Independent mobility of school-aged children in Delft

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Summary

Background: The Children's Environment and Health Action Plan for Europe (CEHAPE) addresses the environmental risk factors that most affect the health of European children and adequate physical activity is decided on as one of four major priority goals for Europe. Supporting independent mobility is one way to stimulate physical activity behavior of school-aged children. Over the last decades, independent mobility of school-aged has been reduced, as illustrated by the rise in the age that children in the Netherlands are allowed to travel unaccompanied to school. In the Netherlands, the age children obtain independent mobility has increased from 6,5 years to about 9 years over the past 25 years.

Design: We here report the first results of a study aimed at operationalizing the physical characteristics of the children's street environment encouraging physical activity and independent mobility in school-aged children. In collaboration with the municipality of Delft, we collected information on street environmental characteristics, independent mobility, and physical activity behavior (accelerometer, GPS) of children in several neighborhoods of Delft.

Results: we found that independent mobility was positively related to a distance from home to school of less than 1000m, a street environment near school supportive of walking children and that the less protective the environment was to children, the more likely they were to independently going to school. Physical activity behavior as measured with digiwalkers was positively associated with a street environment eliciting play and that supports children in using their bikes.

Keywords – Child-friendly neighbourhoods, Kids Street Scan, Obesogenic environment; Physical activity; Independent mobility; Built environment

Introduction

Both the Children's Environment and Health Action Plan for Europe and the EU green paper on 'The promotion of health diets and physical activity' addressed the ever increasing numbers of obese children in Europe. In 2005 in Europe there were more than 14 million overweight children: 3 million of them were obese and this number increases by 400.000 people every year. Across the entire EU25, overweight affects almost 1 in 4 children (IOTF, 2004).
Reviews from health sciences (Ferreira et al. 2007b) showed that the impact of the built environment is as important as psychosocial determinants of physical activity (PA) behaviors. Outdoor play and independent mobility are most important to meet daily norms for physical activity and might be of uttermost importance for children aged 9-13 years to prevent the rise in overweight and obese children. Studies in city planning, design and transport acknowledge the problem of the obesogenic environment (Frank et al. 2005), COST action 358 and action 6), however, in order to effectively change local neighborhoods into child-friendly neighborhoods an multidisciplinary approach is indicated. So far, city planning and transport tend to focus on independent mobility and traffic injury, whereas health sciences more typically address physical

activity behavior. Consequently, there is a difference in vocabulary. Since experts in city planning, design, and transport need an instrumentation to implement child-friendly interventions, concepts should be operationalized into measures meaningful to them, and they need clear guidance on what exactly is supportive to children's PA-behavior.
Furthermore, research into child friendly street environments tends to focus either on urban form characteristics supporting physical activity behavior (Den Hertog et al. 2006;Ferreira et al. 2007a;Frank et al. 2007;Van der Horst et al. 2007), or focuses on the actualization of affordances in different types of children's environments and their interrelations with independent mobility (Kyttä 2004). The former type of research relates objective measures of urban form to objective measures of physical activity behavior as measured by accelerometer and GPS. Frank et al. (2005)) found that an index consisting of residential density, street connectivity and landuse-mix could be used to assess the walkability of a neighborhood for adults. At the European scale, Den Hartog et al. (2006)showed that in youngsters (10-16 years), the presence of formal and informal playing grounds was associated with higher physical activity behavior, favoring the less dense neighborhoods rather than the inner city neighborhood. Also, De Vries et al. (2007) reported that physical activity behavior in 6-11 years old children was related to the presence of e.g. low rises, sports fields and parking places clustered or along the pavement. Typically, these studies emphasis the presence of urban forms such as grid, parks, playgrounds, etc. The merits of research from an ecological psychological perspective is that values the functionality as perceived by children (Kyttä 2002;Kyttä 2004). Children do not construct the way that they live in, but through active detection of information they assign affordances to their environment. Flat, relatively smooth surfaces for instance affords cycling, running, skipping, skating etc (Kyttä 2002). Kyttä (2004) showed that the affordances for children declined with increasing urbanization and showed that children's independent mobility affected the actualization of affordances.
Outdoor physical activity behavior is affected by children's independent mobility. Over the last decades, independent mobility of school-aged has been reduced, as illustrated by the rise in the age that children in the Netherlands are allowed to travel unaccompanied to school. In the Netherlands, the age children obtain independent mobility has increased from 6,5 years to about 9 years over the past 25 years. Children who are restricted in their outdoor range or in their independent mobility do play less and shorter outside, since most parents supervise their children for only 1 or 2 hours (Hüttenmoser & Degen-Zimmermann 1995). Instead, they will play the more and more indoor and substitute outdoor play by indoor playing, including computer gaming and watching television. Another disadvantage of accompanied mobility is that for several reasons parents are more intended to take their car, and by the time their children independently participate in traffic, they have less traffic experience. Traffic injuries are known to occur relatively frequently to cycling children aged between 12 and 14 years, and it deserves further attention whether this partially relates to the amount of experience they have at that time. Indeed, there is a conflict between health promotion messages advocating walking and cycling and outdoor play, and the reality of daily living where fear of traffic and lack of a suitable environment restrict play activities and independent mobility (Davis & Jones 1996).

In the here presented study, we used the Kids Street Scan (2006) as a tool to investigate what characteristics of the street environment increase independent mobility of school aged children. The Kids Street Scan (KISS) was developed to assess the child friendliness of the street environment. The KISS addressed some urban form characteristics and affordances, but also includes items on traffic and social safety. The study was conducted in Delft. Innovation in the field of child-friendly public spaces and traffic has played an important role in Delft since the introduction of the home zone (in Dutch: woonerf) in the 1960s. Delft was in 1986 the first Dutch city to realise a comprehensive bicycle network in an existing town. The municipality of Delft takes part in the Child-Friendly City Network and to support independent mobility currently develops child friendly routes from schools to significant places for children. The aim of our collaborative work is to investigate the characteristics of the children's street environment that influences independent mobility and physical activity in children attending elementary school.

Figure 1 Left the Voorhof neighbourhood, right the Wippolder neighbourhood in Delft

Methods

Subjects

Part of the data was collected in 2007, as pilot study in a comparative study of children attending the elementary schools in two neighborhoods (Voorhof, Wippolder) in Delft, the Netherlands. The Voorhof (more specifically the Poptahof) will be renewed over a ten years period and the pilot study constituted a baseline measure. In the Poptahof, there are two elementary schools, and both schools participated in the study. All children in group 7 were asked to participate in the study. In the Wippolder children were all from one school, but the director and the teachers did not agree on asking children from group 7 because of their lessons and instead all children from group 8 were asked to participate. In 2008, five additional neighborhoods were chosen as part of a training course for students. Students assisted in data collection as part of a course to investigate, advise and design a child friendly route for one out of five neighborhoods for the municipal of Delft. The five neighborhoods were selected by the municipal of Delft as neighborhoods that might have a sense of urgency to improve the local situation near schools. One of these neighborhoods was the Wippolder and the same school as in the baseline measure of the comparative school was asked for participation, since this school was the only school with a student population representing the local neighborhood. The other neighborhoods were Vrijenban, Hof van Delft en Tanthof West. In some schools, it turned out that grade 7 students were mixed with children from other grade (ranging from grade 5 – 8 in one school; grade 7-8 in other schools). If this was the case, children from all these grades were asked to participate, otherwise only children from grade 7 were asked.
Data was obtained on 80 children. Their average age was 11,0 years (range 8,2 -12,9 yrs; sd 0,9 yrs). There were 42 girls and 38 boys of comparable age. Of the 80 children, 4 were in grade 5, 8 in grade 6, 36 in grade 7 and 32 in grade 8.

Neighborhoods

The Poptahof (see figure1) is part of the Voorhof, a typical postwar neighborhood with six high rises, few medium rises and some single family homes built in the sixties. There are large green open spaces and open water. The Voorhof is the most dense neighborhood of the city of Delft. It is a deprived neighborhood with a high multi-ethnic population. Of the residents, 37% have a non-

native ethnicity and most of the multi-ethnic population (57%) lives in the part dominated by the high-rised named the Poptahof. There is a shopping centre close to the high-rises. The Poptahof will be renewed over the next 10 years. The municipal of Delft takes part in the Child-Friendly City Network and declared that renewal will underscore the design of a healthy environment for children. Renewal will specifically focus on traffic safety and opportunities for play to improve physical activity (PA) behavior and thus contributes to future prevention of obesity-related chronic diseases. There are two elementary schools in the Poptahof, both participating in a Neighborhood-School-Sports project aimed at improving sports participation of the children and both having special educational activities for children and parents from low income families.

The Wippolder (figure 1) is neighborhood without high-rises. Most of the houses are built in the twentieth, thirties and fifties of the former century. Houses are rather small and there are often 2 families homes, and frequently have a private or shared garden. There are still several small shops spread throughout this neighborhood. In 2003, the Wippolder was the neighborhood with the lowest nummer of formal playgrounds in Delft. There are two general elementary school in this neighborhood, a orthodox Christian school with a lot of children from the extended area and a roman catholic school with predominantly children from the local neighborhood. Most of the children, however (65%) attend elementary schools in the historical inner city. The catholic school participates in a Neighborhood-School-Sports project to increase sports participation among the children and has special educational activities for children and parents from low income families.

The Vrijenban is situated to the northeast of the historical inner city center. Part of the neighborhood consists of pre-war dwellings, mainly privately owned. Other parts were built after the second world war mainly for social housing. The main type of dwellings is terrace houses, but there is also substantial multi-storey housing. About 70% of residents live in social housing and the average income in the neighborhood is below the average income of Delft. About one fifth of the residents is non native Dutch. There are three elementary schools in the neighborhood. One of these was recommended to contact by a municipal worker. This school is a public Montessori school that partly serves the local neighborhood and is situated at short distance to the city center.

The neighborhood Hof van Delft is located on the northwest side of the city center. Most of the neighborhood was built at the turn of the twentieth century and before the war. The main types of dwellings are single family houses or multi-storey housing and this part is closest to the inner city center. The share of social housing is smaller than in other part of the city. This part of the city has less green spread throughout the neighborhood, but instead there are several parks in Hof van Delft. There are five elementary schools in this neighborhood,.three of these have a special pedagogic signature (Anthroposophy, Montessori, Freinet). The Freinet school participated in the study.

Measures

Digiwalker, GPS

The two main measures to assess physical activity behaviour, were both chosen for being objective measures. We used YAMAX CW700 digiwalkers with a one week memory for number of steps per day, and ‘walking’ time per day. The Garmin forerunner 205 was used to record the GPS tracks. Children wear the pedometer and GPS for 7 days between the last week of September and the first week of November, in 2007 as well as in 2008, but not during the one week holiday that fell in this period.

The first 2 days were discarded because the data should not reflect children’s desire for trying out the digiwalker and the GPS, but should come closest to normal daily behavior. For the data obtained with the digiwalker, a threshold of 500 steps per day was used to exclude data from children who had not put on the digiwalker that day. We only included data of children who had recordings on 3 out of 5 days (in addition to discarding the first two days). Results were not different if we included children who had valid recording over 1 or 2 out of 5 days.

Independent mobility, transport modality

Children filled out a small questionnaire during school time about independent mobility, as well as weight and height. During the week they were also asked to keep a diary.

Characteristics of the street environment near school

The Kids Street Scan (2006) version 3.0 was used to assess the following aspects of child friendliness:

1. Protection (social safety and traffic safety)
2. Walkability (Crossing to the other side of the street and Space for walking)
3. Cyclability (Crossing to the other side of the street and Facilities for cycling)
4. Criss-Crossability (Suitability to use the full width of the street)
5. Enjoyability (Attractiveness and variation)
6. Playability (Suitability for various activities; this also assess affordances for several types of play)

Other measures

1. For all children, distance from home to school was calculated from the global positioning coordinates. To this end, we obtain the RDM x and y coordinates for the addresses of all children and the schools. Distance was classified into 2 classes: up to 1000 m, or more than 1000 m.
2. Since age, grade and gender may influence parents' decisions about their children's independent mobility, these variables will be included in the statistical analysis.
3. Neighborhood (areal) indices of socio-economic status (percentage social rent, percentage of low incomes, average income) and average market value of the dwellings) were used to address potential effects of socio-economic factors.

We here report results of the digiwalkers and the questionnaire.

Statistical analyses

Logistic regression was used to assess the influence of street environmental characteristics on independent mobility. Distance, age, grade, gender and neighborhood indices of socio-economic status were included in the analyses as well. Linear regression was used to investigate the relationship of the selected variables with average number of steps per day. We used backward (logistic) regression modelling to acknowledge for dependency among the physical environmental characteristics, and carefully checked residuals for violating of assumptions.

All statistical analyses were conducted with SPSS version 16. Unless otherwise reported, a p value of 0.05 or less was used as a threshold for significance testing.

Results

Descriptives

Table 1 shows information on the average number of steps, independent mobility, distance, age and BMI of children in the neighborhoods. Table 2 provides descriptive information on the neighborhoods and the street environmental characteristics close to the school.

Table 1 Descriptives of individual measures

Variable	N		
Independent mobility (school)	79	Independent: 74,2%	
Average number of steps (at least 3 out of 5 days)	44	Mean: 8617	sd: 3085
Distance	80	Mean: 890 m	sd: 943 m
Age	80	Mean: 10,96 yrs	sd: 0.90 yr
Body Mass Index (kg/m^2)	59	Mean: 18,5	sd: 3,4

Table 2 Descriptives of neighborhood characteristics

Measure	Poptahof	Wippolder	Vrijenban	Hof van Delft
Protection	School 1: 3.5 School 2: 4.1	2.8	3.6	4.8
Walkability	School 1: 2.7 School 2: 4.1	3.1	2.7	7.5
Cyclability	School 1: 4.6 School 2: 3.3	2.7	1.7	5.0
Criss-Crossability	School 1: 1.0 School 2: 2.0	1.2	1.6	3.4
Enjoyability	School 1: 4.4 School 2: 1.8	2.6	3.7	3.0
Playability	School 1: 5.1 School 2: 2.5	2.8	4.0	3.3
% low income	46%	46%	33%	31%
% social rent	100%	55%	36%	43%
Mean income	€14800	€15700	€19400	€18400
Mean market value dwellings	€112000	€194000	€194000	€186000

Modeling Street Environment

Table 3 Physical characteristics of the street environment that explain independent mobility in children (mean age 10.9 yrs).

Characteristics	Exp(B)	Lower 95% CI	Upper 95% CI	p-value
Distance < 1000 m (ref. distance ≥ 1000 m)	10.40	3.10	35.3	0.00
KISS-protection	0.13	0.02	0.69	0.02
KISS-walkability	2.49	1.38	4.50	0.00
Constant	39.99			0.11

Independent mobility was found to be positive related to a distance from home to school of less than 1000m and with a street environment supportive to walking children. Independent walkability was also associated with the protectiveness of the street environment near school. The lower the protectiveness of the street near school, the more likely it was children were independently

allowed going to school. The distance from home to school was classified in 3 ways, using either a cutoff of 1000 meter, 400 meter which is usually mentioned as the home range for children of this age, and 500 meter. The final model did not depend on threshold was used. However, the explained variance significantly increased from 0.26 (400) or 0.25 (500m) to 0.41 for a home range of 1000m. The Hosmer & Lemeshow test showed good fit for the final model with a threshold for distance of 1000m (X^2=2.15, df=6, p=0.91).

Table 4 Physical characteristics of the street environment that explain physical activity behaviour (average number of steps over the last 5 days) in children (mean age 10.9 yrs).

Characteristics	B	Beta	95% CI	t-value	p-value
Constant	-1315		-13028;10398	-.23	0.82
Age	-3410	-0.74	-4711; -2108	-5.30	0.00
Grade	5094	0.83	3226; 6961	5.52	0.00
KISS-Playability	1386	0.36	462; 2310	3.04	0.00
KISS-Cyclability	1604	0.56	920; 2289	4.74	0.00

We obtained complete data on physical activity behaviour in a subset of children (n=44). For the average number of steps as measured over at least 3 out of the last five days, the final model is presented in table 4. This model explained considerable variance (adjusted R^2 =60.3%). In addition to age (the higher the age of children, the less they moved), grade, playability and cyclability as measured by the Kids Street Scan were positively associated with physical activity behaviour. Children in higher grades moved more, and they also moved more if the street environment near the school was rated with a higher score on playability and cyclability. Cyclability rates whether the street environment supports children in crossing roads and has facilities to park their bikes.

Discussion

We found that most children in Delft gain independent mobility depending on the distance from home to school. Usually a home range of 400m or 500m is indicated as appropriate to their age (Van Duijn 2004). We however found evidence that already in the higher grades (predominantly 7,8) were licensed by their parents to go out at their own, if the street environment is supportive to walking of children. However, the walkability of the street environment was not associated with an increase of physical activity behaviour in a subset of children. Instead, social and traffic safety did not add to independent mobility. The latter compares to the findings we reported before (van Oel & Reek 2008). Among 29 children who lived either in the Poptahof or in the Wippolder, we were surprised to find that traffic safety measures were associated with lower physical activity behaviour in these children. We then thought that this finding was related to whether or not parents licensed their children to independently going to school. We argued that traffic calming measures were applied to improve traffic safety, but that children (still) have restricted mobility within their action range because the perception on traffic safety was not changed. Parents might think that the traffic situation requires traffic calming and judge that street environment as to dangerous to their children. The current findings do not seem to support this way of reasoning. Rather, there might be a difference between parents who have their children on schools outside their neighbourhood. With increasing distance to school, independent mobility declines. In Delft, as in many other Dutch cities, schools with a special pedagogical signature are particularly attractive to the higher educated, native Dutch population. They might restrict independent mobility in children for instance due to time constraints and bring their children more frequently by car. Children living at short distance from school might be more representative of the local community. As shown in table 2, in the current sample the more deprived neighbourhoods dominated in the current sample. We clearly need to further sort out whether parents in the more deprived neighbourhoods may be less protective to their children, or that they simply allow their children to independently going to school in spite of the poor social and traffic safety near their children's school.

From our data, it seems that physical activity behaviour relates to different characteristics in the street environment than independent mobility to school. This might be so, because quite some number of children indicated that the one parent might take them by car, whereas the other parent accompanies children by bike or walking. This might be due to time constraints, but there were quite some children with divorced parents with one of the parents living close by. Physical activity was found to be higher with street environments supporting play and use of bikes. At all schools children indicated that generally they preferred to use their bikes rather than walking, even at small distances. These findings partly compare to the theory on affordances and play Kyttä (2002) developed. In judging the playability of the street environment the affordances for several types of play were rated, including play close to dwellings, affordances of climbing, biking, skating, playing ball games, etc. This kind of informal play might be more supportive of physical activity behaviour in children than formal playgrounds. Both De Vries et al (2007) and Den Hartog et al. (2006) found that physical activity behaviour does not relate to the presence of formal playgrounds.
We currently work on refinement of data analysis using GIS. This will also allow us to take into account more urban form characteristics, and to acknowledge for spatial variation in the data.

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