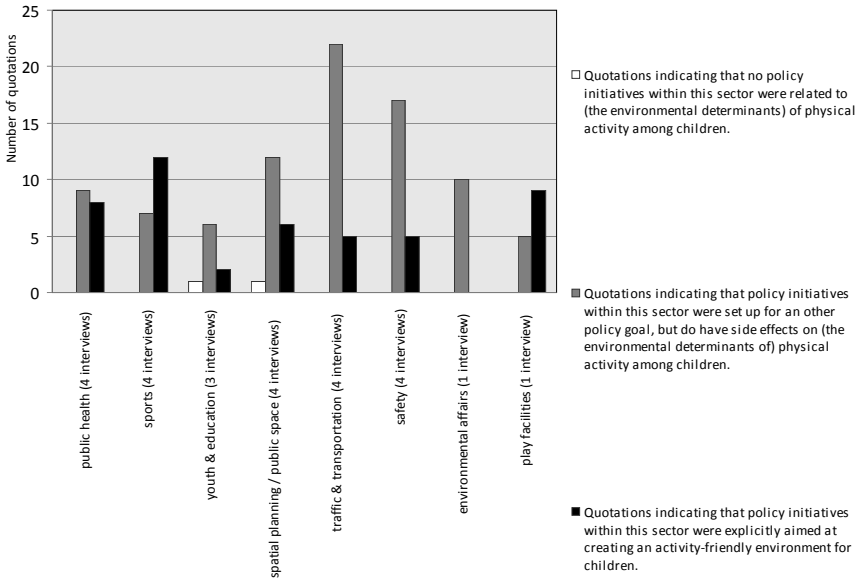
Based on the number of quotations in the transcripts (pooled for the four municipalities), Figure 5.1 gives an indication of the current policy initiatives of the different policy sectors addressing (the environmental determinants of) physical activity in children. The policy initiatives mentioned by the respondents included written policy plans such as a plan for play facilities (municipality A), a bicycle memoran-

dum and air quality plan (municipality B), and a sports memorandum and public health memorandum (municipality C). In municipality D one respondent also mentioned official policy guidelines for distribution of play facilities within neighborhoods. More often however, respondents came up with practical examples of policy measures and projects that were implemented in their municipality, such as the construction of a sports track, increasing social safety at squares by means of placing cameras, lighting and prohibition of gatherings of (problem) youth, providing low-income families with tickets to participate in cultural and sports activities (municipality A), organizing street soccer competitions with famous soccer players, providing sufficient bicycle sheds at popular destinations (municipality B), introduction clinics of sports clubs at primary schools and stimulating active transportation to school among handicapped children (municipality C), and offering after-school sports activities at primary schools, a project to diminish bicycle theft, and a project to decrease vandalism at primary school yards (municipality D).

Each policy sector enrolled in this study conducted policy initiatives that were related to the physical activity level of children or its environmental determinants, such as traffic situation, sports and play opportunities or sports education at primary schools. However, these initiatives were often not directly aimed at stimulating physical activity among children. Rather, the policy initiatives were developed for other purposes. For example a policy officer environmental affairs described the policy plans to reduce air pollution: *"In the air quality plan we have included policy measures that are beneficial for the air quality, but we want to broaden that, because it should not only be better for the air quality, but also bring down the noise of trucks and cars. And it should also lead to an attractive city centre, which is easily accessible, because that is good for the entrepreneurs. (…) We've also got some policy measures that affect the health of the citizens, not specifically children's health, but citizens in general. For example we create bike lanes that are presently absent in commonly used routes. But we also provide bicycle racks and bikes for hire and take care of the communication and marketing around it. But the first goal is always to meet the pollution norm, or even to get below those norms."*

Although some respondents were skeptical about the possible contribution of their policies to children's physical activity at first, during the interview they came up with several examples of how the current policy initiatives within their sector actually contributed to an activity-friendly environment for children. Furthermore, although the sectors public health and sports (and in municipality D also the sector play facilities) were more directly involved with physical activity and children, no single policy sector could be marked as "problem owner" for stimulating physical activity among children by means of creating an activity-friendly environment.

Figure 5.1: Policy initiatives related to (environmental determinants of) PA among children



Multi-sector policy collaboration in relation to activity-friendly environments

Figures 5.2a to 5.2d show that in two of the four municipalities (municipality A and D), collaboration between the different policy sectors had a predominantly incidental character, which meant that collaboration was only sought when there was a direct reason or occasion for it, such as the construction of a skating or cycling track for children. In the other two municipalities (municipality B and C), some form of structural collaboration between sectors had developed, which meant that policy sectors had regular meetings, even when there was no immediate cause. In municipality B, the structural collaboration was a result of a bicycle memorandum to which all collaborating sectors made contributions. Since then, these sectors had decided to meet several times a year to discuss possible common grounds in their policies regarding health and environment. In municipality C, the development of the public health memorandum (as from 2002, all Dutch municipalities are obliged to set up a public health memorandum every four years) was the immediate cause for setting up a collaborative network, which continued after the memorandum came out. Although the structural collaborations in municipalities B and C were

characterized by a high frequency of meetings (several times a year), they nevertheless did not encompass sectors related to the built environment (e.g. spatial planning / public space).

In general, respondents acknowledged the benefits of multi-sector collaboration, because they thought it increased the quality and sustainability of their policy plans: *"Multi-sector collaboration can lead to a good spatial planning, which satisfies everyone, and which has a durable quality, because a well planned neighborhood will still be a good place to live in also within ten years. We don't want to redesign a neighborhood very quickly."* (policy officer spatial planning). Respondents further mentioned the benefits of active and healthy children for other policy goals, such as education goals. In all municipalities however, respondents indicated that multi-sector collaboration was usually aimed at implementation and realization of policy measures instead of policy development such as writing a memorandum. Furthermore, in most collaboration initiatives, there was no plan of action, no concrete objectives were formulated and according to the respondents, the finance structure was still separated between policy sectors. The relationship between the different sectors involved in the collaboration was mostly described as positive and respondents shared the opinion that different policy sectors need each other to achieve the best results: *"If you want to change something in the built environment, then you need them [the other policy sectors like spatial planning]. You need them for the realization, but also for financial reasons."* (policy officer youth and education, talking about making school environments more activity-friendly).

Figure 5.2a: Multi-sector collaboration in municipality A

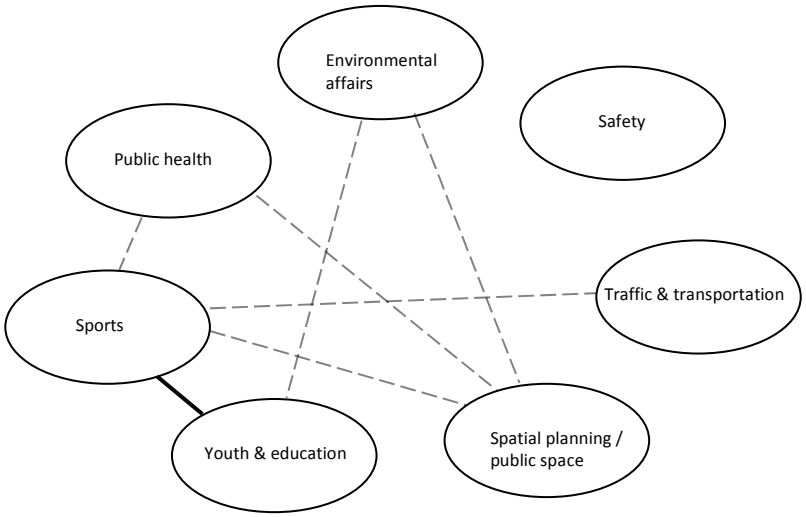


Figure 5.2b: Multi-sector collaboration in municipality B

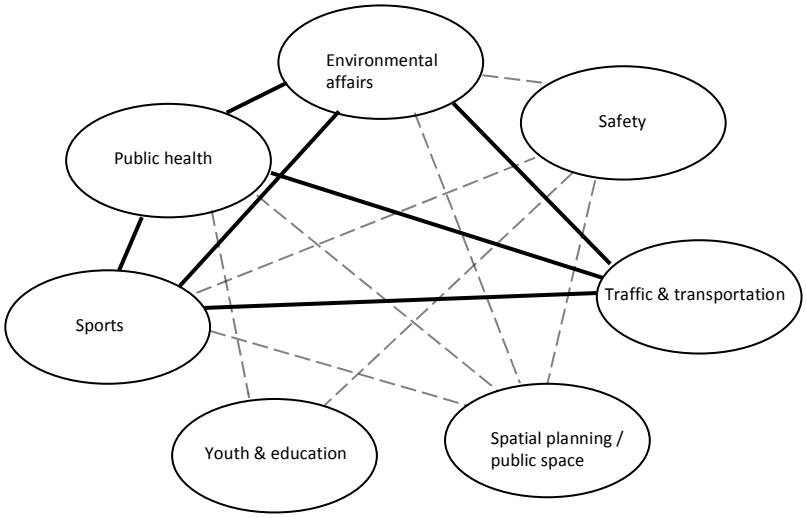


Figure 5.2c: Multi-sector collaboration in municipality C

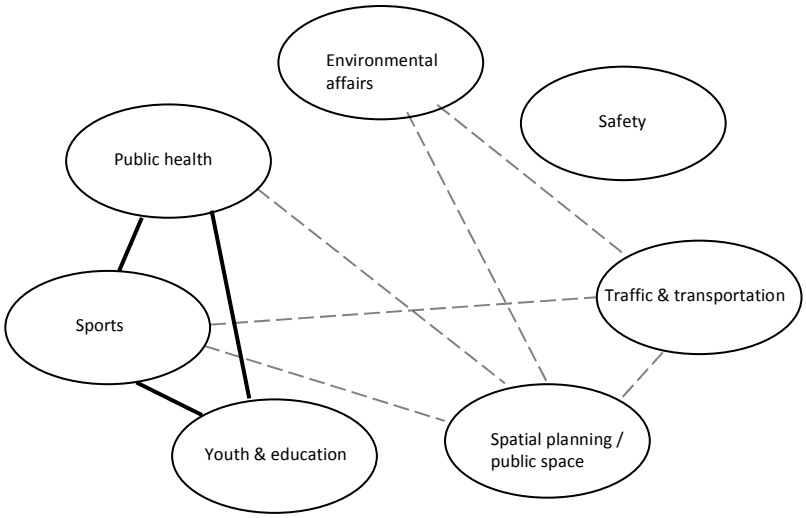
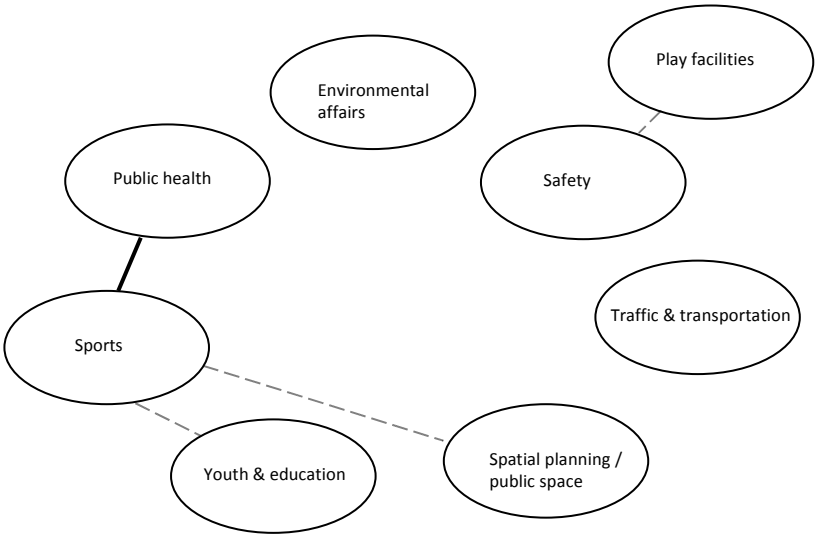


Figure 5.2d: Multi-sector collaboration in municipality D



Solid lines represent structural collaboration, dashed lines represent incidental collaboration. The policy sectors environmental affairs and play facilities were only interview in municipality B and D respectively.

Respondents further underlined the importance of "knowing each other" and being informed about policy plans of other policy sectors, which facilitates timely connection with other policy initiatives. Other facilitators for multi-sector policy action that were put forward by the respondents included working in small settings (the number of employees per municipality ranged from 679 to 2,189 in this study), a low turnover of policy officers and increased mandate among lower policy officers, so that unnecessary deceleration of the policy process due to gathering permission from executives is prevented. Respondents also proposed that there should be more attention for multi-sector policy development during education of policy officers such as at the School for Public Administration and that current policy officers should be trained for the special skills they need for multi-sector policy action, such as negotiation and persuasion techniques: *"We need professionalization. (…) It stays limited to the call for an intersectoral approach, but I think you have to train people for that, because they need other skills."* (policy officer public health).

The most frequently mentioned challenge for multi-sector policy action was lack of time and resources. Besides the view that politicians do not always provide sufficient financial resources to carry out the policy plans that are desired, lack of time among policy officers was mentioned as a real bottleneck for multi-sector policy action. *"Multi-sector collaboration always takes time. It always delays the process. You have to get around the table with more people, so more ideas will come up, and those ideas do not always fit your own ideas. As a consequence, you have to adjust your plans."* (policy officer traffic and transportation). Lack of support from other policy domains for policy plans aimed at creating activity-friendly environments was mentioned to be a challenge as well. Lack of awareness of the effect of policy plans on activity-friendliness of the environment among other policy sectors, but also among politicians was frequently mentioned as a challenge in multi-sector policy action. Respondents also mentioned that the fact that politicians such as municipal council members and alderman are elected every four years, did not support the development of multi-sector policy plans, because such plans usually take more time to show off effects. Respondents indicated that conflicting visions and interests among different policy sectors can hamper multi-sector policy actions as well. For example in new housing developments, esthetic interests or financial concerns (e.g. selling as many houses per square kilometer as possible) often get priority over health considerations. When comparing data across municipalities, it appeared that except for some small divergences, the three most important overall facilitators and challenges described above were also rated as highly important in each individual municipality.

Discussion

This study provides insight into the current multi-sector policy actions aimed at creating activity-friendly environments for children, the role of multi-sector policy collaboration herein, and explores facilitators and challenges for such a multi-sector policy approach in four Dutch municipalities. Based on the results of this and other studies, opportunities for further enhancing multi-sector health policies are discussed below.

Raising awareness and defining problem ownership

This study showed that policy officers from sectors outside the public health domain were not always aware of the (side) effects of their policy initiatives on activity-friendliness of the environment, which implicates that gains could be achieved by making these policy officers more conscious about the potential health effect of their policy initiatives. In addition, this study showed the importance of increasing awareness and support for a multi-sector approach among politicians such as aldermen and municipal council members as well. This finding was also supported by another Dutch study focusing on the municipal setting, which emphasized the importance of multi-sector collaboration at the strategic and tactical level (e.g. collaboration between the management of different policy domains) [23].

Figure 5.3a: Facilitators for multi-sector policy action

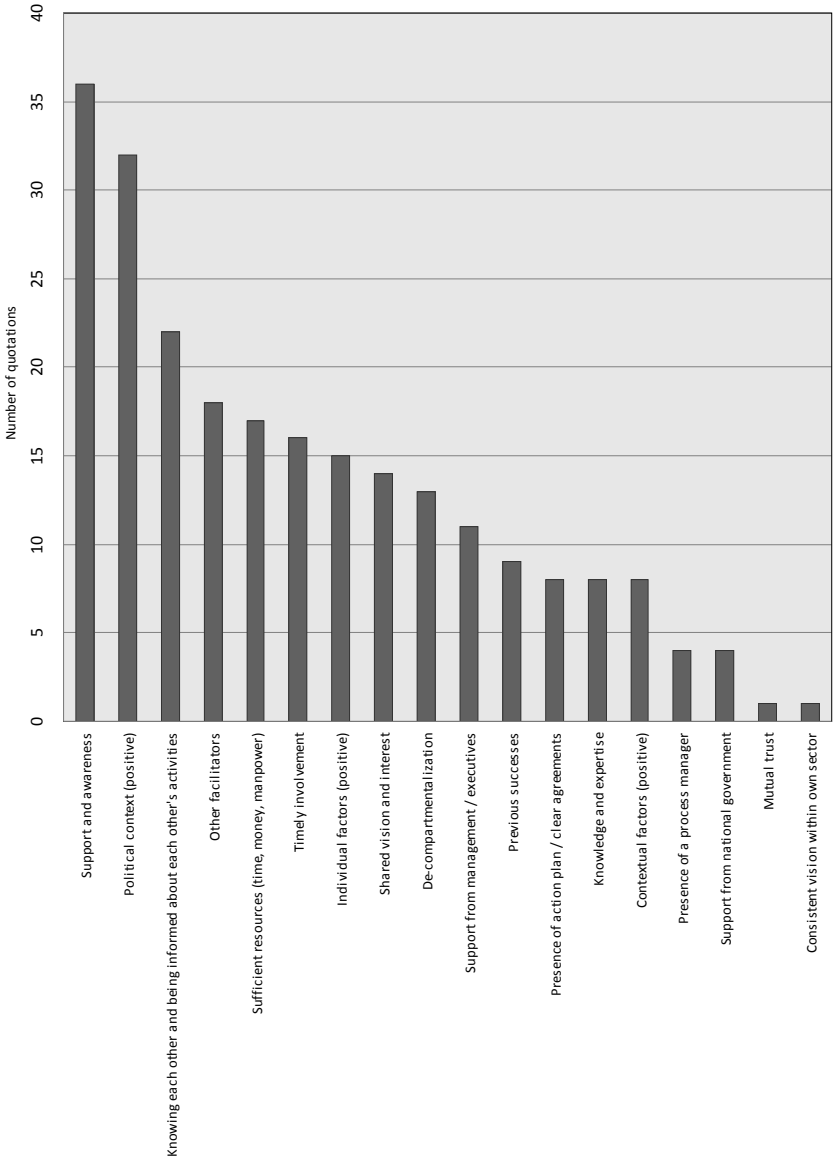
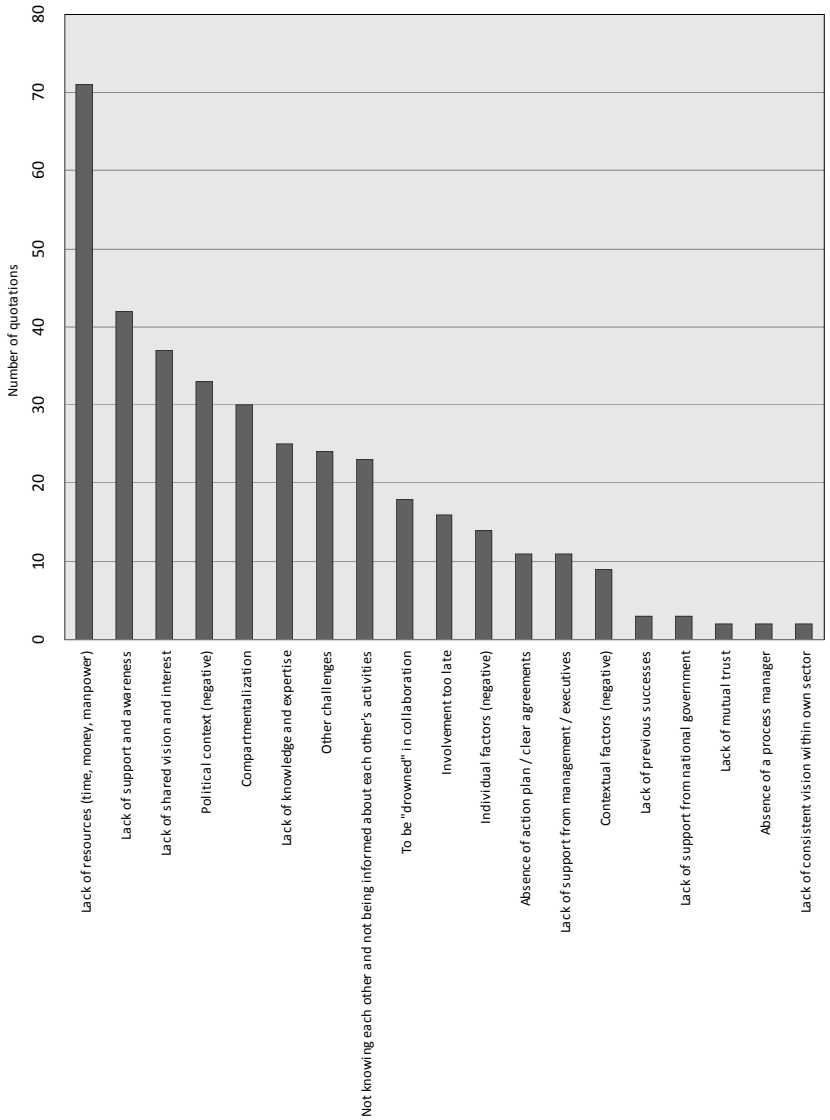


Figure 5.3b: Challenges for multi-sector policy action



A formal policy tool such as Health Impact Assessment (HIA) is likely to stimulate awareness of health effects of policy plans outside the public health sector. For example, after the introduction of HIA in Slovakia it was concluded that intersectoral policy development could benefit from more a formal working framework such as HIA [24]. However, HIA is a reactive tool aimed at quantifying the potential health effects of intended policy plans outside the public health domain, and as such it does not actively stimulate other policy sectors to contribute to an activity-friendly environment [25]. Therefore, HIA might be helpful, but not sufficient, to raise awareness among other policy sectors.

This study further showed that each of the policy sectors contributed to an activity-friendly environment, but no single policy sector could be marked as "problem owner" for this topic. In line with previous Dutch research [21, 26] this indicates that multi-sector policy action can benefit from a more explicitly defined problem ownership and role of the actors involved. The sectors public health, sports and youth and education could be marked as problem owners for the multi-sector approach of physical inactivity among children and could take the lead in future multi-sector policy initiatives. This requires action at a higher (political) level, for instance aldermen of several sectors involved could initiate a multi-sector approach and assign one of the sectors with the leadership of such an integrated approach. In order to achieve this, the "problem" should have political urgency, or at least be at the political agenda, a phenomenon extensively addressed by Kingdon [27].

An alternative possibility to enhance multi-sector policy action is the appointment of an explicit liaison officer that acts as the problem owner for multi-sector health policy development. In one of the municipalities included in this study, a liaison officer called "health broker" had recently started to actively involve other municipal policy domains in public health topics, but because this concept was still in an early stage, it was too early to show off effects yet.

Further enhancing multi-sector collaboration

In two of the four municipalities some form of structural collaboration between policy sectors was present, but the number of sectors involved was still limited, a finding confirmed in other research [16]. Our finding that clear objectives and implementation plans were mostly lacking in multi-sector collaboration initiatives, was confirmed as well in a study in Sweden [28]. Respondents generally did recognize the opportunities of multi-sector policy collaboration, because they thought it

increased the quality and sustainability of their policy plans. Respondents also indicated that they were dependent on other policy sectors for achieving their own goals. As in our study, respondents in other research also shared the opinion that a single policy measure will not be sufficient to tackle complex health problems such as obesity and that an integral (and multi-sector) approach is warranted [29].

In conclusion, these findings indicate that there is room for expansion of multi-sector collaboration, and that this could have a potential stimulating effect on integrated health policy action. Successes within municipalities already involved in (structural) multi-sector collaboration (such as in municipality B and C in this study) could serve as a role model for municipalities that are willing to adopt such an approach as well. Although there is much social research into functioning of inter-organizational networks (for example of a whole network perspective see Provan et al. [30]), less scientific literature is available on intra-organizational networks and collaboration in the field of prevention-related topics, specifically at the local / municipal level. Therefore, future research could further explore the possibilities of stimulating integrated health policy through enhancing multi-sector policy collaboration at the municipal level.

Attention for facilitators and challenges

The main challenge for (structural) multi-sector policy action mentioned by the respondents in this study was lack of time and resources, which was also frequently mentioned in other research [24, 26]. Attention should therefore be given to prevailing - and perhaps appropriate - (negative) presumptions regarding multi-sector policy action, for example by education and training of (future) policy officers and politicians. Because some respondents in this study mentioned that results of multi-sector policy actions were difficult to measure and other research demonstrated that multi-sector policies can also have antagonistic (undesirable) effects [31], it is important to measure and demonstrate the positive aspects of multi-sector policy actions, such as a possible increase in quality and sustainability of policy plans. Research that provides insight into the costs (in terms of time and resource investment) and effects (on quality and sustainability of policy plans and the long term effect for public health and other policy goals) of multi-sector policy measures could help to persuade policy officers and politicians to invest in multi-sector policy action.

In addition, a positive political context at the municipal level was mentioned as an important facilitator for multi-sector policy development in this study. Other

research has shown that a national policy orientation towards “sport for all” is related to better opportunities and a better infrastructure for sports and physical activity [32]. This suggests that there is an interaction between the national and local political context. Hence, a national political context in favor of multi-sector health policy development and creating activity-friendly environments could stimulate such an approach at the local level as well.

Limitations of this study and directions for future research

This study is among the first to empirically address multi-sector policy action at the local level and the qualitative nature of this study provides in depth understanding of the multi-sector policy processes within the municipal organization. However, some methodological limitations should be mentioned. Firstly, the study was conducted in four medium-sized Dutch cities that show resemblance in location and composition of their population, and prudence is called for in generalization of the results. For example, it is likely that multi-sector collaboration processes are influenced by the number of employees within the municipal organization. Although the number of employees of the municipalities included in this study ranged from 679 to 2,189, more research is needed to clarify the role of municipal organization size on collaboration processes and multi-sector policy action. Secondly, this study focused on horizontal collaboration among policy officers of the bureaucratic system of the municipality, because a homogenous sample of respondents increases the internal validity of the results. From the interviews it has emerged however, that factors at other municipal levels, such as the management level or factors in the political context (i.e. aldermen or municipal council) can also play an important role in multi-sector policy action. Future research should therefore include different municipal organization levels and look at vertical collaboration between these levels as well [23]. In addition, this study only looked at intra-organizational collaboration, and future research should also address collaboration with (semi)public or private parties outside the municipal organization, because this can have a beneficial effect on integrated health policies as well. Lastly, although the number of quotations gives a global indication of the relative importance respondents attach to different concepts, no quantitative interpretations (e.g. in terms of percentages) can be derived from these quotations.

Conclusions

This study shows that multi-sector policy action aimed at creating activity-friendly environments for children is still in its infancy and that such an approach can be stimulated by raising awareness and defining problem ownership, further enhancing multi-sector collaboration and paying appropriate attention to facilitators and challenges.

Acknowledgements

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CHAPTER 6

Feasibility of local multi-sector policy measures

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Based on: Aarts MJ, Schuit AJ, Van de Goor LAM, Van Oers JAM. Feasibility of multi-sector policy measures that create activity-friendly environments for children: results of a Delphi study. (submitted for publication).

Abstract

Background: Although multi-sector policy is a promising strategy to create environments that stimulate physical activity among children, little is known about the feasibility of such a multi-sector policy approach. This study aims to quantify the feasibility of local multi-sector policy measures addressing environmental characteristics related to physical activity among children.

Methods: In four Dutch municipalities, a Delphi study was conducted among local policy makers of different policy sectors (public health, sports, youth and education, spatial planning / public space, traffic and transportation, and safety). In the first Delphi round, respondents generated a list of possible policy measures addressing three environmental determinants of physical activity among children (social cohesion, accessibility of facilities and traffic safety). In the second Delphi round, policy makers weighted different feasibility aspects (political feasibility, cultural / community acceptability, technical feasibility, cost feasibility and legal feasibility) and assessed the feasibility of the policy measures derived from the first round. The third Delphi round was aimed at reaching consensus by feedback of group results. Finally one overall feasibility score was calculated for each policy measure.

Results: Cultural / community acceptability, political feasibility and cost feasibility were considered most important feasibility aspects. The Delphi studies yielded 16 highly feasible policy measures aimed at physical and social environmental determinants of physical activity among children. Less drastic policy measures were considered more feasible, whereas environmental policy measures were considered less feasible.

Conclusions: This study showed that the Delphi technique can be a useful tool in reaching consensus about feasible multi-sector policy measures. The study yielded several highly feasible policy measures aimed at physical and social environmental determinants of physical activity among children and can assist local policy makers in designing multi-sector policies aimed at an activity-friendly environments for children.

Introduction

As in many other affluent countries, lack of physical activity among children is a serious problem in the Netherlands [1] and this has several unfavorable health consequences.[2-4] Next to individual characteristics, physical and social environmental characteristics such as access to recreational facilities, traffic situation, social safety and social cohesion are related to children's physical activity behavior such as outdoor play, sports participation or active commuting to school [5-8].

Creating environments that are attractive and stimulating for children to be physically active seems a promising strategy to increase physical activity among children [8, 9]. In their report on promotion of active living in urban environments, the European division of the World Health Organization highlights the role of local governments in creating activity-friendly environments [10]. Policy measures from policy sectors outside the public health domain, for example spatial planning, traffic and transportation, safety and social affairs are warranted to create activity-friendly environments for children [11-14]. Recently, several Dutch advisory boards concluded that there is a large potential health gain, if national and local governments adopt a multi-sector approach in tackling health problems such as physical inactivity [15].

Although much research has been conducted into the environmental determinants of physical activity among children, less is known about the opportunities for multi-sector policy measures to address these determinants. Values, policy context, resources and habits, and tradition play a role in the political decision making process [16] and the perceived feasibility of policy measures affects the chance that policy measures will be implemented [17]. Snowdon et al. distinguish five different aspects of feasibility: political feasibility, cultural / community acceptability, technical feasibility, cost feasibility and legal feasibility [18, 19]. Political feasibility encompasses the politicall will for policy measures, which is also influenced by the cultural acceptability. Technical feasibility is related to the practical issues that can accompany the implementation of policy measures, such as infrastructure and equipment.

The aim of this study is: 1) To identify a set of tangible (multi-sector) policy measures at the local level that address environmental characteristics related to physical activity among children; 2) To assess the multiple aspects of feasibility of these measures, as perceived by local policy makers. This research yields tailored recommendations that can assist local policy makers in developing multi-sector policies that create activity-friendly environments for children.

Methods

Study setting

The study was conducted in four medium-sized Dutch municipalities that were participating in a large scale research project described in more detail elsewhere [20]. To guarantee complete anonymity of the respondents in the study, city names are blinded throughout the text. Table 6.1 summarizes the main characteristics of the cities that were enrolled. Despite the fact that municipality D was somewhat smaller compared to the other municipalities, the municipalities showed much resemblance regarding the composition of their population.

Table 6.1: Population characteristics of municipalities included in the study [a]

Municipality	A	B	C	D	The Netherlands
Total number of inhabitants	201,259	170,349	135,648	77,450	16,357, 992
Degree of urbanization (number of inhabitants per km^2)	1,716	1,344	1,606	727	394
Percentage inhabitants aged 0 - 14 years (%)	16.7	17.3	17.2	17.6	18.1
Percentage Western immigrants (%) [b]	8.2	10.0	8.6	8.7	8.8
Percentage non-Western immigrants (%) [c]	13.4	10.2	9.9	11.9	10.6
Number of municipal employees	1,915	2,189	1,430	679	NA

[a] Characteristics per 01-01-2007 (start date of the research project). All data derived from CBS Statline [1] or the municipal organization (for number of employees); [b] Immigrants are defined as persons with at least one parent born in a foreign country. Western immigrants are all immigrants from Europe (with exception of Turkey), North-America, Oceania or Indonesia or Japan; [c] Immigrants are defined as persons with at least one parent born in a foreign country. Non-western immigrants are all immigrants from Turkey, Africa, Latin-America or Asia (with exception of Indonesia and Japan); NA = Not applicable.

Delphi method

The Delphi method is a well-founded method for reaching consensus among stakeholders in complex (policy) problems [21] and has been widely used in the field of health policies related to obesity [22-25]. Within the Delphi method, respondents are provided with the opportunity to adjust their opinion based on controlled statistical opinion (group) feedback in two or more consecutive Delphi rounds and the procedure stops when consensus is reached or response rates decrease [26]. In this study, four separate Delphi studies were conducted (one in each municipality), to

provide the municipalities with tailored results, which increases the applicability of the research in the municipal policy development process.

Participants

In the Netherlands, three levels of government exist: national, regional and local / municipal. The municipal government consists of a bureaucratic system staffed by policy officers, which supports the aldermen and mayor in administrating the municipality. The members of the municipal council supervise the aldermen and mayor and hold power of decision. Whereas the aldermen and municipal council members are re-elected every four years, the pool of policy officers remains more stable over time. Respondents in this study were chosen from the municipal bureaucratic system, because policy officers are best informed about the content of the policies within their sector and because this yields a homogenous group of respondents. Respondents were selected by means of "snowball sampling", starting with existing contacts with policy officers in the public health domain, who referred to their colleagues from other policy sectors. In each municipality, six policy sectors (public health, sports, youth and education, spatial planning / public space, traffic and transportation, and safety) were invited for participation because of the potential influence on the environmental determinants of children's physical activity [17]. On the respondents' initiative, an additional policy sector was invited in municipality B (environmental affairs), municipality C (economic affairs) and municipality D (play facilities). In addition to policy officers from the municipal organization, policy advisors from the Regional Public Health Services were invited to participate in the study. In order to prevent overrepresentation of particular policy sectors, a maximum of two respondents per policy sector within each municipality was set. In total, 36 respondents were invited for participation.

First Delphi round: brainstorm with policy makers

The first Delphi round took place at the venue of the city hall and took approximately 1,5 hour. The main results of our survey on environmental correlates of physical activity among children (conducted in the participating municipalities) were presented [5] and discussed in relation to the state of the art knowledge from scientific reviews [6, 27]. Based on this, social cohesion, accessibility of facilities and traffic safety were considered important environmental determinants of children's

physical activity [5, 6, 27] which are affected by policy measures of different policy sectors. Participants were asked to identify possible municipal policy measures that address these three determinants in a plenary brainstorm chaired by a professional discussion leader (20 minutes / determinant). Respondents were explicitly asked not to consider the feasibility of policy measures during this first round. At the end of the first round, respondents compiled a list of at least four policy measures per determinant, which were further explored in the second Delphi round.

Second Delphi round: feasibility of policy measures

The second Delphi round followed immediately after the first Delphi round and took about two hours. The five feasibility aspects derived from the literature (political feasibility, cultural / community acceptability, technical feasibility, cost feasibility and legal feasibility [18, 19]) were briefly introduced. Thereupon, each respondent individually weighted the importance of these different aspects of feasibility by dividing 100 points over the five feasibility aspects. Subsequently, each respondent was provided with a printed questionnaire and scored the policy measures derived from the first Delphi round on the five aspects of feasibility (seven-point Likert-type scale, higher scores indicated higher feasibility).

Third Delphi round: group consensus

The aim of the third Delphi round was to develop group consensus and this round consisted of a printed questionnaire sent to the respondents per post. Respondents were provided with their own scores, as well as the median group scores from the second Delphi round and were asked to re-evaluate their individual feasibility scores. Respondents unable to attend the first and second Delphi round were invited to evaluate the feasibility of the policy measures during the third Delphi round as well. These respondents were asked to first weigh the five aspects of feasibility (similar to the other respondents) and were provided with the median group scores from the second Delphi round as well.

Data analysis

By multiplying the individual weighing scores by the feasibility scores on each feasibility aspect and summing the five feasibility scores for each policy measure, one

overall (weighted) feasibility score per policy measure was calculated for each respondent. The median weighted overall feasibility score was then computed per policy measure for each municipality and per Delphi round. In addition, the standard deviation (SD) was calculated as an indicator for consensus within each municipality (higher SD scores indicate less consensus). Two respondents had missing values on their weighing scores and therefore these were imputed by the average weighing scores of the other respondents within the same municipality. Three respondents that participated in the first and second Delphi round did not return or had missing values on the questionnaire during the third Delphi round. In those cases, the missing scores on the third Delphi round were replaced by the respondent's scores from the second round.

Policy measures were considered "consistently highly feasible" if they met the following conditions in the third Delphi round: 1) weighted median overall feasibility score ≥ 5.00 and 2) standard deviation ≤ 1.00 and 3) the minimum overall feasibility score given by any individual respondent within that municipality ≥ 3.50. Policy measures were considered "consistently less feasible" if they met the following conditions: 1) weighted median overall feasibility score ≤ 4.00 and 2) standard deviation ≤ 1.00 in the third Delphi round. These criteria were chosen as natural cut off points based on the scales used and data obtained. To further compare results across municipalities, each policy measure was classified into one or more of the following categories: 1) communicative policy measures such as health education and advertisements; 2) juridical policy measures such as laws and prohibitions; 3) economic policy measures such as subsidies, grants, charges and taxes; 4) environmental policy measures such as changes in facilities, infrastructure or neighborhood design. All policy measures were classified by two authors independently and in case of inconsistencies, consensus on classification was reached by discussion.

Results

The overall response rate was 72.2% (range among municipalities 50.0%-90.0%) in the first and second Delphi round and 88.9% (range 75.0%-100.0%) in the third Delphi round (Table 6.2).

Table 6.2: Participants and response rates per municipality in the different Delphi rounds

Municipality	First and second Delphi round			Third Delphi round		
	Invited	Participated	Response	Invited	Participated	Response
A	10 (6m, 4f)	9 (5m, 4f)	90.0%	10 (6m, 4f)	10 (6m, 4f)	100.0%
B	10 (2m, 8f)	8 (1m, 7f)	80.0%	10 (2m, 8f)	9 (2m, 7f)	90.0%
C	8 (4m, 4f)	5 (2m, 3f)	62.5%	8 (4m, 4f)	6 (4m, 2f)	75.0%
D	8 (4m, 4f)	4 (2m, 2f)	50.0%	8 (4m, 4f)	7 (4m, 3f)	87.5%
Total	36 (16m, 20f)	26 (10m, 16f)	72.2%	36 (16m, 20f)	32 (16m, 16f)	88.9%

m = male, f = female

Figure 6.1a and 6.1b show that the importance respondents assign to the different aspects of feasibility are roughly the same per municipality and per policy sector: legal feasibility and technical feasibility were considered less important and cost feasibility, cultural / community acceptability and political feasibility were considered of greater importance. Furthermore, respondents indicated that cultural / community acceptability, political feasibility and cost feasibility were highly interconnected. According to the respondents, political feasibility is influenced by politicians' perceptions of community acceptability, due to electoral considerations. The political feasibility on its turn defines the financial resources that are reserved for certain policies and hence influences the cost feasibility.

Table 6.3 shows all policy measures aimed at increasing social cohesion, accessibility of facilities and traffic safety that were put forward by the respondents of the four municipalities (a detailed description of each policy measure is given in Appendix D, which can be obtained from the corresponding author on request). The scores from the third Delphi round are presented in Table 6.3. All municipalities showed an increase in perceived overall feasibility and consensus from the second to third Delphi round for the majority of policy measures, except for municipality B where consensus decreased from the second to the third Delphi round for the majority of policy measures (data not shown)

Figure 6.1a: Perceived importance of feasibility aspects per municipality

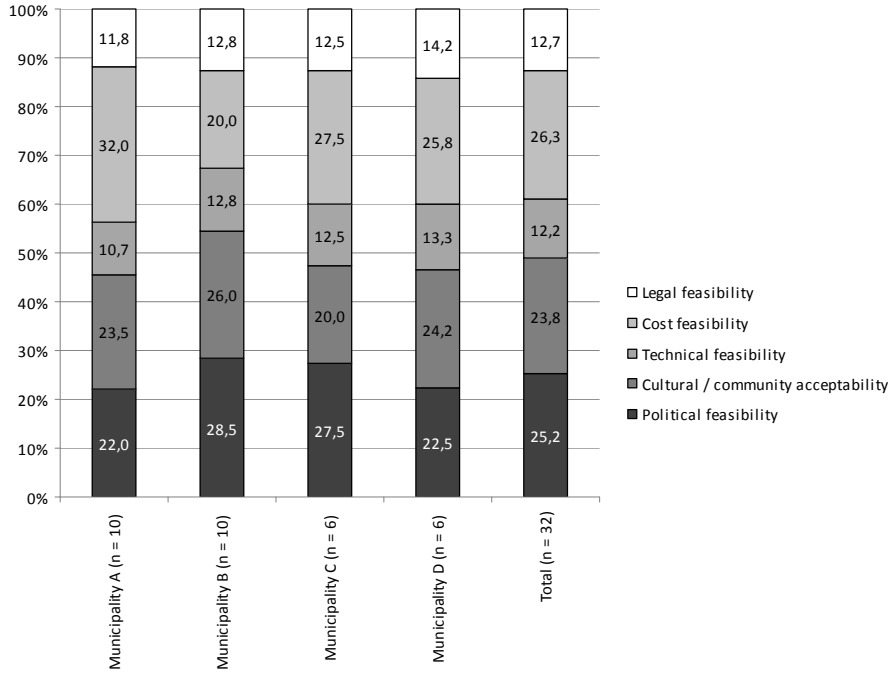

Figure 6.1b: Perceived importance of feasibility aspects per policy sector

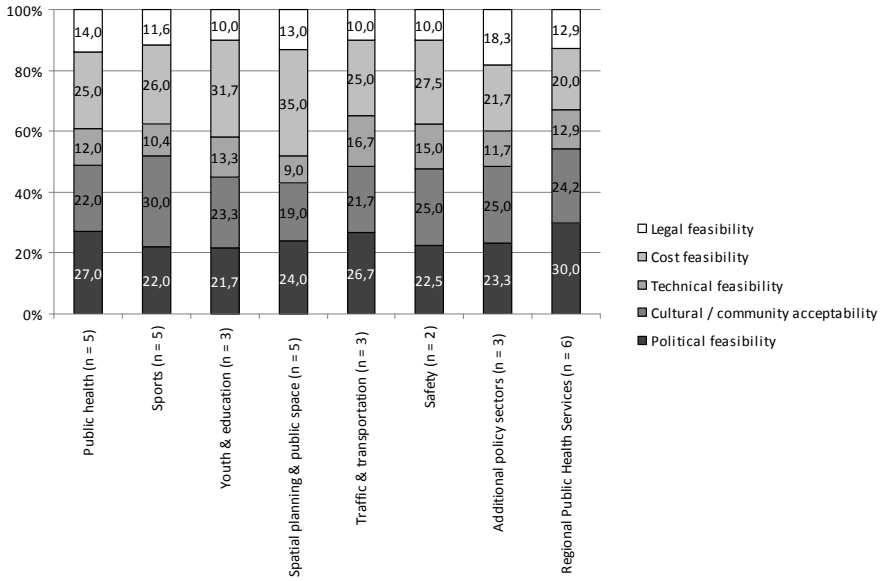

Table 6.3: Perceived feasibility of possible policy measures addressing environmental determinants of physical activity among children

Policy measures derived from the first Delphi round	Type of policy measure	Perceived overall feasibility (weighted median score) [a]	Consensus (SD)	Range
Municipality A: social cohesion				
Multi-use of school yards [b]	**Juridical / environmental**	**5.08**	**0.75**	**4.00-6.37**
Subsidy for citizens' initiatives to increase social cohesion [b]	Economic	5.05	0.80	3.10-6.30
Democratic decision process when implementing new neighborhood facilities	Juridical	4.65	0.65	4.00-6.30
Stimulate / oblige parents to choose primary school within own neighborhood [b]	Communicative / juridical	4.30	1.26	1.00-5.47
Spatial planning that enhances daily encounters [b]	Environmental	4.10	0.95	2.90-6.20
Municipality A: accessibility of facilities				
Attractive (walking) routes for children [b]	**Environmental**	**5.19**	**0.83**	**3.60-7.00**
Informal play facilities (fallow lands, sand hills)	**Juridical / environmental**	**5.01**	**0.81**	**3.80-6.50**
Multi-use of vacant parking places [b]	Juridical / environmental	4.58	0.80	3.00-5.30
Outdoor exercise facilities for adults (role models)	Environmental	4.50	0.74	3.00-5.50
Increase economic accessibility of sport facilities	Economic	4.10	0.65	3.50-5.70
Municipality A: traffic safety				
Local Safety Label for primary schools	Communicative	5.25	1.02	3.70-6.70
Fencing off streets for outdoor play	Juridical / environmental	5.25	1.41	2.00-6.04
Enhance responsibility of school boards and parents for traffic safety [b]	**Communicative**	**5.20**	**0.73**	**3.60-6.00**
Car-free / low-traffic school zones during peak hours [c]	Juridical / environmental	4.43	0.70	3.20-5.15
Municipality B: social cohesion				
Use major changes in neighborhoods to increase social cohesion	Communicative	5.43	0.90	3.00-6.20
Stimulate initiatives of citizens to increase social cohesion [b]	Economic / communicative	5.22	1.03	2.80-6.80
Multi-use of school yards [b]	Juridical / environmental	5.05	1.51	1.30-7.00
Increase social cohesion by business licensing requirements	Juridical	4.61	0.70	3.80-6.10
Municipality B: accessibility of facilities				
Attractive (walking) routes for children [b]	Environmental	5.51	1.09	2.80-7.00
Multi-use of vacant parking places [b]	Juridical / environmental	4.48	0.64	3.90-5.63
Dispersal of play facilities over the neighborhood	*Environmental*	*3.83*	*0.74*	*2.90-5.50*
Car free neighborhoods	Environmental	3.35	1.11	2.30-5.80

Table 6.3: Perceived feasibility of possible policy measures addressing environmental determinants of physical activity among children

Policy measures derived from the first Delphi round	Type of policy measure	Perceived overall feasibility (weighted median score) [a]	Consensus (SD)	Range
Municipality B: traffic safety				
Supervised active commuting to school	**Communicative**	**5.68**	**0.99**	**3.90-6.85**
Increase awareness for active commuting to school	Communicative	4.90	1.04	2.80-6.35
School zones that discourage cars [c]	Juridical / environmental	4.40	0.85	2.70-5.60
Infrastructural facilities that help children reach popular destinations	Environmental	4.20	0.81	2.70-4.95
Municipality C: social cohesion				
Fencing off streets for outdoor play [b]	**Juridical / environmental**	**5.05**	**0.83**	**4.05-6.53**
Maintain play function of play facilities for children	Juridical	4.55	0.40	4.00-5.10
Stimulate / oblige parents to choose primary school within own neighborhood [b]	*Communicative / juridical*	*3.70*	*0.54*	*3.15-4.50*
Improve neighborhood's population composition	Juridical / economical	2.85	1.55	1.75-6.00
Municipality C: accessibility of facilities				
Parking policies that stimulate active transportation	Environmental	4.90	0.64	4.00-5.80
Attract facilities in the neighborhood by adjusting the municipal zoning plan	Juridical	4.90	0.44	4.20-5.45
Physical education facilities in the direct surroundings of the school	*Environmental*	*3.80*	*0.35*	*3.60-4.55*
Dependences of well-known (professional) sport clubs in the neighborhood	*Environmental*	*3.00*	*0.76*	*2.60-4.75*
Municipality C: traffic safety				
Communication around active commuting	**Communicative**	**5.60**	**0.46**	**5.20-6.65**
Traffic education for children at primary schools	**Communicative**	**5.40**	**0.69**	**4.40-6.45**
Attractive routes for recreation (bicycling, skating)	Environmental	4.30	0.57	3.80-5.20
Improve public transportation supply	*Environmental*	*3.85*	*0.89*	*2.80-5.55*
Municipality D: social cohesion				
Assign a part of the neighborhood maintenance budget to citizens	**Economic**	**5.50**	**0.76**	**4.00-6.06**
Organizing agreements with local actors about neighborhood activities	**Juridical / communicative**	**5.40**	**0.48**	**4.75-6.20**
Assign part of the budget for neighborhood activities to local actors	**Economic**	**5.30**	**0.59**	**4.10-5.70**
Neighborhood agreements that increases the feeling of social safety	**Juridical / communicative**	**5.15**	**0.68**	**4.80-6.50**
Spatial planning that enhances daily encounters [b]	**Environmental**	**5.10**	**0.53**	**4.40-5.90**

Table 6.3: Perceived feasibility of possible policy measures addressing environmental determinants of physical activity among children

Policy measures derived from the first Delphi round	Type of policy measure	Perceived overall feasibility (weighted median score) [a]	Consensus (SD)	Range
Municipality D: accessibility of facilities				
Safety Impact Assessment for all sport facilities	**Juridical / communicative**	**5.80**	**0.91**	**4.30-6.80**
Physical infrastructure to increase the accessibility of sport facilities	Environmental	5.40	1.15	2.57-5.75
Spatial planning that fits the needs of different target groups (youth, elderly)	Environmental	4.90	0.74	3.50-5.70
Location of sport facilities (easily accessible from the neighborhood)	Environmental / juridical	4.45	0.69	3.80-5.70
Municipality D: traffic safety				
Provide users of facilities with information to enhance traffic safety [b]	**Communicative**	**5.75**	**0.27**	**5.40-6.10**
Couple maximum traffic speeds to standard street types	**Juridical**	**5.45**	**0.51**	**4.40-5.90**
Car-free / low-traffic school zones [c]	Juridical / environmental	4.50	0.57	3.45-5.30
Deregulation of traffic situations	Juridical / environmental	4.30	0.52	3.90-5.37

[a] Within each municipality and within each determinant, policy measures are sorted descending on weighted overall feasibility score during the third Delphi round. Consistently highly feasible policy measures are represented in bold font, consistently less feasible policy measures are represented in italic font.; [b] Policy measures that were put forward in two municipalities; [c] Policy measures that were put forward in three municipalities; SD = Standard deviation.

Although some policy measures could have beneficial effects on more than one of the three determinants, overall, from the 16 policy measures that were consistently highly feasible, seven were aimed at improving social cohesion, three were aimed at improving the accessibility of facilities and six were aimed at improving traffic safety. From the five consistently less feasible policy measures, one was aimed at improving social cohesion, three were aimed at improving accessibility of facilities and one was aimed at improving traffic safety.

Although some policy measures could be classified into more than one category, overall, from the 16 policy measures that were consistently highly feasible, five measures were predominantly communicative, seven were predominantly juridical, two were predominantly economical and two were predominantly aimed at changes in the environment. From the five consistently less feasible policy measures, one was communicative / juridical, whereas four were predominantly aimed at changes in the environment.

Discussion

This study showed that cultural / community acceptability, political feasibility and cost feasibility were considered of greatest importance in evaluating the feasibility of local policy measures. By using the Delphi method, there was an increase in the perceived feasibility as well as in the consensus regarding the feasibility of policy measures among local policy makers. Finally, this study yielded a number of feasible multi-sector policy measures aimed at activity-friendly environments for children.

The objective of the Delphi technique is to reach consensus among participants, a goal that was met in three out of four municipalities in this study. Although no direct cause for the absence of increase in consensus in municipality B could be distinguished, the Delphi technique did generate many feasible policy measures in this municipality too. The increase in feasibility from the second to third Delphi round observed for many policy measures might be explained by the fact that respondents initially were unfamiliar with the concept of creating activity-friendly environments, and therefore perceived such policy measures less feasible at first. As they might have become more familiar with the concept of activity-friendly environments during the third Delphi round, this might have increased the perceived feasibility. Overall, there were more policy measures classified as consistently highly feasible than as consistently less feasible. This might reflect the respondents' tendency to think in a constructive way about possible policy measures.

In municipality D, many policy measures could be marked as consistently highly feasible. This could be partly due to the fact that in this municipality, the brainstorm tended to focus on policy measures that already existed in some neighborhood(s), but could be broadened to other neighborhoods as well. In municipality C on the contrary, the discussion focused more on theoretically possible policy measures, which might explain why in this municipality more policy measures were classified as consistently less feasible.

In line with the findings of this study, the importance of economic and political factors was also mentioned by municipal employees in previous research [17, 28]. Although respondents initially were less familiar with the possibilities to improve social cohesion within their municipality, during the Delphi process they became aware of several feasible policy measures that address this determinant of children's physical activity. Policy measures aimed at improving traffic safety were also perceived as feasible. However, policy measures aimed at improving accessibility of facilities were considered less feasible, probably because this requires drastic modifications in the built environment. Policy measures that have a more authoritative character (e.g. obliging parents to choose a primary school within their own neighborhood) were also rated less feasible. These findings are in line with the cross-national results from the European PorGrow project, gathered among a broad spectrum of governmental and non-governmental stakeholders. The PorGrow results indicate that although the need for an integrated approach aimed at environmental changes is recognized, less drastic policy options aimed at education and information for parents and children are generally ranked highest [29]. The PorGrow results further confirm our finding that economic policy measures such as subsidies and taxes are given low appraisal scores [29]. In their Delphi study among Dutch experts on opportunities for monetary incentives to stimulate healthy eating, Waterlander et al. have shown that experts tend to rate policy options outside their own area of responsibility more positively [24]. Although respondents did emphasize the own responsibility of parents for their child's activity behavior, there were no indications that respondents from any policy sector tended to pass the responsibility to other policy sectors in the present study. This was probably due to the fact that the respondents were mostly colleagues within the same organization and already discussed the policy options together during the first Delphi round.

Strengths and limitations

Although the aim of this study was to cover roughly the same policy sectors within each municipality, the exact job description of the respondents did vary between municipalities and diversity of respondents between municipalities could not be completely eliminated. The fact that this study was aimed at municipality-specific recommendations somewhat limits the possibilities to generalize the results. However, some of the findings (such as the fact that cost feasibility, cultural / community acceptability and political feasibility were consistently considered of greatest importance) can be generalized to other settings as well. The use of a multi-criteria mapping technique in which respondents have the opportunity to bring up policy options themselves and to weigh the different evaluation criteria, is a useful strategy to provide respondents with adequate freedom of expression, but nevertheless retain the possibility to compare results across municipalities or countries [30, 31]. In addition to assessing the feasibility of different policy measures by assigning scores on Likert-type scales, ranking policy measures could further stimulate participants to single out the different policy alternatives [22, 24, 26]. Although this study provided the respondents with information on which environmental determinants could possibly affect children's physical activity behavior during the first Delphi round, no detailed information was available on the (theoretical) effectiveness of the proposed policy measures. Calculating the potential health gains of different policy measures could be of great value because this could help to persuade policy makers to seriously consider the implementation of less feasible, but possibly more effective policy alternatives as well. Future research should evaluate if local policy makers themselves see the Delphi technique as a valuable tool in the development of multi-sector policy measures aimed at health promotion at the local level and if it facilitates their actual adoption and implementation.

Conclusions

This study showed that the Delphi technique can be a useful tool in identifying feasible multi-sector policy measures aimed at creating activity-friendly environments for children at the local level. Cultural / community acceptability, political feasibility and cost feasibility are of great importance in evaluating the feasibility of local policy measures. Less drastic policy measures are considered more feasible, whereas environmental policy measures are considered less feasible.

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CHAPTER 7

General discussion

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The aim of this research project was to identify, describe and test the feasibility of concrete multi-sector policy measures that create activity-friendly environments for children. In order to reach this aim, the first part of this thesis focused on the environmental characteristics related to physical activity among children. These environmental correlates were either measured subjectively (by means of a survey among parents) or objectively (by means of neighborhood audits). The second part of the thesis focused on the translation of these environmental correlates of physical activity among children into concrete and feasible multi-sector policy measures at the local level. Therefore, the current policy situation in four Dutch municipalities regarding the multi-sector approach to create activity-friendly environments for children was studied. Subsequently, concrete multi-sector policy measures at the local level were identified and tested on their feasibility during interactive workshop sessions with local policy makers (Delphi study). An overview of the different research parts included in this project is given in figure 7.1. In the remainder of this chapter, the main findings of the two research parts will be discussed, followed by a description of important methodological considerations. Finally, the implications for research and policy will be described and some concluding remarks will be made.

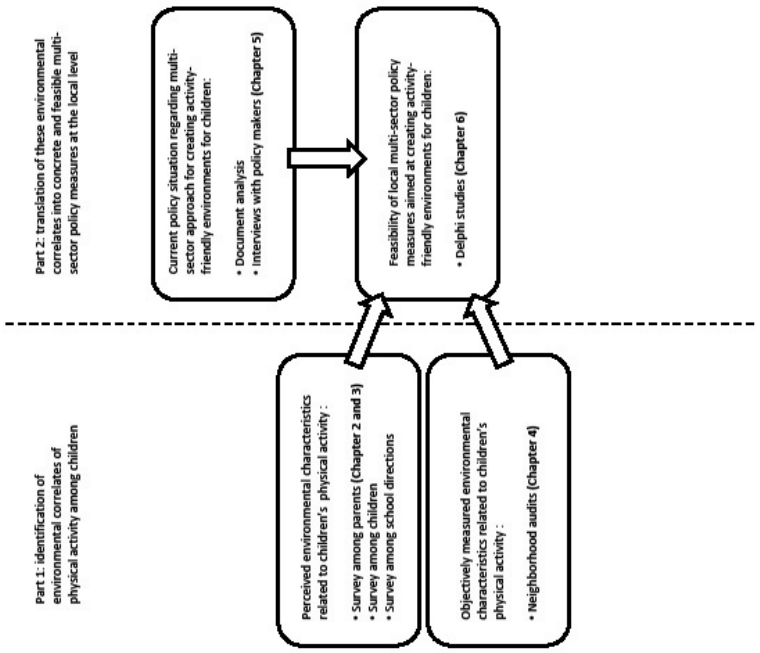

Figure 7.1: Overview of the different research parts included in the project

CHAPTER 7

Interpretation and discussion of the main findings

Part 1: Environmental correlates of physical activity among children

In order to develop evidence-informed policies that create activity-friendly environments, it is necessary to have insight into the environmental factors that correlate with the physical activity behavior of children. Because different aspects of physical activity behavior are likely to be related with different environmental characteristics [1], we have addressed two important aspects of children's physical activity behavior separately, namely outdoor play (**Chapter 2 and 4**) and active commuting to school (**Chapter 3**). Both aspects of physical activity can be incorporated into the daily activities of children and hence contribute to an active lifestyle. Environmental characteristics were either measured subjectively (i.e. by means of questionnaires among parents, **Chapter 2 and 3**), or objectively (i.e. by means of neighborhood audits, Chapter 4). Because different environmental characteristics were expected to be related to outdoor play for children of different age groups and different gender, all outdoor play analyses were subdivided into six subgroups according to age and gender of the children. We included social as well as physical environmental characteristics at the individual, home environmental, neighborhood and school level in our studies.

Regarding the proximal (or home) environmental characteristics, it can be concluded that parents play an important role in relation to their child's physical activity behavior. For example the importance parents pay to outdoor play was positively associated with outdoor play in our study. Previous research has also shown the impact of parental influence on children's physical activity behavior (e.g. by means of parental support, modeling, shared activities) [2, 3]. Therefore, apart from designing neighborhoods in such a way that they become attractive for outdoor play, health education and promotion to increase parental support and role modeling for their children to be physically active also stays an important strategy to stimulate outdoor play among children.

The results of the survey also showed that parental education level was negatively associated with outdoor play. A possible explanation for this finding is that, due to financial reasons, children of higher educated parents are more likely to be involved in organized sports activities, at the expense of outdoor play (and vice versa). Furthermore, in our study sample, lower educated parents more often reported electronic devices in their child's own room. Although the presence of an

electronic device such as a television or computer in the child's own room, was positively associated with outdoor play, our analyses on outdoor play were only corrected for parental education level, and some residual confounding for socio-economic status of the parents might explain the positive association between outdoor play and the presence of electronic devices in children's own room (i.e. children of lower SES parents are more likely to be involved in outdoor play, but are also more likely to have an electronic device in their own room). With regard to active commuting, children of higher educated parents were more likely to go to school by bicycle.

In our study sample, approximately three-quarter of all primary school children usually commute to school by means of active transportation. In comparison with studies in other countries [4-8], this is a fairly high percentage, certainly when the age range of our study population is taken into account. Moreover, it appeared with increasing age and decreasing distance from home to school, children are more likely to walk or bicycle to school. Because age of the child and distance from home to school are non-modifiable factors, stimulating younger children or children living further way from their school to walk or bicycle to school remains challenging and appropriate attention should be given to parents' perception of their child's safety when actively commuting to school. In contrast with prevailing suppositions that double-income families might be more likely to bring their children to school by car (e.g. by combining the car trip to school with the trip to the parent's work), working hours of parents was not consistently related to walking or bicycling to school. The number of days the child goes home directly after school did show a positive association with walking and bicycling to school. This suggests that not the total working hours of parents, but rather the presence of an adult at home after school time, might be an important correlate of active commuting among primary school children. In other words, children that are brought to school by car, are more likely to go child care after school, because their parents are not at home (but at their work). Also the number of siblings was positively associated with both walking and bicycling to school, which might be explained by the opportunity of siblings to commute to school together.

Apart from the proximal (home) environmental characteristics, also characteristics of the neighborhood environment were related to children's physical activity behavior in our studies. Although there was little consistency with regard to the association between physical neighborhood characteristics and physical activity, social environmental characteristics (such as social cohesion) showed a quite consistent association. For example, perceived social cohesion showed a positive association with outdoor play in most subgroups. Growing research points to an impor-

tant role for social cohesion (or social capital) in relation to health in general, especially in urban neighborhoods [9]. Hence, increasing neighborhood social cohesion can be seen as a promising strategy to stimulate physical activity children.

In contrast to most other aspects of leisure time activities such as sports participation, television watching or computer usage which show a favorable gradient with neighborhood socio-economic status [10], outdoor play shows a negative gradient with respect to neighborhood socio-economic status in three out of six subgroups in our study (i.e. a higher neighborhood SES is related with less outdoor play). This might indicate that unorganized leisure time activities such as outdoor play may be of particular importance for children of lower SES parents / neighborhoods and provide a suitable starting point for further stimulating physical activity among children living in lower socio-economic neighborhoods. In contrary, children in lower SES neighborhoods were less likely to walk or bicycle to school. A possible explanation for this finding could be the cultural values regarding (in)active transportation among lower SES parents. For example, commuting to school by foot or by bike, might have a negative connotation in some cultures, which might explain why parents prefer to bring their children to school by motorized travel. Because previous research has shown a lower likelihood of walking / bicycling home from school in deprived neighborhoods as well [7, 11], and our research also has shown the importance of neighborhood social cohesion and social safety in relation to active commuting, this points to an important role for a safe and attractive social neighborhood climate for active commuting.

With regard to the physical (or built) neighborhood characteristics, our survey results indicate that these were not consistently related to active commuting. For example traffic situation and the perceived quality of sidewalks and bike lanes as perceived by parents, were not related to active commuting to school. Possibly, the overall neighborhood type included in the analyses already accounted for much of the differences in built environmental characteristics. Because these findings are in contrast with many other studies showing a relation between physical neighborhood characteristics and active commuting [7, 12-14], a possible explanation may also lie in the specific Dutch infrastructure, which possibly already provides children with a positive built environment with regard to walking and bicycling to school. However, only 23% of the school boards and 38.4% of the parents included in our study perceived the traffic situation around their school as safe, which indicates that there is room for improvement of traffic situations around primary schools.

Results from the neighborhood observations showed that neither the number nor the quality of formal outdoor play facilities were positively related to outdoor play among children. Rather, informal play facilities such as sidewalks were related

to outdoor play, especially among boys and girls from the lowest age groups. This could be due to the fact that sidewalks provide for an informal play space near the children's home. Parents' perceptions of the neighborhood play facilities (as derived from the survey) were also unrelated to their children's outdoor play. As research among children aged 8-12 years has shown that the most frequently mentioned place where children reported to play, was the yard at home [15], it is questionable whether "the neighborhood" is the most important setting for children's outdoor play.

For children of all age categories and especially for boys, objectively measured items related to neighborhood traffic safety were associated with outdoor play. This is in contrast with the results from the subjectively measured neighborhood characteristics related to outdoor play (the survey data), in which traffic items were unrelated to outdoor play. From findings from other European research that compared parents' perceptions of traffic safety with GIS data it can be concluded that parents' perceptions may motivate children's outdoor play behavior more than the actual traffic situation in the neighborhood [16]. These contradictory findings underline the differences is research outcomes when different methods to measure environmental characteristics are applied.

Part 2: Multi-sector policy approach to create activity-friendly environments for children

In order to enhance a multi-sector policy approach at the local level it is important to have insight into the current local policy situation and current policy initiatives aimed at improving environmental characteristics related to children's physical activity level (**Chapter 5**). Moreover, apart from the potential effectiveness of possible policy measures with regard to the expected increase in children's physical activity level, it is also important to have insight into the feasibility of such policy measures for local policy practice (**Chapter 6**), because otherwise the chance that these policy measures will be implemented, is limited.

The interviews with policy officers of different policy sectors (public health, sports, youth and education, spatial planning / public space, traffic and transportation, safety, environmental affairs, and play facilities) indicated that each of these policy sectors carried out policy measures related to (the environmental determinants of) physical activity among children. However, policy makers were not always aware of the (side)effect of these policy measures on physical activity among children. Therefore, raising awareness among policy makers from different policy

sectors about this topic, may stimulate policy makers from sectors outside the public health domain to take into account the activity-friendliness of their policy plans. Moreover, because no single policy sectors could be marked as the "problem owner" for this topic, a more explicit definition of roles could contribute to a multi-sector policy approach for this topic.

Although multi-sector collaboration is not a strict prerequisite for multi-sector contributions to increase the activity-friendliness of the environment (i.e. each individual policy sector can carry out policy plans that improve the activity-friendliness of the environment without collaboration with other policy sectors), literature shows that it is likely that collaboration between policy sectors contributes to an optimal multi-sector approach in tackling health problems [17, 18]. In two of the four municipalities included in our study, some form of structural collaboration between policy sectors was present, but the number of sectors involved was limited. Because the policy officers in our study in general had a positive attitude towards multi-sector collaboration, this indicates that there is room for expanding such collaboration. However, lack of time and financial resources was seen as a major bottleneck for a multi-sector policy approach. If each municipal policy sector is stimulated to incorporate the aspect of activity-friendliness in their policy plans (e.g. by raising awareness regarding this topic), it is questionable whether multi-sector collaboration, which is seen as a costly and time-consuming approach, has an added value. Altogether, the findings of the policy analysis suggests that the multi-sector approach for tackling complex health problems is still in its infancy and that such an approach could be further stimulated, either by raising awareness and defining problem ownership, or by further enhancing multi-sector collaboration and paying appropriate attention to facilitators and challenges. It is important however, to closely connect with the local policy conditions, because there is a large variation in the point of departure between different municipalities.

Taken the results from the first part of the project as a basis, three environmental characteristics (social cohesion, accessibility of facilities and traffic safety) were chosen as a starting point for exploring the feasibility of multi-sector policy measures at the municipal level. Although the accessibility of (play) facilities did not emerge as an important correlate of outdoor play or active commuting to school, it might be an important characteristic in relation to children's involvement in organized sports activities, which was the reason for including this characteristics in our feasibility study as well. In three consecutive Delphi rounds, policy officers from different policy sectors compiled a list of possible policy measures, which they evaluated on perceived feasibility according to the following five feasibility aspects: political feasibility, cultural / community acceptability, technical feasibility, cost

feasibility and legal feasibility [19, 20]. Finally a weighted overall feasibility measure was calculated per policy measure, based on the scores from the last Delphi round.

Cultural / community acceptability, political feasibility and cost-feasibility were rated as the most important feasibility aspects by respondents of each municipality and each policy sector. Furthermore, the Delphi technique was a useful tool in identifying feasible multi-sector policy measures aimed at each of the three environmental characteristics. However, policy measures that imply less drastic (environmental) changes, were generally considered more feasible. Policy measures with an environmental or authoritative character were generally considered less feasible.

Because our research shows that social cohesion as perceived by parents is positively related to children's outdoor play and active commuting to school, this is a promising starting point for municipalities to create activity friendly environments for children. During the Delphi studies, from the policy measures that were considered highly feasible, most were aimed at improving social cohesion. This indicates that also policy makers themselves see social cohesion as a promising point of intervention in creating activity-friendly environments for children. From the neighborhood observations it appeared that informal play facilities and traffic safety are important correlates of outdoor play among children, and the Delphi studies also yielded several feasible policy measures that address these themes as well. Because the policy measures derived from the Delphi studies are based on extensive research into the environmental characteristics related to children's physical activity, and on the other hand are selected based on the perceived feasibility of local policy makers of different policy sectors, this provides a starting point for implementation of evidence-informed and yet feasible multi-sector policy measures.

Methodological considerations

In the previous chapters of this thesis, the specific methodological issues with regard to the separate research parts have been addressed in detail. This paragraph discusses some general methodological considerations of the project. As this study aimed to contribute to evidence-informed policy development at the local level, not only the identification and quantification of environmental correlates of physical activity among children, but also the translation from these findings into concrete and feasible multi-sector policy measures at the local level was a central theme within this research project. The ultimate goal of the project was to combine

research on potential effectiveness with perceived feasibility of policy measures. Quantitative and qualitative research methods were employed and methodological considerations for each of the research parts will be discussed below.

Study setting

The research was conducted in four medium-sized Dutch cities within the service domain of the Regional Public Health Services cooperating in the Academic Collaborative Centre Public Health Brabant. Academic Collaborative Centers are suggested to contribute to bridging the gap between science, practice and policy in public health [21]. Wehrens et al. argue that innovative partnerships between stakeholders of those different disciplines might facilitate interactions, but that this does not automatically lead to successfully bridging of the gap [22]. These authors posit that there should be attention for expectations of the science and policy actors and ways to converge eventual differences herein [22]. Because the current study was not initiated by the municipalities themselves, they had no explicit expectations at the start of the project. Moreover, because a four-year subsidy from The Netherlands Organization for Health Research and Development covered for the personnel and material costs of the research project, the municipalities and Regional Public Health Services did not have to invest financial resources for the project. Instead, employees of the participating municipalities and the Regional Public Health Services were asked to invest (a minimal amount of) time in the project, either as a respondent during the interviews or Delphi studies or as a member of the project's advisory board. Taken together, the role of the municipalities in this research project was relatively passive, which gave much freedom to design the project conform the researchers preferences. In every part of the research however, much emphasis was placed on the practical benefits of the study results. Retrospectively, it could have been more advantageous to take the existing policy situation in the four participating municipalities as the starting point, instead of focusing on the environmental characteristics related to physical activity first. This would have increased the involvement of the municipalities in the project and would have better tailored the results of the study to the local policy conditions. It is expected that if the municipalities were more closely involved in all research stage (i.e. preparation, execution, and interpretation), this would have increased their commitment and hence the chance of incorporation of the study results into the local policy developmental process [23].

Survey among parents and children

One of the strong points of the survey among parents and children is the large sample size and relatively high response rates (approximately 60% among parents and 90% among children). Compared to other survey studies, these percentages are fairly high. For example, the Australian CLAN study among parents of children aged 5-6 years and 10-12 years, only reached response rates of 17% and 44% respectively for their baseline measurements [24]. The large number of respondents in our survey enabled us to analyze the correlation between several environmental characteristics and specific aspects of the physical activity behavior of children in different age groups. From these analyses it appeared that each of the different aspects of the physical activity behavior indeed was correlated with specific environmental characteristics, although there were similarities as well.

A shortcoming of the project is the cross-sectional design of the survey, which hampered the interpretation of some of the results. For example, from our data it is unclear whether an increased neighborhood social cohesion leads to more outdoor play, or whether more outdoor play leads to increased social cohesion (or both). Because the direction of the relation between environmental characteristics and children's physical activity behavior is not clear from our study results, our recommendations for municipalities should be taken with some caution. From our data we cannot guarantee for example that policy measures that increase neighborhood social cohesion will lead to an increase in children's outdoor play behavior (although it is a likely scenario).

Moreover, the survey was conducted from September through January and seasonal effects could not be excluded. By combining accelerometer and GPS data, Cooper et at. have shown that especially outdoor physical activity was seasonally patterned [25]. Because children are more likely to be physically active outdoor during summertime then during wintertime, these authors suggest that stimulating indoor physical activities is an attractive alternative for outdoor activities during wintertime in countries with cold climates [25]. Recent research from Norway reports large seasonal variation in number of children involved in active commuting to school as well [4]. Natural experiments can make an important contribution to further discovering the direction of relationships between environmental characteristics and children's physical activity behavior and seasonal patterns herein.

Measuring physical activity by means of questionnaires is relatively cheap and because questionnaires can be self-administered, they are particularly suitable for large scale research projects [26]. However, measuring physical activity among children by means of questionnaires is subject to some specific methodological

difficulties. First, due to cognitive limitations, especially children of younger age are not able to complete a written questionnaire themselves, and hence researchers have to rely on proxy-reporting by parents. Second, in their review addressing reliability and validity of physical activity questionnaires for youth, Chinapaw et al. conclude that from the 61 versions of questionnaires included in their review, none showed both acceptable reliability and validity [27]. Furthermore, these authors indicated that that lack of a golden standard for measuring physical activity, complicates criterion validation of physical activity questionnaires [27]. Although accelerometry is an often used tool in validation studies of physical activity questionnaires, accelerometers are unable to distinguish between different aspects of physical activity behavior (e.g. outdoor play, active commuting, sports participation) [1]. Therefore, in our study, we chose to rely on questionnaires following the standard phrasing of questions regarding physical activity as used in the national youth monitor from the Regional Public Health Services [28], and we adjusted these phrasings on some points to better fit our research questions. At this moment, no information about the validity and reliability of these standard phrasing of questions is available and validating such a questionnaire remains a difficult issue.

For measuring parental perceptions of environmental characteristics, we included several topics covering the physical as well as social characteristics of the home and neighborhood environment possibly related to children's physical activity behavior. The majority of these questions were derived from existing large-scale Dutch research on environmental correlates of physical activity and health among children [29, 30]. Although the NEighborhood Walkability Scale (NEWS) is a well known and often used questionnaire to assess walkability aspects of neighborhoods among adults [31], this questionnaire is not directly suitable for assessing environmental correlates of physical activity among children, because it lacks items addressing for example play grounds and other places where children play. Moreover, because the NEWS originates from the USA, this questionnaire cannot be directly be applied to the Dutch (physical) infrastructure. Again, validation of questionnaires addressing environmental characteristics is difficult, due to lack of a golden standard to validate against. Some topics can be validated by using geographical information systems (GIS), but this was outside the scope of the current project. Likewise, no information about the reliability of our questionnaires is available.

Neighborhood audits

In addition to the perceived environmental characteristics as measured by the health survey among parents and children, the data collection of this project also included objective measurement of neighborhood characteristics by means of neighborhood audits (observations). Because in this study the outcome measure and the independent variables (the neighborhood characteristics) were derived from different data sources, same source bias was prevented [32]. Because the perception of neighborhood characteristics can be different from (and equally important as) the objective neighborhood characteristics, the neighborhood observations were not set up to validate our findings from the survey among parents.

The neighborhood audits were conducted by trained research assistants using a standardized neighborhood observation checklist. The checklist was based on the NEighborhood Walkability Scale [31], but was specifically adapted for screening Dutch neighborhoods on environmental characteristics related to children's physical activity [33]. The inter-rater reliability of the checklist was evaluated as good (percentage of agreement = 77%) in earlier Dutch research [34].

In addition to the original neighborhood observation protocol, we have added some guidelines to improve the quality of the protocol. Firstly, the definition of a typical neighborhood and the appropriate method to define neighborhood boundaries is an ongoing methodological discussion [35]. For example constructing a buffer around the residents' home (either as a straight line radius or as a street network buffer) is a commonly used method to define neighborhood boundaries in studies using geographical information systems or environmental audits [12, 36-39]. However, this does not always match the actual area that residents consider as their neighborhood. Also, there is an ongoing scientific debate about what is the appropriate buffer size, especially for children. For example Bringolf-Isler et al. employ a radius as small as 100 meters around the place of residence [16], whereas others use distances up to one mile from adolescent girls' homes [39]. Neighborhood boundaries in our study were defined by postal code data from the municipal organization. In general, this matches the perception of the residents about what are the neighborhood boundaries and it also facilitates the interpretation of the study results by local policy makers. However, this definition of neighborhood boundaries complicates the comparison of the results with studies that use a radius around the residents' home.

A second adjustment in the neighborhood observation protocol was derived from another Dutch neighborhood observation protocol developed by Van Lenthe et al. [40] and addresses the selection of streets to be observed during the neigh-

borhood audit. Before the start of the actual data collection, a random sample of 10% of the streets within each neighborhood was selected for observation, based on a list of all streets per neighborhood. During the neighborhood observations, after observing the selected streets per foot, all remaining streets were observed per bicycle, within the time limits given (approximately three hours) for each neighborhood observation.

Lastly, all observations were carried out during normal school days after school time and before dark, to mimic best the real conditions under which children are usually involved in outdoor play in their neighborhood. This was usually enough time to observe the majority of streets in the neighborhoods per bicycle (in addition to the selected streets that were observed by foot).

To our knowledge, we are one of the first to report on objectively measured quantitative as well as qualitative aspects of neighborhood characteristics related to children's physical activity behavior. In current research, there is a trend towards objective measurement of both physical activity behavior (e.g. by means of accelerometers) and the environment (e.g. by means of geographical information systems). Moreover the increased availability of GPS systems further strengthens the trend of objective measurement in this field of research. The major advantages of objective measurement methods are that social desirability bias and recall bias are prevented. However, the objective measurement of neighborhood characteristics has also some disadvantages, because certain concepts (e.g. social cohesion) are hard to measure with objective measurement tools. Kremers et al. suggest that the relation between objective environmental characteristics and physical activity behavior may be mediated by the perception of these environmental characteristics [41]. For policy makers it is primarily important to know whether their policies should be targeted at improving the actual environment or whether they should be targeted at changing the perception of parents and children, without actually changing environmental characteristics. Cross-sectional data such as described in this thesis, cannot demonstrate whether policies addressing environmental characteristics will actually lead to an increase of physical activity levels among children.

Policy analysis

The multiple-case study described in Chapter 5, comprised a policy analysis based on semi-structured interviews with policy makers from different municipal policy sectors. According to Yin [42], the quality of case study research is dependent on

the internal validity, the external validity and the reliability. Each of these aspects will be elaborated on in the next paragraph.

Ideally, qualitative research is based on triangulation (the use of three or more data collection methods), for example by combining qualitative interviews with document analysis and structured observations [43]. Triangulation contributes to the internal validity of case study research [44]. Although we have collected policy documents from all policy sectors, these documents did not play a central role in our policy analysis. The reason for that was that written policy documents do not always comprehensively reflect the actual policy initiatives that are developed in practice and do not capture facilitators and challenges for a multi-sector policy approach. Likewise, collaboration initiatives or plans for multi-sector collaboration described in written policy plans, do not always lead to actual collaborations in practice. More thoroughly analyzing the written policy documents in our in policy analyses (e.g. by coding them in way similar as we did with the interview transcripts) would also have been a time-consuming process. Nevertheless, not including a more extensive analysis of the policy documents is a missed chance for triangulation within our policy analysis. Therefore the results described in Chapter 5 (which are based on the interview data only) should be seen as a first explorative description of the multi-sector policy development approach at the municipal level.

In our analyses, we have chosen to rely on the number of quotations derived from the transcripts of the interviews as an indicator for the importance respondents adhere to different topics. Although the *ad verbatim* transcription of interview recordings is an accurate manner of analyzing qualitative data, it is also a very time consuming process that is not always feasible within a given research time frame or within given financial boundaries. Moreover, although the "quantification" of qualitative data provides a way of dealing with subjectivity during qualitative research, the strength of qualitative research lies in the fact that the researcher can give a meaningful interpretation of the outcomes given the specific context of the research setting [45].

In each of the four participating municipalities, interviews were conducted with policy makers from different policy sectors. We initially invited policy makers from the sectors public health, sports, youth and education, spatial planning, traffic and transportation, and safety. These sectors were chosen because of their potential influence on (the environmental determinants of) physical activity among children [46]. In two municipalities, an additional policy sector was included (environmental affairs and play facilities). From the policy interviews (as well as from the discussion during the Delphi studies), it appeared that apart from the six policy sectors initially invited for participation in our research project, other municipal

policy sectors could also contribute to the activity-friendliness of the environment for children. For example sectors like recreation, economic affairs, cultural affairs, immigration and welfare could be linked to this theme as well. Furthermore, the policy analysis described in this thesis focuses only on the bureaucratic level of policy makers. Recent research however has shown the importance of vertical collaboration (i.e. between different levels within municipalities such as policy makers, management and alderman) to come to an optimal integrated approach of tackling health problems [47]. Perhaps even more important, commitment and support for a multi-sector approach at all organizational levels may be an important factor in optimizing integrated health policies.

Although the policy analysis described in this thesis gives a first impression of the multi-sector policy approach and multi-sector collaboration in the four participating municipalities, the analyses could benefit from a more extensive network analysis, in which the role of the different actors is described more profoundly. For example Hoeijmakers et al. used a network mapping technique as an analytic tool to study local health policy development in four Dutch municipalities. These authors concluded that the municipal authorities occupy a central position within the network of stakeholders involved in local health policy development [48]. From the perspective of multi-sector collaboration between the different policy sectors within the municipal organization, network analysis could yield valuable information about the density of the network and the centrality of the sectors involved within each municipality as well.

Because we conducted a policy analysis in four different municipalities (multiple case study), the external validity of our study is high. Cross-case analyses were performed to identify similarities and differences between cases in perceived facilitators and challenges for multi-sector policy action. Although there were considerable differences in the degree of multi-sector collaboration between the four municipalities, it appeared that except for some small divergences, the three most important overall facilitators and challenges described above were also rated as highly important in each individual municipality. This indicates that the findings regarding these facilitators and challenges may be applicable to other municipalities as well.

Delphi studies

The Delphi studies described in Chapter 6 were aimed to translate the research findings from the first part of the project (i.e. on the environmental correlates of

physical activity among children), into concrete and feasible multi-sector policy measures at the local level.

The Delphi method is a well founded method for reaching consensus among stakeholders involved in complex (policy) problems [49], and has been widely used in the field of health policies related to obesity [50-53]. In this study, four separate Delphi studies were conducted (one in each of the participating municipalities), to provide the municipalities with results that are tailored to the specific context and conditions within their own municipality, which increases the applicability of the study results within the municipal policy development process. We used a multi-criteria mapping technique, in which the respondents had the opportunity to bring up policy options themselves and weigh the different evaluation criteria, which can be seen as a useful strategy to provide respondents with adequate freedom of expression, but nevertheless retain the possibility to compare results across municipalities [54, 55]. In this way, we have attempted to find a balance between the practical usability of the Delphi study results and the opportunities to compare results across municipalities. Although there were some differences between the four participating municipalities, in general the results from the second to the third Delphi round showed an increase in the perceived feasibility as well as consensus scores. This indicates that the Delphi technique succeeded in identifying feasible policy measures about which consensus exists among policy makers of different policy sectors. However, because we did not ask participants' feedback about the set up of the workshop session and the usability of the results, it remains unclear whether the policy officers themselves see the Delphi technique as a useful tool for the identification of feasible policy measures.

Regarding the choice of the three important environmental correlates of physical activity among children that were the starting point for the brainstorm during the first Delphi round (social cohesion, accessibility of facilities and traffic safety), we relied on both the findings from or own research [56], as well as on scientific reviews published previously [13, 57]. Although the environmental correlates of organized sports participation among children were not specifically addressed in the studies described in this thesis, nevertheless we have chosen to include the accessibility of facilities as a theme in the Delphi studies. This could be either sport facilities, play facilities or other neighborhood facilities that provide children with the opportunity for active commuting. For policy makers, these three characteristics highlighted during the Delphi studies provided opportunities to brainstorm about physical as well as social environmental characteristics related to outdoor play, and possible policy measures from different policy sectors that could address these characteristics. However, respondents were free to decide how detailed their

proposals for possible policy measures were. As a consequence, there was great variation in the level of elaboration between the various policy measures that came up during the first Delphi round. For example, very globally outlined policy plans were put forward, such as “Improve spatial planning in such a way that public spaces fit the needs of different target groups (youth, elderly)”. In general however, the policy plans that were put forward, were more detailed, such as “Couple maximum traffic speeds to standard street types (30 km / h in residential neighborhoods, 50 km / h in connecting streets, 60 and 80 km / h in areas surrounding the city)”. Lack of clarity regarding the desired level of detail in the proposed policy measures, was mentioned as a complicating factor by the discussion leader who chaired the Delphi meetings. However, giving policy makers the opportunity to determine the degree of elaboration during the Delphi studies themselves, may fit best with the prevailing ideas and policy situation within each particular municipality.

Generalizing the findings to other settings

The studies described in this thesis generally have a local focus. This does not mean however, that the results cannot be generalized to other settings. It is likely that the environmental correlates of physical activity among children as found in our study population are also applicable to other Dutch cities with a comparable population composition and infrastructure. However, because the current study did not include rural municipalities, the results are difficult to generalize to rural populations. The study results from the second part of the research project (i.e. the policy analysis and the Delphi studies) are more dependent on the local (policy) context. Some results however, are likely to apply to other settings as well. For example our finding that policy makers from different policy sectors and different municipalities consistently rate the cost feasibility, political feasibility and cultural / community acceptability as the most important aspects of the five feasibility aspects included in the Delphi studies, is likely to be applicable to other local policy settings as well.

Implications for research, policy and practice

Implications for research

The results of this study confirm the assumption that different aspects of the physical activity behavior of children (e.g. outdoor play, active commuting to school) are related to different aspects of the environment. Likewise, different environmental characteristics may be related to walking or bicycling and a further distinction can be made between walking and cycling for recreation or transportation. Therefore, in line with the recommendations of Giles-Corti [1], this study underlines the need for specificity when studying the relation between neighborhood characteristics and children's physical activity behavior. Dutch research has also shown that the way the guidelines for healthy physical activity are operationalized, has huge effects on the number of children meeting these guidelines [58]. Therefore, if research focuses too much on meeting the guidelines as an outcome measure, this will yield unrealistic outcomes, which will not contribute to the stimulation of the specific components of physical activity among children. Furthermore it is important to gather information about all the relevant aspects of the physical activity levels of children. For example, if a certain intervention has a positive effect on sports participation among children, but in the mean time this leaves children with less time for outdoor play (compensation behavior), the overall health benefit of such an intervention may be limited. To exclude such compensation effects, it is important to map all the aspects of children's physical activity behavior.

Our study results, as well as findings from recent studies point towards an important role of social characteristics in relation to children's physical activity behavior [56, 59-61]. Because social and physical correlates of children physical activity behavior cannot be seen in isolation, future research should include physical as well as social characteristics within different environmental settings that are relevant for children's physical activity, such as the home environment, the neighborhood, the school, but also the environmental characteristics of sports accommodations. Because social neighborhood characteristics might be even more important than physical environmental characteristics, future research should address possibilities to intervene in the social environment in such a way that it stimulates children to be physically active.

Because research into the relation between environmental characteristics and the physical activity behavior of children is a relatively new field in science, standardized methods to assess environmental correlates of physical activity among

children are currently lacking. To enhance the comparability of studies, future research should strive to use standardized methods and protocols (e.g. providing questionnaires per e-mail or per post), and whenever possible check the validity and reliability of these methods. Relatively new trends such as the use of data from geographical information systems or GPS, might be of great value in this respect. However, not only the objective environmental characteristics, but also the perceptions of parents and children are of indispensable value for research aimed at stimulating physical activity among children. Especially for older children, who are less dependent on their parents for outdoor play or active commuting to school or other facilities (such as sports facilities), the children's own perception of the environment is important as well. Therefore, it is important to gather information among children themselves, instead of relying on parental report only.

The results of this study show that children of lower educated parents are more likely to be involved in outdoor play during leisure time. However, from other studies it is known that children of lower SES parents (as measured by parental income) have lower general physical activity levels and are also more involved in sedentary leisure time activities such as television watching and computer usage [62]. Cross-sectional data have shown that a lower neighborhood socio-economic status is associated with more "screen time", particularly among girls [63]. Although there is extensive scientific research available addressing the (environmental) determinants of inactive leisure time activities of children and its relation with physical activity [64, 65], it is beyond the scope of this thesis to further explore the complex relationship between active and inactive leisure time activities among children of parents with different SES backgrounds.

In addition to the numerous studies addressing environmental correlates of physical activity among children in urban settings, future studies should explicitly include children living in rural areas as well. Insights in differences in the relation between environment and physical activity between children living in rural vs. urban areas might provide interesting leads for creating activity-friendly environments in general.

Research addressing policy conditions related to the multi-sector approach for tackling public health problems such as physical inactivity is still in its infancy, and should not be restricted to the policy sectors included in the current study. Recent studies suggest that it is important to look at vertical collaboration (i.e. collaboration between the bureaucratic, tactic and political level within each municipality) [47], and collaboration with stakeholders outside the municipal organization (e.g. public private collaboration) as well. However, because extensive collaboration is a time-consuming process, the added value of collaboration should first be more

profoundly established by (scientific) studies, prior to advising municipalities to invest in collaboration. A possible alternative for extensive collaboration between policy sectors is increasing awareness among policy makers from sectors outside the public health domain with regard to creating activity-friendly environments, but also this strategy should be underpinned by research outcomes.

The research described in this thesis focused on theoretically effective and potentially feasible policy measures aimed at designing activity-friendly environments for children. An important next step in the field of public health is to demonstrate the actual effectiveness of a multi-sector approach in tackling health problems such as physical inactivity among youth. In order to facilitate the actual adoption and implementation of multi-sector policy measures at the local level, an action oriented research approach can be utilized. Such an approach is characterized by a close collaboration with local policy makers and focuses on those variables that have a high potential for change (e.g. agenda setting, policy development aimed at changeable environmental characteristics), while simultaneously contributing to the scientific knowledge basis. Within an action-oriented research approach, the researcher can be seen as a "friendly outsider" who assists the local community partners with scientific expertise so that this can be used to create opportunities for improvement [66]. Longitudinal studies addressing the facilitators and barriers for the adoption and implementation of multi-sector policy measures at the local level, are warranted to gain further insight in multi-sector policy development. Therefore, we have set up a follow-up project which will be conducted in close collaboration with the four municipalities participating in the current research project. Figure 7.2 outlines the future research steps included in this follow-up project. The follow-up project will start with actively introducing the promising policy measures derived from the current project in the municipal decision making process by means of action research. By conducting a process evaluation, facilitators and challenges for the actual adoption and implementation of multi-sector policy measures will be studied. Ultimately, demonstrating the (cost)effectiveness of such an approach is an important future step for research in this field [67]. In our follow-up project we have planned to repeat the survey among parents and the neighborhood audits in the same schools and neighborhoods as included in the current project. This provides us with the opportunity to measure effects of implemented policy measures on the (environmental characteristics related to) physical activity among children by means of a repeated cross-sectional design. By simultaneously monitoring the costs of development and implementation of these policy measures, a cost-effectiveness analysis can be performed. In this way, the follow-

up research will contribute to the scientific underpinning of local multi-sector policy measures aimed at creating activity-friendly environments for children.

Implications for policy and practice

Recently, the Dutch minister of Public Health, Welfare and Sports, has formulated her ambitions for the coming period of government. One of her main aims is to create easily accessible and nearby opportunities for physical activity and sports, especially for youth [68]. Because the minister emphasizes that life style is a matter of free choice, she strives to make the healthy choice the easy choice at the local level. The results from this thesis provide practical indications for local governments to contribute to the policy aims as formulated by the national government.

Firstly, different municipal policy sectors can contribute to an activity-friendly environment for children. Hereby, they can choose to focus on different aspects of the physical activity behavior of children, such as outdoor play, active commuting to school or sports participation. However, because several policy sectors are currently unaware of the influence of their policy plans on the activity behavior of children, there is need for actively introducing this theme within those policy sectors. By making policy makers of different policy sectors more aware of this topic, they will be stimulated to take into account the activity-friendliness of their policy plans. An action oriented research approach (as planned in our follow up project), in which there is continuous feedback from policy to research and vice versa, may be a valuable approach to increase awareness among policy makers. As already mentioned in one of the previous paragraphs, it is important to closely connect with the local policy conditions, because there is a large variation in the point of departure between different municipalities. There is no “one-size-fits-all” instruction for stimulating municipalities in the development of multi-sector health policies, but rather recommendations specifically tailored to the needs of an individual municipality are needed.

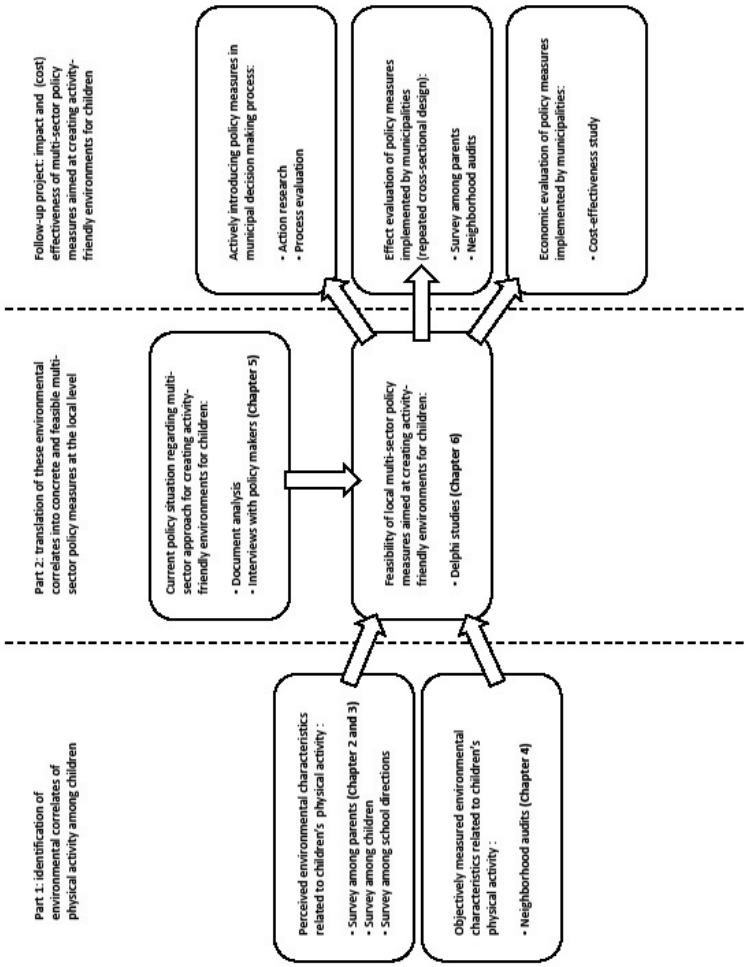

Figure 7.2: Overview of the future research steps included in the follow up project

If municipalities are willing to incorporate policies that stimulate outdoor play among children, it is important to not only address the physical environmental characteristics, but also take into account the social environmental characteristics related to outdoor play. Because the social environmental characteristics are more consistently related to children's physical activity behavior, it is even justifiable for municipalities to invest primarily in the social environmental characteristics related to physical activity, at the expense of investments in the physical environment. Results from our Delphi study have shown that several policy sectors can contribute to, for example, neighborhood social cohesion and that these policy measures were considered feasible by policy makers as well. For example, municipalities could stimulate parents to choose a primary school for their children within the neighborhood they live in. This might enhance the commitment of parents with their neighborhood and could provide opportunities for outdoor play at school yards after school time, or active commuting initiatives such as a walking school bus (in which groups of children commute to school under supervision of trained adults following a standard route).

Furthermore it is important to realize that apart from formal play facilities in the neighborhood, also informal play facilities such as sidewalks are an important correlate of children's outdoor play behavior. Because girls generally spend less time on outdoor play than boys, municipalities should incorporate policy measures specifically aimed at stimulating outdoor play among girls. For example, municipalities could examine whether play facilities such as "Cruyff soccer courts" are equally attractive for boys as for girls, and if necessary organize activities or programs that specifically attract girls at such play facilities.

Our study results show that the majority of the primary school children already commutes to school by means of active transportation. Younger children and children living further away from their school are brought to school by car by their parents, but because age of the child and distance from home to school are non-modifiable factors, stimulating younger children or children living further way from their school to walk or bicycle to school remains challenging. Appropriate attention should be given to (parents' perception of) the child's safety when actively commuting to school. In designing interventions targeting these specific groups of children, it is of crucial importance to guarantee social as well as traffic safety for children when actively commuting to school. Because children living in lower SES neighborhoods are less likely to go to school by means of active transportation, this might be an area where municipalities should intensify their efforts to stimulate active commuting.

Although we did not address the environmental characteristics related to organized sports participation, future analyses on our data may provide additional recommendations about which environmental correlates are important to address with regard to organized sports activities among children.

The Delphi technique as used in this project appeared to be a useful tool in starting a discussion with policy makers from different sectors about evidence-based environmental correlates of physical activity among children and to translate these findings into concrete and (in theory) feasible multi-sector policy measures at the local level. The fact the physical activity among children is a theme that receives much (media) attention nowadays, further enhances the chance that such policy measures will be adopted by policy makers from policy sectors outside the public health domain. In municipalities where collaboration is restricted to policy sectors already familiar with the topic "physical activity and youth" (e.g. sports, youth and education, public health), policy sectors less familiar with health-related themes (e.g. spatial planning, safety, traffic and transportation) could be invited and stimulated to join existing collaboration initiatives. Furthermore, in some municipalities, the intensity of collaboration could be expanded by moving from incidental to more structural collaboration. However, as the added value of collaboration is not yet scientifically demonstrated, it is not a strict prerequisite for municipalities to invest in collaboration. It is also possible to create health gain, by raising awareness about the possible side-effects of policy plans from other policy sectors, for example by means of conducting a Health Impact Assessment (HIA).

To gain insight in the costs and effects of a multi-sector policy approach, it is advisable to accompany the multi-sector policy development with research addressing the (cost)effectiveness of such initiatives, as planned in our follow-up project. In this way, the costs and benefits on health and other outcomes (such as participation, sustainability etc.) of multi-sector policy initiatives become clear, which enhances the scientific underpinning and argumentation for multi-sector policy plans in the local policy arena.

General conclusion

This project focused on the opportunities for multi-sector policies to create activity-friendly environments for children at the municipal level. Apart from aspects in the home environment of children (such as parental education level or parental attitude towards physical activity), the studies described in this thesis showed the relation between neighborhood characteristics and children's physical activity

behavior. It appeared that especially social neighborhood characteristics were consistently related to specific aspects of children's physical activity behavior and that policy makers from different policy sectors see feasible opportunities for policy measures addressing the social environment in their municipalities. Moreover, findings from objective neighborhood observations suggest that informal play facilities (such as sidewalks) and traffic situation are important correlates of children's outdoor play behavior. Because girls spent generally less time on outdoor play than boys, special attention should be given to policies stimulating outdoor play among girls. Because the majority of children already goes to school by means of active transportation, municipalities should bear in mind that health gain in this area are more challenging to achieve, but improvements can be achieved in lower SES neighborhoods.

Policy analysis has shown that multi-sector approach for tackling physical inactivity among children is still in its infancy and that such an approach could be further stimulated by raising awareness among policy sectors and defining problem ownership, further enhancing multi-sector collaboration and paying appropriate attention to facilitators and challenges. However, because extensive collaboration is a time-consuming process, the added value of multi-sector collaboration over enhancing awareness among policy sectors outside the public health domain should be demonstrated. Furthermore, as there are large differences in starting positions between municipalities regarding the multi-sector approach for creating activity-friendly environments for children, it is important to tailor the recommendations for improving such an approach to the specific local policy conditions. The Delphi technique appeared a useful method to translate scientific results on the environmental correlates of children's physical activity into concrete policy measures that were perceived as feasible by local policy measures. In this way, potentially effective and feasible policy measures to increase neighborhood social cohesion, accessibility of facilities and traffic safety were identified.

Future steps aimed at improving the activity-friendliness of the environment for children should focus on the actual adoption and implementation of such multi-sector policies. Action-oriented research addressing critical success and failure factors in this process, as well as the (cost)effectiveness of such multi-sector policy initiatives can further assist municipalities in optimizing their opportunities to design activity-friendly environments for children by means of multi-sector policies.

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SUMMARY

Summary

The aim of this research project was to identify, describe and test the feasibility of concrete multi-sector policy measures that create activity-friendly environments for children. In order to reach this aim, the first part of this thesis focused on the environmental characteristics related to physical activity among children. These environmental correlates were either measured subjectively (by means of a survey among parents) or objectively (by means of neighborhood audits). The second part of the thesis focused on the translation of these environmental correlates of physical activity among children into concrete and feasible multi-sector policy measures at the local level. Therefore, the current policy situation in four Dutch municipalities regarding the multi-sector approach to create activity-friendly environments for children was studied. Subsequently, concrete multi-sector policy measures at the local level were identified and tested on their feasibility during interactive workshop sessions with local policy makers (Delphi study).

Chapter 1 starts with a description of the background for this thesis. Physical inactivity among children is a major health problem in The Netherlands as well as in many other Western countries. In addition to health promotion among parents and children, creating "activity-friendly" neighborhoods can contribute to the solution of this health problem. However, changing environmental characteristics is often the responsibility of policy sectors outside the public health domain. Therefore this project identifies and evaluates the possibilities of multi-sector policy measures to stimulate physical activity among children.

Next, a global overview of the methods and study design is given. The project consists of quantitative as well as qualitative research methods and is conducted in four medium-sized Dutch cities. The data collection of the project consists of four major parts. To identify perceived environmental correlates of physical activity among children, a large scale health survey was conducted at 42 primary schools. Written questionnaires including topics on the children's physical activity behavior (i.e. sports participation, outdoor play, active commuting, television watching and computer usage) and physical and social environmental characteristics were completed by 6,601 parents of children aged 4-12 years old and 3,449 children aged 9-12 years old. In addition, 33 neighborhood audits (systematic observations) were conducted to assess objective neighborhood characteristics. Furthermore, a policy analysis was conducted in the four participating municipalities to provide an overview of the current local policy measures directed at stimulation of physical activity among children. Semi-structured interviews were conducted with policy makers of

each of different municipal policy sectors (public health, sports, youth and education, spatial planning, traffic and transportation, and safety) to identify current multi-sector policy initiatives, the role multi-sector collaboration herein and possible facilitators and challenges for multi-sector policy action aimed at stimulating physical activity among children. The results of all these research activities were discussed with local policy makers during interactive workshop sessions (Delphi studies) in order to identify clear cut and feasible multi-sector policy measures that stimulate physical activity in children.

In conclusions, Chapter 1 describes the study design of a project that focuses on multi-sector policy measures that stimulate physical activity among children. Apart from extensive research into the environmental correlates of physical activity among children, much emphasis is placed on the translation of the research outcomes into concrete and feasible policy plans.

Chapter 2 focuses on the perceived environmental characteristics in relation to outdoor play among children. Outdoor play is a cheap and natural way for children to be physically active. The study described in this chapter is based on the survey among parents and aims to identify physical as well as social correlates of outdoor play in the home and neighborhood environment among children of different age groups. Cross-sectional data were derived from 6,470 parents of children from 42 primary schools in four Dutch cities by means of questionnaires. Multilevel multivariate sequential Poisson GEE analyses were conducted to quantify the correlation between physical and social home and neighborhood characteristics and outdoor play among boys and girls aged 4-6, 7-9 and 10-12 years old. The study showed that next to proximal (home) environmental characteristics such as parental education (negative association, RR ranges from 0.93-0.97), the importance parents pay to outdoor play (positive association, RR ranges from 1.32-1.75) and the presence of electronic devices in the child's own room (positive association, RR ranges from 1.04-1.15), several neighborhood characteristics were significantly associated with children's outdoor play. Neighborhood social cohesion was positively related to outdoor play in five out of six subgroups (RR ranges from 1.01-1.02), whereas physical neighborhood characteristics (e.g. green neighborhood type, presence of water, diversity of routes) were associated with outdoor play in specific subgroups only. It can be concluded that improving social characteristics (such as social cohesion) is a promising point of action for policy development. Policies aimed at improving physical neighborhood characteristics in relation to outdoor play, should acknowledge the fact that changes may only affect subgroups of the target population.

Chapter 3 addresses the perceived environmental characteristics in relation to active commuting to school. The aim of this study was to quantify the correlation between (perceived) physical and social environmental characteristics and walking and cycling to school among children. Cross-sectional data were collected among parents (n = 5,963) of children aged 4-12 years of 42 primary schools in four Dutch cities. Parents reported mode of transportation to school of their child, individual, home environmental, social and physical neighborhood, and school environmental characteristics. Multilevel multinomial logistic regression analyses were conducted to quantify the association between environmental characteristics and walking and bicycling to school. Three-quarter of all children usually commuted to school by means of active transportation. Age of the child (years) was positively related to walking (OR = 1.31) and bicycling (OR = 1.71) and distance from home to school (km) was negatively related to walking (OR = 0.18) and bicycling (OR = 0.70). Number of siblings was positively related to walking (OR = 1.44) and bicycling (OR = 1.24), as was number of days per week the child goes home after school (OR = 1.18 and 1.13 for walking and bicycling respectively). Number of cars in the household showed a negative association (OR = 0.58 and 0.49 for walking and bicycling respectively). Lower neighborhood SES was negatively associated with walking (OR = 0.51) and cycling (OR = 0.86). Social safety was positively related to walking and cycling (OR = 1.04 for both), as was social cohesion (OR = 1.04 and 1.02 for walking and cycling respectively). Compared to the reference group (living in a city non-centre neighborhood), living in a city centre neighborhood was positively associated with walking (OR = 1.91), whereas living in a city green neighborhood was negatively associated with walking (OR = 0.48) and cycling (OR = 0.76). Traffic safety around school as perceived by the school board was positively associated with bicycling (OR = 1.25). From this study it can be concluded that also for commuting social environmental characteristics were consistently related to walking and bicycling to school, and the relations for built environmental characteristics were less clear.

Research has shown that differences exist in correlates of physical activity when the environmental characteristics are measured subjectively or objectively. The aim of the study described in **Chapter 4** was to identify quantitative as well as qualitative neighborhood characteristics related to outdoor play among children when measured objectively. Neighborhood observations were conducted in 33 Dutch neighborhoods (in four cities) and coupled to survey data of 3,651 parents of primary school children (aged 4-12 years), which included parental reporting of the child's outdoor play behavior. The neighborhood observations included the follow-

ing main topics: buildings, formal outdoor play facilities, public space, street pattern, traffic safety, social neighborhood characteristics, and general impression of the activity-friendliness of the neighborhood for children. Multilevel multivariate Poisson GEE analyses were performed to quantify the association between neighborhood characteristics and children's outdoor play in three age groups (4-6, 7-9, and 10-12 years), and for boys and girls separately. Neither the presence nor the quality of formal outdoor play facilities were (positively) related to outdoor play in this study. Rather, informal play areas such as the presence of sidewalks were related to children's outdoor play (RR ranged from 1.44-1.66). Also, traffic safety was an important characteristic associated with outdoor play, especially for boys. In general, the presence of roundabouts was positively associated with outdoor play (RR ranged from 1.10-1.15 in four out of six subgroups), whereas the presence of intersections was negatively associated with outdoor play (RR ranged from 0.78-0.87 in five out of six subgroups).This study showed that, apart from individual factors such as parental education level, certain modifiable characteristics in the neighborhood environment (as measured by neighborhood observations) were associated with outdoor play among boys and girls of different age groups in The Netherlands. Local policy makers from different sectors can use these research findings in creating more activity-friendly neighborhoods for children.

Chapter 5 describes a study that addresses the current policy situation in four Dutch municipalities regarding the multi-sector approach to create activity-friendly environments for children. The aim of this study was 1) to gain insight into current multi-sector policy initiatives that contribute to activity-friendly environments for children, 2) to investigate the role of multi-sector collaboration in multi-sector policy action and 3) to gain insight into critical facilitators and possible challenges for multi-sector policy action aimed at creating activity-friendly environments for children. A policy analysis was conducted in four Dutch municipalities by means of semi-structured interviews with 25 policy officers from different policy sectors (public health, sports, youth and education, spatial planning, traffic and transportation, safety, environmental affairs and play facilities). Interviews were transcribed ad verbatim and analyzed using qualitative data coding software. The results showed that each policy sector carried out policy measures related to (the environmental determinants of) physical activity among children, but most respondents were not aware of the potential effectiveness of their policy measures regarding this topic. In two municipalities structural collaboration between policy sectors was present, but the number of sectors involved was limited. Awareness and support among all policy sectors, a stimulating political environment, and knowing each

other and being informed about other sectors' policies were mentioned as facilitators for multi-sector policy action. The main challenge for multi-sector policy action was lack of time and resources. In conclusion, this study shows that multi-sector policy action aimed at activity-friendly environments could be stimulated by raising awareness and defining problem ownership, enhancing multi-sector collaboration and paying attention to facilitators and challenges.

Although multi-sector policy is a promising strategy to create environments that stimulate physical activity among children, little is known about the feasibility of such a multi-sector policy approach. The study described in **Chapter 6** aimed to quantify the feasibility of local multi-sector policy measures addressing environmental characteristics related to physical activity among children. In four Dutch municipalities, a Delphi study was conducted among local policy makers of different policy sectors (public health, sports, youth and education, spatial planning / public space, traffic and transportation, and safety). In the first Delphi round, respondents generated a list of possible policy measures addressing three environmental determinants of physical activity among children (social cohesion, accessibility of facilities and traffic safety). In the second Delphi round, policy makers weighted different feasibility aspects (political feasibility, cultural / community acceptability, technical feasibility, cost feasibility and legal feasibility) and assessed the feasibility of the policy measures derived from the first round. The third Delphi round was aimed at reaching consensus by feedback of group results. Finally, one overall feasibility score was calculated for each policy measure. The results showed that cost feasibility, cultural / community acceptability and political feasibility were considered most important feasibility aspects. The Delphi studies yielded 16 highly feasible policy measures aimed at physical and social environmental determinants of physical activity among children. Less drastic policy measures were considered more feasible, whereas environmental policy measures were considered less feasible. This study showed that the Delphi technique can be a useful tool in reaching consensus about feasible multi-sector policy measures. The study yielded several highly feasible policy measures aimed at physical and social environmental determinants of physical activity among children and can assist local policy makers in designing multi-sector policies aimed at an activity-friendly environments for children.

Chapter 7 comprises the general discussion of this thesis and starts with the interpretation and discussion of the main findings, followed with a discussion of the some methodological considerations. Especially the cross-sectional design of the study, the measurement tools for addressing environmental characteristics and

physical activity among children, and the relation between research and policy are important methodological issues with regard to the study design of the project. Finally, Chapter 7 describes the implications for research, policy and practice.

In conclusion, this project focused on the opportunities for multi-sector policies to create activity-friendly environments for children at the municipal level. Apart from aspects in the home environment of children (such as parental education level or parental attitude towards physical activity), the studies described in this thesis showed the relation between neighborhood characteristics and children's physical activity behavior. It appeared that especially social neighborhood characteristics were consistently related to specific aspects of children's physical activity behavior and that policy makers from different policy sectors see feasible opportunities for policy measures addressing the social environment in their municipalities. Moreover, findings from objective neighborhood observations suggest that informal play facilities (such as sidewalks) and traffic situation are important correlates of children's outdoor play behavior. Because girls spent generally less time on outdoor play than boys, special attention should be given to policies stimulating outdoor play among girls. Because the majority of children already goes to school by means of active transportation, municipalities should bear in mind that health gain in this area are more challenging to achieve, but improvements can be achieved in lower SES neighborhoods.

Policy analysis has shown that multi-sector approach for tackling physical inactivity among children is still in its infancy and that such an approach could be further stimulated by raising awareness among policy sectors and defining problem ownership, further enhancing multi-sector collaboration and paying appropriate attention to facilitators and challenges. However, because extensive collaboration is a time-consuming process, the added value of multi-sector collaboration over enhancing awareness among policy sectors outside the public health domain should be demonstrated. Furthermore, as there are large differences in starting positions between municipalities regarding the multi-sector approach for creating activity-friendly environments for children, it is important to tailor the recommendations for improving such an approach to the specific local policy conditions. The Delphi technique appeared a useful method to translate scientific results on the environmental correlates of children's physical activity into concrete policy measures that were perceived as feasible by local policy measures. In this way, potentially effective and feasible policy measures to increase neighborhood social cohesion, accessibility of facilities and traffic safety were identified.

Future steps aimed at improving the activity-friendliness of the environment for children should focus on the actual adoption and implementation of such multi-

sector policies. Action-oriented research addressing critical success and failure factors in this process, as well as the (cost)effectiveness of such multi-sector policy initiatives can further assist municipalities in optimizing their opportunities to design activity-friendly environments for children by means of multi-sector policies.

SAMENVATTING

(SUMMARY IN DUTCH)

Samenvatting

De doelstelling van dit onderzoeksproject was het identificeren en beschrijven van multisectorale beleidsmaatregelen gericht op het beweegvriendelijk inrichten van de omgeving voor kinderen. Hierbij werd expliciet aandacht besteed aan de haalbaarheid van dergelijke maatregelen. In het eerste deel van dit proefschrift werd onderzocht welke omgevingskenmerken gerelateerd zijn aan het beweeggedrag van kinderen. Deze omgevingskenmerken werden zowel subjectief (d.m.v. een vragenlijst voor ouders) als objectief (d.m.v. buurtobservaties) gemeten. In het tweede gedeelte van dit proefschrift stond de vertaling van de gevonden associaties tussen omgevingskenmerken en fysieke activiteit bij kinderen, naar concrete en haalbare beleidsmaatregelen op lokaal niveau centraal. Hiervoor werd de huidige beleidssituatie m.b.t. de multisectorale aanpak gericht op een beweegvriendelijke omgeving voor kinderen in vier Nederlandse gemeenten in kaart gebracht. Vervolgens werden concrete multisectorale beleidsmaatregelen op lokaal niveau geïdentificeerd en getest op haalbaarheid tijdens interactieve workshops met lokale beleidsmakers (Delphi studie).

Hoofdstuk 1 schetst de achtergrond en aanleiding voor dit proefschrift. Net als in andere westerse landen vormt het gebrek aan lichaamsbeweging bij kinderen een ernstig gezondheidsprobleem in Nederland. Naast het geven van gezondheidsvoorlichting aan ouders en kinderen, kan het creëren van een “beweegvriendelijke” omgeving bijdragen aan het oplossen van deze problematiek. Het veranderen van omgevingskenmerken is echter de verantwoordelijkheid van beleidssectoren buiten het volksgezondheidsdomein. Daarom richt dit project zich op het identificeren en evalueren van de mogelijkheden van multisectorale beleidsmaatregelen gericht op het stimuleren van lichaamsbeweging bij kinderen.

In Hoofdstuk 1 wordt vervolgens een globaal overzicht gegeven van de opzet en de onderzoeksmethoden van het project, dat plaats vond in vier middelgrote steden in Nederland. Er werd gebruik gemaakt van zowel kwantitatieve als kwalitatieve onderzoeksmethoden en de dataverzameling bestond uit vier delen. Om te achterhalen welke subjectieve omgevingskenmerken (zoals ervaren door ouders) gerelateerd zijn aan het beweeggedrag van kinderen, werd er een grootschalige enquête uitgevoerd op 42 basisscholen. De enquête omvatte een vragenlijst voor ouders en voor kinderen, met daarin vragen over het beweeggedrag van het kind (d.w.z. sportparticipatie, buiten spelen, actief transport naar school, televisie kijken en computeren) en de fysieke en sociale omgevingskenmerken. In totaal hebben 6601 ouders van kinderen in de leeftijd van 4 tot en met 12 jaar een vragenlijst

ingevuld. Ook hebben 3449 kinderen in de leeftijd van 9 tot en met 12 jaar zelf een vragenlijst ingevuld. Bovendien werden er in 33 buurten systematische buurtobservaties uitgevoerd om de objectieve omgevingskenmerken in kaart te brengen. Ook werd er een beleidsanalyse uitgevoerd in ieder van de vier deelnemende gemeenten, met als doel een overzicht te geven van de huidige lokale beleidsmaatregelen gericht op het stimuleren van lichaamsbeweging bij kinderen. Hiertoe werden semigestructureerde interviews afgenomen bij beleidsmakers van verschillende beleidsvelden (volksgezondheid, sport, jeugd en onderwijs, ruimtelijke ordening, verkeer en vervoer, veiligheid), waarin werd nagevraagd welke multisectorale beleidsinitiatieven er momenteel speelden binnen de gemeente, wat de rol van multisectorale samenwerking hierin was en wat mogelijke succes- en faalfactoren zijn voor een multisectorale aanpak. De onderzoeksresultaten werden vervolgens besproken met lokale beleidsmakers tijdens een interactieve workshop (Delphi studie) waarin het identificeren van concrete en haalbare beleidsmaatregelen gericht op het stimuleren van lichaamsbeweging bij kinderen centraal stond.

Concluderend geeft het eerste hoofdstuk een overzicht van de opzet van een onderzoek naar multisectorale beleidsmaatregelen gericht op het stimuleren van lichaamsbeweging bij kinderen. Naast uitgebreid onderzoek naar de omgevingskenmerken die gerelateerd zijn aan het beweeggedrag van kinderen, is er binnen dit project veel aandacht voor de vertaling van deze inzichten naar concrete en haalbare beleidsplannen.

In **Hoofdstuk 2** komen de omgevingskenmerken (ervaren door ouders) in relatie tot buiten spelen bij kinderen aan bod. Buiten spelen is een goedkope en vanzelfsprekende manier voor kinderen om lichamelijk actief te zijn. Het onderzoek in dit hoofdstuk is gebaseerd op de enquête onder ouders en heeft als doelstelling het identificeren van fysieke en sociale omgevingskenmerken (thuis en in de buurt) die gerelateerd zijn aan het buitenspeelgedrag van kinderen van verschillende leeftijdscategorieën. Er werden cross-sectionele data verzameld onder 6470 ouders van kinderen op 42 basisscholen in vier Nederlandse steden door middel van vragenlijsten. Multilevel, multivariate, sequentiële Poisson GEE analyses werden uitgevoerd om de relatie tussen fysieke en sociale omgevingskenmerken in de thuis- en buurtsituatie en het buitenspeelgedrag van kinderen te kwantificeren. De analyses werden apart uitgevoerd voor jongens en meisjes en voor verschillende leeftijdscategorieën (4 tot en met 6, 7 tot en met 9 en 10 tot en met 12 jaar). De resultaten laten zien dat naast proximale omgevingskenmerken (d.w.z. kenmerken van de thuissituatie) zoals het opleidingsniveau van de ouders (negatieve associatie, relative rate (RR) varieerde van 0.93 tot 0.97), de mate waarin ouders buiten spelen

belangrijk vinden (positieve associatie, RR varieerde van 1.32 tot 1.75), de aanwezigheid van een televisie of computer in de kamer van het kind (positieve associatie, RR varieerde van 1.04 tot 1.15), verschillende buurtkenmerken significant gerelateerd waren aan het buitenspeelgedrag van kinderen. De sociale cohesie in de buurt was positief gerelateerd aan buiten spelen in vijf van de zes subgroepen (RR varieerde van 1.01 tot 1.02), terwijl de fysieke buurtkenmerken (bijvoorbeeld groen buurttype, de aanwezigheid van water, diversiteit van routes) alleen gerelateerd waren aan buiten spelen in specifieke subgroepen. Op basis van deze resultaten kan geconcludeerd worden dat het verbeteren van de sociale omgevingskenmerken (zoals de sociale cohesie in de buurt) een veelbelovend uitgangspunt is voor beleidsontwikkeling. Beleid dat gericht is op het verbeteren van de fysieke omgevingskenmerken in relatie tot buiten spelen bij kinderen, moet rekening houden met het feit dat hiermee slechts subgroepen van de doelgroep bereikt worden.

In **Hoofdstuk 3** komen de omgevingskenmerken (ervaren door ouders) in relatie tot actief transport naar school bij kinderen aan bod. Het doel van deze studie was het kwantificeren van de correlatie tussen de (ervaren) fysieke en sociale omgevingskenmerken en lopen en fietsen naar school. Er werden cross-sectionele data verzameld onder 5963 ouders van basisschoolkinderen (leeftijd 4 tot en met 12 jaar) op 42 basisscholen in vier Nederlandse steden. Ouders rapporteerden de manier waarop hun kind meestal naar school gaat en de kenmerken van de thuisomgeving, de sociale en fysieke buurtkenmerken en de kenmerken van de schoolomgeving. Multilevel, multinomiale, logistische regressie-analyes werden uitgevoerd om de associatie tussen de omgevingskenmerken en lopen en fietsen naar school te kwantificeren. Driekwart van de kinderen in het onderzoek ging meestal via actief transport naar school. De leeftijd van het kind (in jaren) was positief gerelateerd aan lopen (OR = 1.31) en fietsen (OR = 1.71) naar school en de afstand van huis tot school (km) was negatief geassocieerd met lopen (OR = 0.18) en fietsen (OR = 0.70) naar school. Het aantal broers en zussen was positief geassocieerd met lopen (OR = 1.44) en fietsen (OR = 1.24) naar school, net zoals het aantal dagen per week dat een kind rechtstreeks uit school naar huis gaat (OR = 1.18 en 1.13 voor lopen en fietsen respectievelijk). Het aantal auto's in het huishouden was negatief geassocieerd met actief transport naar school (OR = 0.58 en 0.49 voor lopen en fietsen respectievelijk). Een lagere buurt SES was negatief geassocieerd met lopen (OR = 0.51) en fietsen (OR = 0.86). Sociale veiligheid was positief geassocieerd met lopen en fietsen (OR is 1.04 voor beiden), net zoals sociale cohesie in de buurt (OR = 1.04 en 1.02 voor lopen en fietsen respectievelijk). Kinderen die in een centrumwijk wonen, hebben een hogere kans om lopend naar school te gaan (OR = 1.91), terwijl

kinderen die in een groenstedelijke wijk wonen een lagere kans hebben om lopend (OR = 0.48) of fietsend (OR = 0.76) naar school te gaan ten opzichte van kinderen die in een referentiewijk wonen. De verkeersveiligheid rondom de school (ervaren door de schooldirectie) was positief geassocieerd met fietsen naar school (OR = 1.25). Op basis van deze resultaten kan geconcludeerd worden dat ook voor actief transport naar school de sociale buurtkenmerken een belangrijke rol spelen. De resultaten voor de fysieke buurtkenmerken waren minder consistent.

Onderzoek heeft uitgewezen dat de correlaties tussen omgevingskenmerken en fysieke activiteit kunnen verschillen wanneer de omgevingskenmerken subjectief dan wel objectief gemeten worden. De doelstelling van de studie die staat beschreven in **Hoofdstuk 4**, was het identificeren van zowel kwantitatieve als kwalitatieve aspecten van de buurt in relatie tot het buitenspeelgedrag van kinderen, wanneer deze buurtkenmerken op een objectieve manier gemeten worden. Data van buurtobservaties in 33 Nederlandse buurten (verspreid over 4 gemeenten) werden gekoppeld aan data van vragenlijsten ingevuld door 3651 ouders van basisschoolkinderen (leeftijd 4 tot en met 12 jaar), waarin de ouders het buitenspeelgedrag van hun kind rapporteerden. Tijdens de buurtobservaties kwamen de volgende onderwerpen aan bod: de gebouwen in de buurt, de formele speelfaciliteiten, de openbare ruimte en groenvoorzieningen, het stratennetwerk, de verkeersveiligheid, de sociale omgevingskenmerken en de algemene indruk m.b.t. de beweegvriendelijkheid van de buurt voor kinderen. Multilevel, multivariate Poisson GEE analyses werden uitgevoerd om de associatie tussen de omgevingskenmerken en het buitenspeelgedrag van kinderen te kwantificeren. De analyses werden apart uitgevoerd voor jongens en meisjes en voor verschillende leeftijdscategorieën (4 tot en met 6, 7 tot en met 9 en 10 tot en met 12 jaar). Zowel de kwantiteit als de kwaliteit van formele speelfaciliteiten waren in deze studie niet (positief) geassocieerd met buiten spelen. Informele speelplekken daarentegen zoals de aanwezigheid van trottoirs waren wel positief gerelateerd aan het buitenspeelgedrag van kinderen (RR varieerde van 1.44 tot 1.66 in de verschillende subgroepen). Ook verkeersveiligheid was een belangrijk buurtkenmerk dat gerelateerd was aan buiten spelen, in het bijzonder voor jongens. Over het algemeen was de aanwezigheid van rotondes positief geassocieerd met buiten spelen (RR varieerde van 1.10 tot 1.15 in vier van de zes subgroepen), terwijl de aanwezigheid van kruispunten negatief geassocieerd was met buiten spelen (RR varieerde van 0.78 tot 0.87 in vijf van de zes subgroepen). Deze studie toont aan dat naast individuele factoren zoals het opleidingsniveau van de ouders, ook bepaalde veranderbare omgevingskenmerken (gemeten d.m.v. buurtobservaties) gerelateerd zijn aan het buitenspeelgedrag van jongens en

meisjes van verschillende leeftijdscategorieën in Nederland. Beleidsmakers van verschillende lokale beleidssectoren kunnen deze resultaten gebruiken bij het creëren van beweegvriendelijke buurten voor kinderen.

Hoofdstuk 5 beschrijft een studie naar de huidige beleidssituatie in vier Nederlandse gemeenten wat betreft de multisectorale aanpak voor het creëren van een beweegvriendelijke omgeving voor kinderen. Het doel van deze studie was: 1) om inzicht te verkrijgen in de lopende beleidsinitiatieven die bijdragen aan een beweegvriendelijke omgeving voor kinderen, 2) het onderzoeken van de rol van multisectorale samenwerking daarbij en 3) inzicht te verkrijgen in mogelijke succes- en faalfactoren voor een multisectorale aanpak gericht op het creëren van een beweegvriendelijke omgeving voor kinderen. In vier Nederlandse gemeenten werd een beleidsanalyse uitgevoerd in de vorm van semigestructureerde interviews met 25 beleidsmakers van verschillende beleidssectoren (volksgezondheid, sport, jeugd en onderwijs, ruimtelijke ordening, verkeer en vervoer, veiligheid, milieu en speelfaciliteiten). De interviews werden *ad verbatim* uitgeschreven en deze transcripten werden geanalyseerd m.b.v. een codeerprogramma voor kwalitatieve data. De resultaten toonden aan dat ieder beleidsveld maatregelen uitvoerde die gerelateerd waren aan (de omgevingsdeterminanten van) lichaamsbeweging bij kinderen, maar dat de respondenten zich niet altijd bewust waren van het potentiële effect van hun beleid op dit onderwerp. In twee van de vier gemeenten was er structurele samenwerking tussen sectoren, maar het aantal beleidssectoren dat betrokken was bij deze samenwerking was beperkt. Bewustzijn en draagvlak onder alle beleidssectoren, een positief politiek klimaat en elkaar kennen en op de hoogte zijn van elkaars beleidsactiviteiten werden als belangrijke succesfactoren voor een multisectorale aanpak genoemd. Gebrek aan tijd en middelen werd als de belangrijkste faalfactor voor een multisectorale aanpak gezien. Op basis van deze studie kan geconcludeerd worden dat de multisectorale aanpak om een beweegvriendelijke omgeving voor kinderen te creëren, gestimuleerd zou kunnen worden door het vergroten van het bewustzijn onder beleidsmakers en het definiëren van het probleemeigenaarschap, het stimuleren van multisectorale samenwerking en hierbij aandacht te besteden aan de genoemde succes- en faalfactoren.

Alhoewel multisectoraal beleid een veelbelovende strategie is voor het creëren van een beweegvriendelijke omgeving voor kinderen, is er weinig bekend over de haalbaarheid van een dergelijke aanpak. Het onderzoek dat staat beschreven in **Hoofdstuk 6** had als doel het kwantificeren van de haalbaarheid van lokale, multisectorale beleidsmaatregelen gericht op de omgevingskenmerken die gerelateerd zijn aan

lichaamsbeweging bij kinderen. In vier Nederlandse gemeenten werd een Delphi studie uitgevoerd onder lokale beleidsmakers van verschillende beleidssectoren (volksgezondheid, sport, jeugd en onderwijs, ruimtelijke ordening, verkeer en vervoer en veiligheid). Tijdens de eerste Delphi ronde werd er door de respondenten een lijst met mogelijke beleidsmaatregelen samengesteld, die aangrijpen op drie belangrijke omgevingsdeterminanten van lichaamsbeweging bij kinderen (sociale cohesie, bereikbaarheid van faciliteiten en verkeersveiligheid). Tijdens de tweede Delphi ronde werden verschillende aspecten van haalbaarheid (politieke haalbaarheid, culturele/maatschappelijke aanvaardbaarheid, praktische haalbaarheid, financiële haalbaarheid en juridische haalbaarheid) door de respondenten gewogen naar rato van het belang dat de respondenten toekenden aan deze aspecten. Vervolgens werden de maatregelen uit de eerste Delphi ronde door de respondenten op ieder haalbaarheidsaspect beoordeeld. De derde Delphi ronde was gericht op het bereiken van consensus onder de deelnemers d.m.v. het verstrekken van groepsfeedback. Uiteindelijk werd er per maatregel één overall haalbaarheidsscore berekend. Uit de resultaten bleek dat met name de maatschappelijke aanvaardbaarheid, de politieke haalbaarheid en de financiële haalbaarheid door de respondenten als belangrijk werden ervaren. De Delphi studies leverden in totaal 16 haalbare maatregelen op die gericht zijn op de fysieke en sociale omgevingskenmerken gerelateerd aan fysieke activiteit bij kinderen. Minder drastische maatregelen werden als meer haalbaar gezien, terwijl maatregelen gericht op de omgeving als minder haalbaar gezien werden. Deze studie laat zien dat de Delphi techniek een bruikbare methode is voor het bereiken van consensus over de haalbaarheid van multisectorale beleidsmaatregelen. De studie leverde verschillende beleidsmaatregelen op die gericht zijn op de fysieke en sociale omgevingskenmerken gerelateerd aan het beweeggedrag van kinderen, die tevens door de beleidsmakers als haalbaar worden gezien. Op deze manier kan dit onderzoek lokale beleidsmakers ondersteunen in het ontwikkelen van multisectorale maatregelen om een beweegvriendelijke omgeving voor kinderen te creëren.

Hoofdstuk 7 beslaat de algemene discussie van dit proefschrift en start met de interpretatie en discussie van de belangrijkste onderzoeksbevindingen, gevolgd door een discussie over de methodologische aspecten van het onderzoeksproject. De cross-sectionele opzet van het onderzoek, de meetmethoden voor het meten van omgevingskenmerken en fysieke activiteit bij kinderen en de koppeling tussen wetenschap en beleid vormen daarbij specifieke discussiepunten. Tenslotte worden in Hoofdstuk 7 de implicaties voor onderzoek, beleid en praktijk beschreven.

Het project richtte zich op de mogelijkheden van multisectoraal gemeentelijk beleid voor het creëren van een beweegvriendelijke omgeving voor kinderen. Naast factoren in de thuissituatie van kinderen (zoals het opleidingsniveau van de ouders of de houding van ouders ten opzichte van beweging), beschrijft dit proefschrift de relatie tussen buurtkenmerken en het beweeggedrag van kinderen. Met name de sociale buurtkenmerken waren consistent gerelateerd aan specifieke componenten van het beweeggedrag van kinderen. Beleidsmakers van verschillende beleidssectoren zagen haalbare mogelijkheden voor beleid dat zich richt op het verbeteren van de sociale omgeving binnen hun gemeente. Bovendien suggereren de resultaten van de buurtobservaties dat de informele speelruimte (zoals trottoirs) en de verkeerssituatie belangrijke factoren zijn die gerelateerd zijn aan het beweeggedrag van kinderen. Omdat meisjes in het algemeen minder buiten spelen dan jongens, zou er specifiek aandacht moeten zijn voor beleid dat zich richt op het stimuleren van buiten spelen bij meisjes. Gezien het feit dat het merendeel van de kinderen al via actief transport naar school gaat, is het voor gemeenten lastiger om op dit gebied winst te behalen. Mogelijk liggen er wel kansen voor het stimuleren van actief transport naar school in lage SES buurten.

De beleidsanalyses hebben laten zien dat de multisectorale aanpak voor het reduceren van fysieke inactiviteit onder de jeugd nog in de kinderschoenen staat en dat een dergelijke aanpak verder gestimuleerd zou kunnen worden door het vergroten van het bewustzijn bij andere beleidssectoren en het definiëren van het probleemeigenaarschap, het stimuleren van multisectorale samenwerking en het expliciet aanpakken van succes- en faalfactoren. Omdat uitgebreide samenwerking echter een tijdsintensief proces is, zal de toegevoegde waarde van samenwerking boven het vergroten van het bewustzijn onder beleidsmakers buiten het volksgezondheidsdomein nader onderzocht en aangetoond moeten worden. Bovendien zijn er grote verschillen in de uitgangssituatie van gemeenten wat betreft de multisectorale aanpak en samenwerking. Dit vraagt om adviezen en aanbevelingen die specifiek aansluiten bij de lokale beleidscondities binnen een gemeente. De Delphi techniek bleek een geschikte methode voor het vertalen van wetenschappelijke bevindingen over de omgevingskenmerken die gerelateerd zijn aan lichaamsbeweging bij kinderen, naar concrete beleidsmaatregelen op lokaal niveau die door beleidsmakers als haalbaar gezien worden. Op deze manier werden potentieel effectieve en haalbare beleidsmaatregelen geïdentificeerd die gerelateerd zijn aan sociale cohesie, bereikbaarheid van faciliteiten en verkeersveiligheid.

Vervolgstappen in onderzoek en (beleids)praktijk gericht op het verder verbeteren van de beweegvriendelijkheid van de omgeving voor kinderen, zou zich moeten richten op de daadwerkelijke adoptie en implementatie van dergelijke multi-

sectorale beleidsmaatregelen. Zowel actie-onderzoek gericht op succes- en faalfactoren in dit proces, als inzicht in de (kosten)effectiviteit van een dergelijke multisectorale aanpak kan beleidsmakers verder ondersteunen in het optimaliseren van de mogelijkheden van multisectoraal beleid om een beweegvriendelijke omgeving voor kinderen te creëren.

APPENDIX A

Detailed description of variables
Chapter 2

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation	Descriptive data: mean (SD) or proportions
Dependent variable						
Outdoor play	4	Considering a typical week in the past month: How many days does your child play outside on week-days? On average, how long does your child spend on outdoor play on such a weekday? How many days does your child play outside in the weekend? On average, how long does your child spend on outdoor play on such a weekend day?	NA	For the first item: 0 or less than 1 day per week, 1 day per week, 2 days per week, 3 days per week, 4 days per week, 5 days per week. For the second and fourth item: my child does not play outside during weekdays / weekend days, less than 30 min-utes per day, 30 -60 minutes per day, 60-120 minutes per day, more than 120 minutes per day. For the third item: 0 or less than 1 day per week-end, 1 day per weekend, 2 days per weekend.	The minutes per day the child was involved in outdoor play was recoded as follows: less than 30 minutes per day = 15 minutes per day, 30 minutes to one hour per day = 45 minutes per day, one to two hours per day = 90 minutes per day, more than two hours per day = 150 minutes per day. Number of days involved in outdoor play per week / weekend were multiplied by the minutes spent on outdoor play per day on a week / weekend day. Minutes spend on outdoor play during the week and weekend were summed to give the total min-utes of outdoor play in a seven day week.	412 (280)
Individual factors						
Gender of the child	1	What is the gender of your child?	NA	Boy; girl.	NA	50.1% boy; 49.9% girl.
Age of the child	1	How old is your child?	NA	Open question	Range from 3 to13 years. [a]	7.8 (2.4) years

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation	Descriptive data: mean (SD) or proportions
Covariate						
Parental education	1	What is your highest completed education?	NA	no education primary education lower vocational education lower general secondary education intermediate vocational education higher general secondary education or pre-university education higher vocational education university	Parental education was treated as an ordinal variable, higher scores represent higher education.	4.2% no education 2.5% primary education 11.0% lower vocational education 10.8% lower general secondary education 25.0% intermediate vocational education 10.4% higher general secondary education or pre-university education 24.8% higher vocational education 11.2% university
Proximal social variables						
Presence of rules in the household	6	In your household, are there rules regarding... - the moment of TV watching? - the duration of TV watching? - the moment of computer usage? - the duration of computer usage? - the moment of outdoor play? - the location of outdoor play?	0.805	yes no	Sum score was computed by assigning 1 point to each question that was answered with "yes". Sum score range is 0-6, higher sum scores represent more rules.	4.27 (1.89)

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation	Descriptive data: mean (SD) or proportions
Importance parents ascribe to outdoor play	1	I find it important that my child is regularly involved in outdoor play.	NA	Five-point Likert-type scale (strongly disagree to strongly agree).	Scores range 1-5, higher scores represent greater importance.	4.85 (0.50)
Number of siblings	1	How many brothers and sisters does your child have?	NA	Open question.	NA	1.40 (0.99)
Proximal physical variables						
Type of residence	1	In what type of residence do you live?	NA	detached semi-detached / duplex corner house row house flat / apartment other	Dummy coded, row house is reference.	12.2% detached 17.7% semi-detached / duplex 17.3% corner house 48.1% row house 3.5% flat / apartment 1.2% other
Rental / private property	1	Do you live in a private property or rental house?	NA	private property rental house	Dummy coded, private property is reference.	87.2% private property 21.8% rental house
Presence / absence of a garden	1	Does your home have a garden where your child can play?	NA	yes no	Dummy coded, presence of a garden is reference.	95.2% garden 4.8% no garden
Number of electronic devices (TVs / computers) in the household	2	How many televisions does your household have? How many (game) computers does your household have?	0.635	no TV / computer one TV / computer two TVs / computers more than two TVs / computers	"More than two TVs/computers" was recoded into three TV's/computers. Then, number of televisions and number of computers was summed to determine the number of electronic devices in the household.	4.03 (1.32)

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation	Descriptive data: mean (SD) or proportions
Electronic device (TV / computers) in child's own room	2	Does your child have a television in his or her own room? Does your child have a computer in his or her own room?	0.603	yes no	Dummy coded, no TV or computer in child's own room is reference.	59.2% no electronic device in child's own room 40.8% electronic device in child's own room
Distal social variables						
Neighborhood SES	1	Based on postal code of residence address.	NA	Status score based on percentage unemployed people, percentage people with low education and percentage of low income households.	Scores could range from -4 to 4, higher scores represent lower socio-economic status.	-0.16 (1.16)
Degree of unoccupied houses	1	There are not many unoccupied buildings or houses in the direct environment.	NA	Five-point Likert-type scale (strongly disagree to strongly agree).	Scores range from 1-5, higher scores represent more unoccupied houses.	1.57 (1.14)
Presence of trash and litter	1	There is not much trash or litter in the direct environment.	NA	Five-point Likert-type scale (strongly disagree to strongly agree).	Scores range from 1-5, higher scores represent more trash or litter.	1.90 (1.19)
Presence of dog dirt	1	There is not much dog dirt in the direct environment.	NA	Five-point Likert-type scale (strongly disagree to strongly agree).	Scores range from 1-5, higher scores represent more dog dirt.	3.38 (1.47)
Social safety	5	The streets in the neighborhood are well lit at night. Pedestrians and cyclists can be easily seen by the residents of the houses in the neighborhood. The risk on trouble and petty crime makes it unsafe to	0.612	Five-point Likert-type scale (strongly disagree to strongly agree).	Negatively worded items were reversed. Sum score was computed, range 5-25, higher scores represent greater social safety.	19.14 (3.80)

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation	Descriptive data: mean (SD) or proportions
		walk through the neighbor-hood with my child during daytime. The risk on trouble and petty crime makes it unsafe to walk through the neighborhood with my child at night. The neighborhood is safe enough for my child to walk or play on the streets without supervision (during daytime).				
Social cohesion	6	People in the neighborhood are willing to help each other. The neighborhood is a tight community. The people in the neighbor-hood can be trusted. In general, the people in the neighborhood get along well. People in the neighborhood share the same norms and values. There are many children living in the neighborhood.	0.842	Five-point Likert-type scale (strongly disagree to strongly agree).	Sum score was computed, range 6-30, higher scores represent greater social cohesion.	23.17 (4.79)
Satisfaction with social contacts	1	Could you please indicate your satisfaction with the social contacts (such as family and friends) in the neighborhood?	NA	not satisfactory indifferent satisfactory NA	Scores range from 1-3, higher scores represent greater satis-faction.	2.58 (0.60)

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation	Descriptive data: mean (SD) or proportions
Distal physical variables						
Type of neighbor-hood	1	Based on postal code of residence address	NA	city centre city non-centre city green town centre rural area work area	Dummy coded, city non-centre is reference.	4.9% city centre 51.6% city non-centre 40.4% city green 0.5% town centre 2.5% rural area 0.2% work area
Degree of high- vs. low-rise buildings	2	There are not many high-rise buildings in our neighborhood. There are many low-rise buildings in our neighborhood.	0.603	Five-point Likert-type scale (strongly disagree to strongly agree).	Negatively worded items were reversed. Sum score was com-puted, range 2-10, higher scores represent more high-rise build-ings.	3.44 (1.92)
Presence of green in the neighborhood	1	There is much green in the direct environment.	NA	Five-point Likert-type scale (strongly disagree to strongly agree).	Scores range from 1-5, higher scores represent more green.	4.20 (1.12)
Presence of water in the neighborhood (such as a lake, pool, pond or river) in the neighborhood	1	There is much water in the direct environment.	NA	Five-point Likert-type scale (strongly disagree to strongly agree).	Scores range from 1-5, higher scores represent more water.	3.62 (1.48)
Traffic situation	5	There are sufficient pedestrian crossings and traffic lights to help pedestrians (children) crossing busy traffic points in the neighborhood. The speed of the traffic in the neighborhood is usually low (maximum 30 km / hour).	0.657	Five-point Likert-type scale (strongly disagree to strongly agree).	Negatively worded items were reversed. Sum score was com-puted, range 5-25, higher scores represent less favorable traffic situation.	16.83 (4.53)

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation	Descriptive data: mean (SD) or proportions
		Most drivers in the neighborhood drive too fast. There is so much traffic in our neighborhood, that it is difficult or inconvenient for my child to walk there. There are a lot of exhaust fumes (from cars, buses) in the neighborhood.				
Quality of sidewalks and bike lanes	4	Most sidewalks in the neighborhood are well maintained. Most sidewalks in the neighborhood are separated from the street (by parked cars, plants, concrete obstacles). Most streets in the neighborhood have bike lanes. Most bike lanes in the neighborhood are separated from the street (by parked cars, plants, concrete obstacles)	0.604	Five-point Likert-type scale (strongly disagree to strongly agree).	Sum score was computed, range 4-20, higher scores represent better quality.	12.50 (3.77)
Diversity of routes	1	There are many different routes in the neighborhood my child can take to get somewhere.	NA	Five-point Likert-type scale (strongly disagree to strongly agree).	Scores range from 1-5, higher scores represent greater diversity.	3.84 (1.18)
Distance to facilities	8	How long would it take for your child to walk from your home to a park or woodland,	0.658	0-5 minutes 6-10 minutes 11-20 minutes	Answering categories were recoded into 2.5 minutes, 8.0 minutes, 15.5 minutes, 25.5	11.94 (5.15)

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation	Descriptive data: mean (SD) or proportions
		water (such as a lake, pool, pond or river), school yard, paved play ground, unpaved playground (like a patch of grass), sport facilities, swimming pool, your child's school?		21-30 minutes more than 30 minutes I don't know.	minutes, 35.0 minutes and missing respectively. Average distance to facilities was computed by adding up the distances to the individual facilities and then dividing by the total number of facilities.	
Satisfaction with play facilities	1	Could you please indicate your satisfaction with the play facilities in your neighborhood (such as play grounds and play fields)?	NA	not satisfactory indifferent satisfactory NA	Scores range from 1-3, higher scores represent greater satisfaction.	2.22 (0.85)
Satisfaction with public space and green space	1	Could you please indicate your satisfaction with public space and green space (such as a park)?	NA	not satisfactory indifferent satisfactory NA	Scores range from 1-3, higher scores represent greater satisfaction.	2.42 (0.73)

[a] In The Netherlands, children aged 4–12 years are educated together at the same primary school. In the current study sample, 3 children in the lowest grade were aged 3 years and 12 children in the highest grade were aged 13 years; SD = Standard deviation; NA = Not applicable.

APPENDIX B

Detailed description of variables
Chapter 3

Appendix B: Detailed description of variables Chapter 3

Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
Dependent variable (questionnaire for parents)						
Mode of transportation to school	1	What is the usual mode of transportation to school for your child?	NA	Walking; bicycling; on the back of parent's bike / in a buggy; on the back of parent's moped / scooter; brought by car; by bus; other.	On the back of parent's bike / in a buggy, on the back of parent's moped / scooter, brought by car and by bus were recoded into inactive transportation (reference category).	43.4% walking; 31.8% bicycling; 24.8% inactive.
Individual factors (questionnaire for parents)						
+	1	What is the gender of your child?	NA	Boy; girl.	NA	50.3% boy; 49.5% girl, 0.2% missing value.
Age of the child	1	How old is your child?	NA	Open question	Range from 3 to13 years. [a]	7.82 (2.39)
Home environmental factors (questionnaire for parents)						
Parental education	1	What is your highest completed education?	NA	No education; primary education; lower vocational education; lower general secondary education; intermediate vocational education; higher general secondary education or pre-university education; higher vocational education; university.	Parental education was treated as an ordinal variable ranging from 1 to 8, higher scores represent higher education.	4.1% no education; 2.5% primary education; 10.8% lower vocational education, 10.8% lower general secondary education; 24.8% intermediate vocational education; 10.6% higher general secondary education or pre-university education; 24.8% higher vocational education; 11.5% university.

Appendix B: Detailed description of variables Chapter 3

Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
Parental ethnic background	1	What is your country of birth?	NA	The Netherlands; Surinam; The Netherlands Antilles; Turkey; Morocco; other country.	Surinam, The Netherlands Antilles, Turkey, Morocco, and other country were recoded into "other country".	84.0% born in the Netherlands; 15.5% born in an other country; 0.5% missing value.
Working situation of parent(s)	2	Which situation is most applicable to you and your partner? (respondents were asked to indicate their civil status and working situation)	NA	For civil status: Married / official registration of cohabitation and living together; living together, not married; unmarried, never been married; divorced, separated; widow(er); enduring relationship, living apart; living with my parents; other (open answers). For working situation of the respondent and (if applicable) their partner: Full time job; part time job (… hours); housewife / househusband / voluntary	Based on their civil status, respondents were categorized as either single-parent family or two-parent family. Number of working hours of the respondent and (if applicable) the partner were calculated. Full time job was recoded into 38 hours per week. Part time job working hours were filled in by the respondents (open question). Other answer categories were recoded in 0 hours per week, except for respondents who indicated that they are self-employed / entrepreneur which was recoded into 38 hours. Working hours of the respondents and (if applicable) the partner were collapsed into three categories: less than 12 hours per week, 12 – 36 hours per week, 36 hours per week or more.	3.1% single-parent family, parent works less than 12 hours per week; 5.5% single-parent family, parent works 12-36 hours per week; 2.3% single-parent family, parent works 36 hours per week or more; 2.2% two-parent family, both parents work less than 12 hours per week; 1.4% two-parent family, one parent works 12-36 hours per week, one parent works less than 12 hours per week; 6.9% two-parent family, both parents work 12-36 hours per week; 23.2% two-parent family, one parent works 36 hours per week or more, one parent works less than 12

Appendix B: Detailed description of variables Chapter 3

Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
				work; out of work / unable to work; student on a daytime course; other (open answers).	Finally, respondents were classified into 9 categories (see next column). These 9 categories were coded into 8 dummy variables, with two-parent family, one parent works 36 hours per week or more, one parent works 12-36 hours per week as reference category.	hours per week; 47.5% two-parent family, one parent works 36 hours per week or more, one parent works 12-36 hours per week; 5.6% two-parent family, both parents work 36 hours per week or more; 2.3% missing value.
Number of siblings	1	How many brothers and sisters does your child have?	NA	Open question.	Range from 0 to 8 siblings. 5, 6, 7 or 8 siblings were combined into one category "5 siblings or more".	10.6% 0 siblings; 54.5% 1 sibling; 24.7% 2 siblings; 6.8% 3 siblings; 1.9% 4 siblings; 1.5% 5 siblings or more.
Distance from home to school	1	What is the distance (in km) between your house and your child's school?	NA	Less than 1 km; 1-2 km; 2-5 km; more than 5 km	Less than 1 km was recoded into 0.5 km, 1-2 km was recoded into 1.5 km, 2-5 km was recoded into 3.5 km, more than 5 km was recoded into 6.0 km.	50.0% less than 1 km; 28.3% 1-2 km; 18.7% 2-5 km; 3.0% more than 5 km.
Number of days per week that the child goes home after school time.	1	How many days per week does your child go home after school time?	NA	0, 1, 2, 3, 4, 5 days	Range from 0 to 5 days.	1.7% 0 days; 1.6% 1 day; 7.6% 2 days; 19.2% 3 days; 16.5% 4 days; 51.9% 5 days; 1.4% missing value.
Number of cars in household	1	How many cars does your household have?	NA	No car, 1 car, 2 or more cars.	2 or more cars was recoded into 2 cars.	5.3% no car; 49.3% 1 car; 44.9% 2 or more cars; 0.5% missing value.

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
Social neighborhood characteristics (questionnaire for parents)						
Neighborhood SES	1	What is your postal code?	NA	NA	Status score based on the postal code of the respondent's address. The status score is based on percentage unemployed people, percentage people with low education and percentage of low income households. Scores could range from -4 to 4, higher scores represent lower neighborhood SES.	-0.18 (1.16) 0.4% missing value
Social safety	5	The streets in the neighborhood are well lit at night. Pedestrians and cyclists can be easily seen by the residents of the houses in the neighborhood. The risk on trouble and petty crime makes it unsafe to walk through the neighborhood with my child during daytime.The risk on trouble and petty crime makes it unsafe to walk through the neighborhood with my child at night.The	0.609	Five-point Likert-type scale (strongly disagree to strongly agree).	Negatively worded items were reversed. Sum score was computed, range from 5 to 25, higher scores represent greater social safety.	19.19 (3.79) 0.9% missing value

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
		neighborhood is safe enough for my child to walk or play on the streets without supervision.				
Social cohesion	6	People in the neighborhood are willing to help each other. The neighborhood is a tight community. The people in the neighborhood can be trusted. In general, the people in the neighborhood get along well. People in the neighborhood share the same norms and values. There are many children living in the neighborhood.	0.841	Five-point Likert-type scale (strongly disagree to strongly agree).	Sum score was computed, range from 6 to 30, higher scores represent greater social cohesion.	23.20 (4.76) 0.9% missing value
Degree of unoccupied houses	1	There are not many unoccupied buildings or houses in the direct environment.	NA	Five-point Likert-type scale (strongly disagree to strongly agree).	Scores range from 1 to 5, higher scores represent more unoccupied houses.	1.56 (1.12) 1.5% missing value

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
Presence of trash and litter	1	There is not much trash or litter in the direct environment.	NA	Five-point Likert-type scale (strongly disagree to strongly agree).	Scores range from 1 to 5, higher scores represent more trash or litter.	1.89 (1.18) 1.2% missing value
Presence of dog dirt	1	There is not much dog dirt in the direct environment.	NA	Five-point Likert-type scale (strongly disagree to strongly agree).	Scores range from 1 to 5, higher scores represent more dog dirt.	3.38 (1.46) 1.1% missing value
Physical neighborhood characteristics (questionnaire for parents)						
Type of neighborhood	1	What is your postal code?	NA	NA	Based on postal code of residence address: city centre, city non-centre, city green, town centre, rural area, work area. Dummy coded, city non-centre is reference.	4.9 % city centre; 50.6 % city non-centre; 40.3 % city green; 0.5 % town centre; 2.5 % rural area; 0.2 % work area; 1.1% missing value.
Degree of high- vs. low-rise buildings	2	There are not many high-rise buildings in our neighborhood. There are many low-rise buildings in our neighborhood.	0.606	Five-point Likert-type scale (strongly disagree to strongly agree).	Negatively worded items were reversed. Sum score was computed, range from 2 to10, higher scores represent more high-rise buildings.	3.43 (1.92) 1.7% missing value
Presence of green in the neighborhood	1	There is much green in the direct environment.	NA	Five-point Likert-type scale (strongly disagree to strongly agree).	Scores range from 1to 5, higher scores represent more green.	4.21 (1.11) 0.8 % missing value

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
Presence of water in the neighborhood	1	There is much water in the direct environment.	NA	Five-point Likert-type scale (strongly dis-agree to strongly agree).	Scores range from 1-5, higher scores represent more water.	3.63 (1.48) 1.2% missing value
Traffic situation	5	There are sufficient pedestrian crossings and traffic lights to help pedestrians (children) crossing busy traffic points in the neighbor-hood. The speed of the traffic in the neighborhood is usually low (maximum 30 km / hour). Most drivers in the neighborhood drive too fast. There is so much traffic in our neighborhood, that it is difficult or inconvenient for my child to walk there. There are a lot of exhaust fumes (from cars, buses) in the neighborhood.	0.655	Five-point Likert-type scale (strongly dis-agree to strongly agree).	Negatively worded items were reversed. Sum score was com-puted, range from 5 to 25, higher scores represent less favorable traffic situation.	16.78 (4.51) 0.5 % missing value

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
Quality of sidewalks and bike lanes	4	Most sidewalks in the neighborhood are well maintained. Most sidewalks in the neighborhood are separated from the street (by parked cars, plants, concrete obstacles). Most streets in the neighborhood have bike lanes. Most bike lanes in the neighborhood are separated from the street (by parked cars, plants, concrete obstacles).	0.603	Five-point Likert-type scale (strongly disagree to strongly agree).	Sum score was computed, range from 4 to 20, higher scores represent better quality.	12.47 (3.76) 3.2 % missing value
Diversity of routes	1	There are many different routes in the neighborhood my child can take to get somewhere.	NA	Five-point Likert-type scale (strongly disagree to strongly agree).	Scores range from 1 to 5, higher scores represent greater diversity.	3.84 (1.18) 0.8% missing value
School environment (questionnaire for parents and questionnaire for school boards)						
Traffic safety around school as perceived by parents	1	Do you think the traffic situation around your child's school is safe?	NA	Yes; yes, provided that I watch my child carefully; no (reason could be specified).	"Yes" and "yes, provided that I watch my child carefully" were recoded into "safe" (code 1), "no" was recoded into "unsafe" (code 0).	61.6% unsafe; 38.4% safe; 0.4% missing value.

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
Traffic safety around school as perceived by school direction [b]	1	How do you judge the traffic safety around your school?	NA	Very safe; safe; average; unsafe; very unsafe.	Scores range from 1 to 5, higher scores represent greater safety.	2.84 (0.91)
Sufficiency of bicycle shed at school as perceived by school direction [b]	1	Does the capacity of the bicycle shed satisfy the needs of your school?	NA	Yes, more than sufficient; yes, sufficient; no, insufficient; no, very insufficient.	Scores range from 1 to 4, higher scores represent greater sufficiency.	2.90 (0.70)

[a] In The Netherlands, children aged 4–12 years are educated together at the same primary school. In the current study sample, 3 children in the lowest grade were aged 3 years and 12 children in the highest grade were aged 13 years; [b] Derived from the questionnaire for school board; SD = Standard deviation; NA = Not applicable.

APPENDIX C

Detailed description of variables
Chapter 4

Appendix C: Detailed description of variables Chapter 4

Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
Dependent variable (questionnaire among parents)						
Outdoor play	4	Considering a typical week in the past month: How many days does your child play outdoors on school days? On average, how long does your child spend on outdoor play on such a weekday? How many days does your child play outdoors during the weekend? On average, how long does your child spend on outdoor play on such a weekend day?	NA	For the first item: 0 or less than 1 day per week, 1 day per week, 2 days per week, 3 days per week, 4 days per week, 5 days per week. For the second and fourth item: my child does not play outside during weekdays / weekend days, less than 30 minutes per day, 30 - 60 minutes per day, 60-120 minutes per day, more than 120 minutes per day. For the third item: 0 or less than 1 day per weekend, 1 day per weekend, 2 days per weekend.	The minutes per day the child was involved in outdoor play was recoded as follows: my child does not play outside = 0 minutes per day, less than 30 minutes per day = 15 minutes per day, 30 minutes to one hour per day = 45 minutes per day, one to two hours per day = 90 minutes per day, more than two hours per day = 150 minutes per day. Number of days involved in outdoor play on school days / weekend days was multiplied by the minutes spent on outdoor play per school day / weekend day. Minutes spent on outdoor play during school days and weekend days were summed to give the total minutes of outdoor play in a seven day week.	411 (277)
Individual factors (questionnaire among parents)						
Gender of the child	1	What is the gender of your child?	NA	Boy; girl.	NA	50.6% boy; 49.4% girl.
Age of the child	1	How old is your child?	NA	Open question	Range from 3 to13 years. [a]	7.8 (2.4) years

Appendix C: Detailed description of variables Chapter 4

Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
Parental education	1	What is your highest completed education?	NA	No education; primary education; lower vocational education; lower general secondary education; intermediate vocational education; higher general secondary education or pre-university education; higher vocational education; university.	Parental education was treated as an ordinal variable ranging from 1 to 8, higher scores represent higher education.	4.3% no education; 2.8% primary education; 11.7% lower vocational education, 10.8% lower general secondary education; 25.6% intermediate vocational education; 10.7% higher general secondary education or pre-university education; 24.0% higher vocational education; 10.1% university.
Buildings (neighborhood observations)						
Residential density	9	How often do the following types of residences occur in the neighborhood?	NA	Detached residences; semi-detached / duplex residence; row houses / single-family dwelling; upstairs flat / maisonette; flats / condo's < 3 stories; flats / condo's 4-6 stories; flats / condo's < 6-12 stories; flats / condo's > 12 stories;	The scores were weighted and summed to calculate residential density (higher scores represent greater density), according to the protocol of Saelens et al. [20].	247 (45)

Appendix C: Detailed description of variables Chapter 4

Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
				farmhouses. Each type of residence was scored on a five-point Likert-type scale ranging from 1 (none) to 5 (all).		
Land use mix	1	What is the proportion of enterprises to residences?	NA	0-100%	NA	15.2 (14.7)
Presence of unoccupied houses	1	How many unoccupied houses are there in the neighborhood?	NA	Five-point Likert-type scale (none-all).	Range from 0-4, higher score represent more unoccupied houses.	0.1 (0.3)
Maintenance of buildings	1	How is the maintenance of buildings in the neighborhood?	NA	Three-point Likert-type scale (bad -good).	Range from 1-3, higher scores represent better maintenance.	2.7 (0.6)
Formal outdoor play facilities (neighborhood observations)						
Number of formal outdoor play facilities per km^2	4	How many playgrounds, schoolyards, paved playgrounds and half pipes or skating racks are there in the neighborhood?	NA	Open question.	The total number of outdoor play facilities in the neighborhood was divided by the number of km^2 per neighborhood.	12.8 (8.4)
Quality of formal outdoor play facilities	10	Ten quality aspects of each outdoor play facility were scored.	NA	1) location of play facility nearby residences, 2) safely acces-	Each quality aspect was awarded with 0.10 point whenever applicable. Hence the total quality score	0.7 (0.1)

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
				sible, 3) always accessible, 4) sufficient surveillance during daytime, 5) good level of maintenance, 6) sufficient (street) lighting, 7) sufficient variation in outdoor play equipment, 8) useful separation from the street (e.g. a fence, covering), 9) absence of trash and litter, and 10) absence of dog waste.	per outdoor play facility could range from 0.00 to 1.00, higher scores represent better quality. A mean quality score for all outdoor play facilities was then calculated.	
Public space (neighborhood observations)						
Presence of green space	1	How much green space (trees, grass, parks and public green spaces) is there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more green space.	1.5 (0.8)
Quality of green space	4	Four quality aspects of green space were scored.	NA	1) good level of maintenance, 2) absence of weeds and thornbushes, 3) absence of trash and litter, 4) absence of dog waste.	Each quality aspect was awarded with 0.25 point whenever applicable. Hence the total quality score could range from 0.00 to 1.00, higher scores represent better quality.	0.4 (0.2)

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
Presence of water	1	How much water (ditches, pools, lakes) is there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more water.	1.3 (0.9)
Quality of water	4	Four quality aspects of water were scored.	NA	1) good level of maintenance, 2) absence of deep waters, 3) absence of high and steep waterssides, 4) absence of trash and litter.	Each quality aspect was awarded with 0.25 point whenever applicable. Hence the total quality score could range from 0.00 to 1.00, higher scores represent better quality.	0.6 (0.2)
Street pattern (neighborhood observations)						
Presence of sidewalks	1	How many sidewalks are there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more sidewalks.	2.9 (0.2)
Quality of sidewalks	4	Four quality aspects of sidewalks were scored.	NA	1) good level of maintenance, 2) good quality (e.g. width and room to walk), 3) absence of trash and litter, 4) absence of dog dirt.	Each quality aspect was awarded with 0.25 point whenever applicable. Hence the total quality score could range from 0.00 to 1.00, higher scores represent better quality.	0.9 (0.2)
Presence of bike lanes	1	How many bike lanes are there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more bike lanes.	1.6 (0.6)
Quality of bike lanes	4	Four quality aspects of bike lanes were scored.	NA	1) good level of maintenance, 2) good quality (e.g. width and room to bicycle), 3) bike lane	The four quality aspects were awarded with 0.25 or 0.50 points whenever applicable: good level of maintenance (0.25 points), good	0.7 (0.3)

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
				integrated in main road by means of a dashed line, 4) bike lane separated from main road by means of a solid line or other separation.	quality (0.25 points), bike lane integrated in main road by means of a dashed line (0.25 points), or bike lane separated from main road by means of a solid line or other separation (0.50 points). Hence the total quality score could range from 0.00 to 1.00, higher scores represent better quality.	
Traffic safety (neighborhood observations)						
Presence of pedestrian crossings without traffic lights	1	How many pedestrian crossings without traffic lights are there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more pedestrian crossings without traffic lights.	0.8 (0.8)
Presence of pedestrian crossings with traffic lights	1	How many pedestrian crossings with traffic lights are there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more pedestrian crossings with traffic lights.	0.6 (0.8)
Presence of traffic lights	1	How many traffic lights are there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more traffic lights.	0.5 (0.7)
Presence of refuges / safety islands	1	How many refuges / safety islands are there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more refuges / safety islands.	1.0 (0.9)
Presence of parallel parking places	1	How many parallel parking places are there in the	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more parallel parking	2.9 (0.3)

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
		neighborhood?			places.	
Presence of parking lots (grouped)	1	How many parking lots are there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more parking lots.	2.2 (0.6)
Presence of speed bumps	1	How many speed bumps are there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more speeds bumps.	2.3 (0.8)
Presence of home zones	1	How many home zones are there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more home zones.	2.1 (0.9)
Presence of 30 km/ hour zones	1	How many 30 km/ hour zones are there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more 30 km/ hour zones.	2.4 (0.7)
Presence of roundabouts	1	How many roundabouts are there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more roundabouts.	0.6 (0.7)
Presence of intersections	1	How many intersections are there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more intersections.	1.3 (0.6)
Traffic volume and speed	6	How many fast driving cars or motorcycles are there in the neighborhood? How many fast driving scooters or mopeds are there in the neighbor-	0.898	Each item was scored on a four-point Likert-type scale (none-a lot).	Range from 0 to 18, higher scores represent higher traffic volume and speed.	4.7 (3.7)

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
		hood? How many cars are parked outside parking places in the neighborhood? How much busy traffic is there in the neighborhood? How much heavy truck or bus traffic is there in the neighborhood? How many other traffic problems are there in the neighborhood?				
Social neighborhood characteristics (neighborhood observations)						
Presence of dog walking area	1	Is there a dog walking area in the neighborhood?	NA	No; yes.	No (0), yes (1).	51.9 % no; 48.1% yes.
Presence of litter basket for dog waste	1	Is there a litter basket for dog waste in the neighborhood?	NA	Absent; insufficiently present; sufficiently present.	Absent and insufficiently present were recoded into 0, sufficiently present was coded as 1.	88.0 % absent or insufficiently present; 12.0 % sufficiently present.
Presence of graffiti	1	How much graffiti is there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more graffiti.	1.6 (0.7)
Presence of vandalism	1	How much vandalism (e.g. vandalized bus	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more vandalism.	0.2 (0.4)

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Concept	Number of items	Exact formulation of items	Cronbach's alpha	Answer categories	Recode / sum score calculation and range	Descriptive data: mean (SD) or proportions
		shelters or litter baskets) is there in the neighborhood)?				
Presence of street lighting	1	Is there street lighting in the neighborhood?	NA	Absent; insufficiently present; sufficiently present.	Absent and insufficiently present were recoded into 0, sufficiently present was coded as 1.	3.1 % absent or insufficiently present; 96.1 % sufficiently present.
Presence of dark spaces	1	How many dark spaces (such as tunnels) are there in the neighborhood?	NA	Four-point Likert-type scale (none-a lot).	Range from 0 to 3, higher scores represent more dark spaces.	1.4 (0.7)
General impression (neighborhood observations)						
General impression	1	What is your general impression of the neighborhood in terms of opportunities to play, walk, bicycle for children?	NA	1-10	NA	7.1 (1.2)

[a] In The Netherlands, children aged 4–12 years are educated at the same primary school. In the current study sample, 3 children in the lowest grade were aged 3 years and 8 children in the highest grade were aged 13 years. These children were included in the lowest (4-6 years) and highest (10-12 years) age groups, respectively; SD = Standard deviation; NA = Not applicable.

APPENDIX D

Detailed description of policy measures Chapter 6

Appendix D: Detailed description of policy measures Chapter 6

Municipality A: social cohesion
Increase multi-use of school yards so that children can play there after school time and in the weekends (e.g. by placement of fences and appointment of key holders).
Subsidies for initiatives of citizens to increase social cohesion (e.g. street barbeques, coffee break projects, shared play equipment in the neighborhood).
Establish a democratic decision process when implementing new neighborhood facilities so that people get involved in spatial planning issues in their neighborhood and NIMBY effects are overcome.
Stimulate or oblige parents to choose a primary school for their children within their own neighborhood (e.g. provide parents with information on the primary schools within their neighborhood or assign primary school based on postal codes of the parents' residence).
Enhance daily encounters between people by taking this into account in spatial planning (e.g. front gardens, dog walking areas, benches etc.).
Municipality A: accessibility of facilities
Construct attractive (walking) routes for children to popular facilities (e.g. by means colorful, playful street design).
Facilitate informal play facilities (e.g. by providing children access to fallow lands, sand hills etc at construction sites).
Stimulate multi-use of vacant parking places (e.g. business parking places that are vacant in the weekends) so that they can be used as play grounds.
Provide with outdoor exercise facilities for adults, so that they can serve as a role model for children.
Increase the economic accessibility of sport facilities (e.g. by subsidies for poor families).
Municipality A: traffic safety
Stimulate primary schools to acquire the Local Safety Label.
Fence off streets for a couple of hours to create opportunities for safe outdoor play (e.g. every Wednesday afternoon).
Stimulate the own responsibility of school boards and parents to maintain traffic safety around their primary school (because often the parents create unsafe situations themselves).
Create car-free / low-traffic school zones during the peak hours for parents to fetch /collect their children (e.g. by means of a barrier).
Municipality B: social cohesion
Use major changes in neighborhoods to increase social cohesion (because often, neighborhood's residents unify when faced with major changes).
Stimulate initiatives of citizens to increase social cohesion (e.g. street barbeques, cooking classes, supervised reading clubs for children).
Increase multi-use of school yards so that children can play there after school time and in the weekends.
Increase social cohesion by business licensing requirements (e.g. businesses are obliged to connect with the residents in their neighborhood by means of internships etc.).
Municipality B: accessibility of facilities
Construct attractive routes for children to popular facilities (e.g. by means colorful, playful street design).
Stimulate multi-use of vacant parking places (e.g. business parking places that are vacant in the weekends, can be used as parking places for residents so that neighborhoods become car-free and children can reach play facilities more easily).
Disperse several (smaller) play facilities over the neighborhood, instead of one central play facility.
Realizing car-free neighborhoods so that children can reach play facilities more easily (e.g. by locating parking places at the borders of existing neighborhoods).

Appendix D: Detailed description of policy measures Chapter 6

Municipality B: traffic safety
Stimulate supervised active commuting to school (e.g. older children or relatives such as grandparents supervise groups of younger children in active commuting to and from school). Increase awareness among parents for active commuting to school by means of long-lasting communication campaigns. Create and sustain school zones that discourage cars (parking policies, one-way streets, police control). Realize infrastructural facilities such as crossing places and viaducts that help children reach popular destinations (such as sport and play facilities).
Municipality C: social cohesion
Fence off streets at specific days to create opportunities for safe outdoor play. Maintain play function of play facilities for children (e.g. tackle problems with older youth that hangs around). Stimulate or oblige parents to choose a primary school for their children within their own neighborhood. Increase social cohesion by formulating policies that affect the neighborhood's population composition.
Municipality C: accessibility of facilities
Develop parking policies that stimulate active transportation to facilities (e.g. providing bicycle racks at facilities). Attract facilities such as shops, hairdressers and physiotherapists in the neighborhood by adjusting the municipal zoning plan. Provide primary schools with adequate physical education facilities in the direct surroundings of the school, so that they can be reached by foot. Realize dependences of well-known (professional) sport clubs in the neighborhood, to facilitate intake of youth.
Municipality C: traffic safety
Expand communication around active transportation such as the initiative "park your car and rent a bike" which is set up to keep the city centre free of cars. Provide traffic education for children at primary schools. Create attractive routes for recreation (bicycling, skating) or create connections from neighborhoods to such routes. In collaboration with higher government (province) improve public transportation supply (e.g. frequency of busses, location of bus stops near primary schools etc.)
Municipality D: social cohesion
Assign a part of the municipal neighborhood maintenance budget to citizens, so that residents become collectively responsible for the maintenance of their own neighborhood. Make organizing agreements with local actors about regular neighborhood activities. Assign part of the municipal budget for neighborhood activities to local actors so that they become collectively responsible for organizing these activities. Increase social cohesion by making neighborhood agreements that define the tasks and roles of different actors in the neighborhood and increases the feeling of social safety among citizens. Enhance daily encounters between people by taking this into account in spatial planning (e.g. front gardens, dog walking areas, benches etc.).

Appendix D: Detailed description of policy measures Chapter 6

Municipality D: accessibility of facilities
Oblige / stimulate all sport facilities to conduct a Safety Impact Assessment, so that (traffic) safety in and around sport facilities is increased, which in turn increases the opportunities for children to use these facilities independently. Provide physical infrastructure such as bike lanes to increase the accessibility of sport facilities. Improve spatial planning in such a way that public spaces fit the needs of different target groups (youth, elderly). Instead of placing sport facilities at the city borders, situate them in such as way that they become more easily accessible from the neighborhood.
Municipality D: traffic safety
Provide users and providers of facilities with information, so that they can enhance the traffic safety around their school, sports club etc. themselves. Couple maximum traffic speeds to standard street types (30 km / h in residential neighborhoods, 50 km / h in connecting streets, 60 and 80 km / h in areas surrounding the city). Create car-free / low-traffic school zones. Deregulation of traffic situations i.e. remove excessive traffic signs and infrastructure to increase alertness among road users.

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(ACKNOWLEDGEMENTS)

Dankwoord

Tijdens mijn AiO-schap heb ik veel hulp gehad van de mensen om mij heen. Graag wil ik daarom iedereen bedanken die, direct of indirect, een bijdrage heeft geleverd aan dit proefschrift.

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Anne, Coryke, Denise, Eva, Anouk, Ivo, Milou en Karin V, jullie hebben als stagiaires ieder een eigen bijdrage geleverd aan mijn project. Duizenden vragenlijsten uitdelen, buurten observeren door weer en wind, drukbezette ambtenaren overhalen tot deelname aan een interview, lastige statistische analyses uitvoeren: niets werd

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Marie-Jeanne Aarts, Tilburg, zomer 2011

CURRICULUM VITAE

Curriculum Vitae

Marie-Jeanne Aarts was born on November 14th 1981 in Heerlen, The Netherlands. After completing her pre-university education at the Eurocollege in Maastricht in 2000, she studied Health Sciences at Maastricht University, with specialization Movement Sciences. After completion of her master thesis on the development of insulin resistance, she graduated cum laude in 2004.

From 2004 till 2006 Marie-Jeanne worked at the department of Human Biology at Maastricht University, on a research project investigating the role of lipid metabolism in the development of type 2 diabetes mellitus. Within this project, she also worked three months in Paris (Institute de Cancérologie Gustave Roussy) to optimize research techniques. Afterwards, she temporarily worked as a research assistant at Medtronic Bakken Research Center and TNO.

In October 2006 Marie-Jeanne was appointed as a PhD-student at the department of Tranzo (Scientific Centre for Care and Welfare) of Tilburg School of Social and Behavioral Sciences of Tilburg University, on a PhD project addressing the opportunities for multi-sector policies that stimulate physical activity among children. Besides her work as a researcher, Marie-Jeanne was also involved in organizing the "Tranzo Zorgsalon", a discussion meeting on actualities in care and welfare for researchers, professionals, policy makers and all others interested.

In collaboration with her supervisor Jantine Schuit, Marie-Jeanne applied for a research grant within the Netherlands Organization for Health Research and Development (ZonMw), which was awarded with a four-year subsidy at the end of 2010. The focus of this follow up project, in which Marie-Jeanne fulfills an advisory role, is on the implementation and impact of multi-sector policies that create activity-friendly environments for children.

From April 2011, Marie-Jeanne started working as a post-doc researcher at the department of Health Services Research at Maastricht University on the INFORMEH project, which is about the development of an INstrument FOR Outcome Measurement in Economic evaluations of Health promotion.

Curriculum Vitae (in Dutch)

Marie-Jeanne Aarts werd geboren op 14 november 1981 te Heerlen. Na het behalen van haar Vwo-diploma aan het Eurocollege te Maastricht in 2000, studeerde zij Gezondheidswetenschappen aan de Universiteit Maastricht, met als afstudeerrichting Bewegingswetenschappen. Na afronding van haar master scriptie over het ontstaan van insuline resistentie, studeerde zij in 2004 cum laude af.

Van 2004 tot 2006 werkte Marie-Jeanne bij het departement Humane Biologie van de Universiteit Maastricht, aan een onderzoek naar de rol van vetmetabolisme bij het ontstaan van type 2 diabetes mellitus. In het kader van dit project werkte zij ook drie maanden in Parijs (Institute de Cancérologie Gustave Roussy) voor het optimaliseren van onderzoekstechnieken. Hierna werkte zij tijdelijk als onderzoeksassistent bij Medtronic Bakken Research Center en TNO.

Vanaf oktober 2006 werkte Marie-Jeanne als promovenda bij het departement Tranzo (Wetenschappelijk Centrum voor Zorg en Welzijn) van Tilburg School of Social and Behavioural Sciences van Tilburg University, aan een promotieonderzoek naar de mogelijkheden van multi-sectoraal beleid gericht op het stimuleren van lichaamsbeweging bij kinderen. Naast haar werk als onderzoeker, was Marie-Jeanne ook betrokken bij de organisatie van de “Tranzo Zorgsalon”, een discussiebijeenkomst over actuele thema’s in zorg en welzijn, bedoeld voor onderzoekers, professionals, beleidsmakers en overige geïnteresseerden.

In samenwerking met haar begeleider Jantine Schuit, werkte Marie-Jeanne aan een subsidieaanvraag voor ZonMw. Deze aanvraag werd eind 2010 gehonoreerd met een vierjarige subsidie. Dit vervolgproject, waarin Marie-Jeanne een adviserende rol heeft, gaat over de implementatie en impact van multi-sectorale beleidsmaatregelen gericht op het creëren van een beweegvriendelijke leefomgeving voor kinderen.

Sinds april 2011 werkt Marie-Jeanne als postdoc onderzoeker bij het departement Health Services Research van Maastricht University. Hier werkt zij aan het ontwikkelen van een Instrument FOR Outcome Measurement in Economic evaluations of Health promotion (INFORMEH project).

LIST OF PUBLICATIONS

International publications

Valentijn KJM, Aarts MJ, Schuit AJ. Agreement between children's self-report and parents' proxy-report of recreational physical activity and sedentary behavior. Submitted for publication.

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Stellingen
behorende bij het proefschrift

Children, physical activity and the environment:
Opportunities for multi-sector policy

1. De sociale cohesie die ouders in hun buurt ervaren is positief gerelateerd aan zowel buiten spelen als actief transport naar school van kinderen. *(Dit proefschrift).*

2. Het aantal uren dat kinderen buiten spelen is meer gerelateerd aan informele speelmogelijkheden dan aan formele speelfaciliteiten in de buurt. *(Dit proefschrift).*

3. Het verbeteren van de sociale cohesie in de buurt is niet alleen potentieel effectief om beweging bij kinderen te stimuleren, maar wordt door gemeenten ook als haalbaar gezien. *(Dit proefschrift).*

4. Op het gebied van een beweegvriendelijke omgeving voor kinderen, is er binnen de gemeentelijke organisatie nog winst te behalen door het creëren van bewustwording rondom dit thema bij verschillende beleidssectoren. *(Dit proefschrift).*

5. Alhoewel multi-sectorale samenwerking wordt gezien als een veelbelovende methode om tot beweegvriendelijk beleid te komen, vormt de tijdsinvestering hiervan een belemmering voor structurele samenwerking. *(Dit proefschrift).*

6. Geef mensen een uitdagende omgeving en sporten wordt overbodig. *(Gebaseerd op Midas Dekkers in Lichamelijke oefening).*

7. "If, as growing body of evidence recommends, contact with nature is as important as good nutrition and adequate sleep, then current trends in children's access to nature need to be addressed." *(Richard Louv based on Faber Taylor and Frances Kuo in The last child in the woods; saving our children from nature-deficit disorder).*

8. De opkomst van sociale media heeft enerzijds een positief effect op de sociale cohesie, maar werkt anderzijds sedentair gedrag in de hand.

9. Ondanks het groene karakter van de campus van Tilburg University, is de Universiteit tijdens het schrijven van een proefschrift geen beweegvriendelijke omgeving voor promovendi.

10. One coincidence is better than one-hundred appointments. *(Marokkaans gezegde).*

Marie-Jeanne Aarts, 16 september 2011