

Summary



SUMMARY

Activity-friendly neighborhoods for children: measurement of physical activity and environmental correlates

With the current epidemic of overweight and obesity among youth and the decline in their physical activity, promoting an active lifestyle has become a public health priority. In order to develop effective prevention and intervention strategies designed to promote an active lifestyle and inhibit a sedentary lifestyle among children and adolescents, it is essential to gain a thorough understanding of their physical activity patterns. Physical activity is a complex behavior which is difficult to measure, especially among youth. This thesis aims to provide an insight into the assessment of physical activity among children and adolescents, and to identify characteristics of the Dutch built environment that can promote or inhibit an active lifestyle among children.

The introductory **chapter 1** provides a general background and a rationale for the studies presented in this thesis. Two conceptual models are discussed. The first model relates to Part I of the thesis and describes the role of assessment in different domains of physical activity research. The second conceptual model relates to Part II of the thesis and revolves around characteristics of the Dutch built environment that are potentially associated with children's physical activity. The chapter concludes with the research questions addressed in the subsequent chapters of the thesis. The following sections present the main findings of these chapters.

Part I: Assessing physical activity among youth

In the first part of the thesis (chapter 2-5), four studies on the assessment of physical activity among youth are presented. Accurately assessing physical activity is essential for examining trends in children's and adolescents' physical activity over time, for establishing appropriate public health objectives in youth, for improving our understanding of the dose-response relationship between physical activity in early life and health in later life, for identifying determinants of physical activity among youth, for detecting children and adolescents at risk, and for setting and evaluating goals for prevention and intervention strategies designed to increase physical activity among youth.

According to the health-related physical activity guideline, children and adolescents should accumulate a minimum of 60 minutes per day in moderate to vigorous physical activity. **Chapter 2** shows that the proportion of 6- to 11-year-old children meeting this guideline are highly dependent on the guideline's operationalization in terms of intensity threshold, bout duration and number of days of moderate to vigorous activity, and on the assessment method used. Thus depending on the guideline operationalization, between 3% and 86% of 521 children who

completed a 7-day physical activity diary and between 0% to 100% of 51 children who simultaneously wore an ActiGraph accelerometer met the physical activity guideline. In accordance with our expectations, more children met the guideline when a lower intensity threshold (3 metabolic equivalents (METs)) and a shorter bout duration (1 minute) were used than when a higher intensity threshold (5 METs) and a longer bout duration (5 or 10 minutes) were used. In addition, more children met the guideline if the 60-minute threshold was considered as the average rather than the daily amount of activity. It was concluded that the use of different guideline operationalizations results in conflicting information on the proportion of youth meeting the health-related 60-minute physical activity guideline. This conflicting information hampers national policy making. In order to monitor the extent to which populations of children meet the guideline and in order to simplify comparisons between studies, consensus is needed on the guideline's operationalization.

Motion sensors (i.e., pedometers and accelerometers) are increasingly being used to assess physical activity among youth. **Chapter 3** presents the results of a systematic review of 35 studies on the feasibility, validity, and reproducibility of using motion sensors to assess physical activity in healthy children (2-11 years old) and adolescents (12-18 years old). In this review performed in 2004, the clinimetric quality of two pedometers (Digi-Walker and Pedoboy) and seven accelerometers (LSI, Caltrac, ActiGraph, Actiwatch, Tritrac-R3D, RT3, and Tracmor2) was evaluated and compared, using a 20-item checklist. The results showed that there was strong evidence for good reproducibility of the Caltrac in adolescents (12-18 years old), poor reproducibility of the Digi-Walker in children (8-11 years old), good validity of the ActiGraph in both children and adolescents (8-18 years old), and good validity of the Tritrac-R3D in children (8-11 years old). The ActiGraph was the most studied motion sensor. There was extensive evidence for good feasibility, validity, and reproducibility of the ActiGraph in children (3-11 years old) as well as in adolescents (12-18 years old). However, none of the 35 studies provided information about the reproducibility of using motion sensors to assess physical activity in preschool children (2-4 years old) or information about the reproducibility of using three-axial accelerometers in youth. Therefore, further clinimetric motion-sensor based studies are warranted, although not without improving the quality of the reported information.

Since 2004, the number of motion sensor-based studies have increased dramatically, the technology of existing motion sensors has improved, and new motion sensors have been developed. For these reasons, the review of 2004 was updated in 2007. In this update, 32 new studies were reviewed describing the clinimetric quality of three pedometers (Digi-Walker, Walk4Life, and Sun TrekLINQ) and nine accelerometers (ActiGraph, BioTrainer, StepWatch Activity Monitor, Actiwatch, Actical, Tritrac-R3D, RT3,

ActivTracer, and Mini-Motionlogger). The results of this update are presented in **chapter 4**. Compared with the review of 2004, there was increased evidence for the clinimetric quality of pedometers and accelerometers in youth. Most motion sensors seemed feasible, valid, and reproducible devices to assess physical activity in children and adolescents.

Few motion sensor-based studies have focused on very young children. In **chapter 5** the feasibility of using motion sensors to assess physical activity in 2-year-old children was investigated. Five hundred children participating in the Generation R Study conducted by the Erasmus Medical Center in Rotterdam were asked to wear an ActiGraph accelerometer during waking time on a weekday and on Saturday or Sunday. Their parents provided information about the child's experience with wearing the accelerometer and about non-wearing time. Finally, the data of 347 children with proper accelerometer data were included in the analysis. Most children were positive about wearing the accelerometer, 5% had mixed feelings, and merely 2% were negative. All in all, the results suggested that it is possible to perform accelerometer measurements in children as young as 2 years of age. In addition, it was shown that this age group already engaged in low levels of physical activity. Therefore, further motion sensor-based studies should focus on identifying important and modifiable determinants of their physical activity patterns and examining physical activity-related short- and long-term health effects.

Part II: Activity-friendly environment for youth

In the second part of the thesis (chapters 6 and 7), the association between characteristics of the Dutch built environment and children's physical activity level was examined. The way the built environment is designed, land is used and streets are connected, and where sports facilities and parks are located may either promote or inhibit physical activity among youth. Creating an 'activity-friendly' environment is considered a promising strategy to promote physical activity among youth, because of its potential for having a sustained impact on populations rather than a short-term impact on individuals. Moreover, improving the activity-friendliness of the built environment may influence population groups that are hard to reach with other strategies.

The findings of both chapter 6 and chapter 7 are based on the first measurements of the Spatial Planning And Children's Exercise (SPACE) study, a survey on the physical activity level of children from ten disadvantaged Dutch urban neighborhoods conducted by TNO Quality of Life in 2004-2005. Five neighborhoods were selected from a list of 56 disadvantaged neighborhoods designated by the government for spatial restructuring. The other five neighborhoods served as controls; they were selected to investigate the effects of changes in the built environment on children's physical activity level in the near future.

Chapter 6 describes the association between characteristics of the built environment and the time 422 children aged 6 to 11 years spend in moderate to vigorous physical activity, as assessed with a 7-day physical activity diary. Characteristics of the built environment were collected by neighborhood observation. Adjusted multivariate regression analyses showed that the children who lived in neighborhoods with a high frequency of parallel parking spaces and a high subjective rating of the activity-friendliness of the neighborhood on average spent more time in moderate to vigorous physical activity than the children who lived in neighborhoods with fewer parallel parking spaces and a lower subjective rating of the activity-friendliness of the neighborhood. It is concluded that children's physical activity is associated with certain modifiable built environmental characteristics. Longitudinal studies should examine whether there is a causal relationship.

Chapter 7 focuses on the 'walkability' and 'cyclability' of neighborhoods for 6- to 11-year-old children. The association between characteristics of the built environment and children's walking and cycling behavior was examined among 448 children. Whereas in adjusted multivariate regression analyses none of the investigated built environmental characteristics were significantly associated with recreational walking, a considerable proportion of both the variance in walking and cycling for transportation and the variance in walking and cycling to school could be explained by characteristics of the built environment. The characteristics that were most consistently associated with walking and cycling for transportation as well as with walking and cycling to school were the frequency of pedestrian crossings and the frequency of parallel parking spaces in the neighborhood. The children who lived in neighborhoods with a high frequency of pedestrian crossings and a high frequency of parallel parking spaces, on average walked and cycled for transportation and walked and cycled to school more often than the children who lived in neighborhoods with fewer pedestrian crossings and less parallel parking spaces. The results not only showed that built environmental correlates of children's walking and cycling behavior differed by purpose (transportation, school, and recreation), but also by commuting mode (walking and cycling) which implies a behavior specific approach for intervention strategies.

Lastly, in **chapter 8** the main findings of the thesis are put in a wider perspective. Furthermore, strategies to promote an active lifestyle among youth are proposed and recommendations for future studies are made.

The **general conclusions** of the thesis are:

- The proportion of 6- to 11-year-old children meeting the health-related 60-minute physical activity guideline are highly dependent on the guideline's operationalization in terms of intensity threshold, bout duration, and number of days of moderate to vigorous physical activity, and on the assessment method used.
- Most pedometers and accelerometers are feasible, valid, and reproducible devices to assess physical activity in healthy children (2-11 years old) and adolescents (12-18 years old).
- It is feasible to assess physical activity in 2-year-old children with accelerometers.
- The time 6- to 11-year-old children spend in moderate to vigorous physical activity is associated with the frequency of parallel parking spaces and the subjective rating of the activity-friendliness of the neighborhood the children live in.
- The number of walking and cycling trips 6- to 11-year-old children make are associated with certain modifiable characteristics of the built environment the children live in, such as the frequency of pedestrian crossings and the frequency of parallel parking spaces in the neighborhood. However, these characteristics differ by the purpose of walking and cycling and by the commuting mode.