

# **Environmental influences on physical activity among adolescents**

studies on determinants and intervention strategies

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# **Environmental Influences on Physical Activity among Adolescents: Studies on Determinants and Intervention Strategies**

Omgevingsinvloeden op beweeggedrag bij jongeren:  
studies naar determinanten en interventiestrategieën

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# Chapter 1

## General introduction







Physical activity (PA) is an important factor in public health, since improvement of PA levels may prevent up to six percent of annual deaths<sup>1-2</sup>. Nevertheless, a lack of sufficient PA is highly prevalent in the Netherlands, among adults and also among adolescents<sup>3</sup>. The lack of PA among adolescents is worrisome, as PA of adolescents has shown to track into adulthood, meaning that low PA levels persist to a certain extent from adolescence to adulthood<sup>4-6</sup>. Promotion of PA is thus important for all age groups, but for adolescents in particular. Given the high number of adolescents who are insufficiently active, it is important to develop and implement effective interventions that can reach large numbers of adolescents. Such interventions do currently hardly exist, so there is a need for PA promotion interventions that are carefully planned and are well grounded in theory and empirical evidence.

One of the first steps in developing an effective intervention is targeting the most important determinants of PA. The current evidence for determinants of PA among adolescents is mostly based on individual level determinants (e.g. attitudes, perceived behavioural control or awareness). Nevertheless, socio-ecological models assume that PA is influenced by both individual level factors (e.g. attitudes, intentions) and environmental level factors (e.g. availability of sports facilities, parks)<sup>7</sup>. Socio-ecological models suggest that environmental level factors can have a direct influence or an indirect influence on PA, when mediated through individual level factors. Furthermore, environmental factors may act in interaction with individual level factors or with each other in shaping PA. At the start of this PhD project it was not yet known how environmental factors interplay (i.e. through mediation or moderation) with individual level factors in shaping adolescent PA. Therefore, the first part (chapters 2 to 6) of this thesis aims to extend current knowledge with regard to the influence of physical and social environmental factors on PA among adolescents.

Despite the fact that theories suggest this shared influence of environmental-level and individual level factors on PA, they are not often targeted simultaneously. The knowledge gained from the first part of this thesis was used to develop and evaluate a newly developed intervention, which is described in the second part of this thesis (chapters 7 and 8). This part is focused on the development and evaluation of two versions of YouRAction, an online computer-tailored PA promotion intervention for adolescents. One version of the interventions targets individual level determinants (YouRAction) and the other targets in addition environmental level determinants (YouRAction+e).

This introductory chapter provides a general background and rationale for the studies presented in this thesis. This section starts with a brief overview on how PA makes a significant contribution to health. Subsequently the levels of PA of Dutch adolescents

and which individual and environmental level factors are associated with adolescent PA will be discussed. Finally the development and evaluation of YouRAction interventions, which aim to promote PA among adolescents, will be introduced.

## 1. PHYSICAL ACTIVITY IN ADOLESCENCE AND HEALTH

PA is important for healthy growth and development of adolescents<sup>8</sup>. More specifically, PA in adolescence has shown to be associated with a decreased risk of a range of diseases and health states such as adiposity, cancers, skeletal disorders, psychosocial disorders and low quality of life<sup>9-12</sup>. Furthermore, various studies have demonstrated that adolescents who are physically active are more likely to become adults who are physically active<sup>4-6</sup>. Hence, also in later life adolescent PA may (indirectly) be related to health. It has been shown that PA during adolescence is associated with risk reductions in various diseases later in life. For example, the risk of breast cancer in adulthood is approximately 20% lower among the most active adolescents as compared with the least active adolescents<sup>13-14</sup>. Similarly, high levels of PA were associated with reductions in risk of 18% for renal cancers<sup>15</sup> and significantly reduced the odds (OR:0.92) in feelings of malaise<sup>16</sup> in adulthood.

Since PA tracks from adolescence to adulthood, it is also of importance to examine how PA during adulthood influences health in adulthood. PA during adulthood has an impact on all-cause mortality with a relative risk (RR) of 0.65 (95%CI: 0.66-0.71)<sup>17</sup>. It is also known how specific PA behaviours impact all-cause mortality. For example, leisure time PA has a RR of 0.74 (95%CI: 0.70-0.77), exercise and sport of 0.66 (95%CI: 0.61-0.71) and active transportation of 0.88 (95%CI: 0.79-0.98)<sup>17</sup>. In addition PA in adulthood is strongly associated with the risk for specific diseases, such as risk of coronary heart disease (Population Attributable Risk (PAR): 16%)<sup>18</sup>, various cancers (PAR: 9-19%)<sup>19</sup> and stroke (PAR: 28.5%)<sup>20</sup>. In a modeling study de Vries et al. found that if all adults in Europe would adhere to the PA guideline, 21% of new colon cancer cases could be prevented by 2040<sup>21</sup>. Given the health effects of PA during adolescence and adulthood, it is of undeniable importance that people should already be sufficiently physically active during adolescence.

## 2. PHYSICAL ACTIVITY LEVELS AMONG ADOLESCENTS

### 2.1 What is sufficient physical activity for adolescents?

In 1998 experts in PA and health reached consensus on a Dutch guideline for PA. For adolescents, the guideline states that: *“Adolescents should be physically active at mod-*

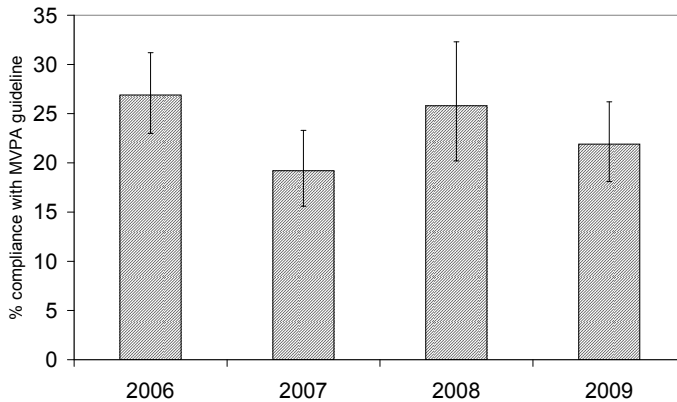
erate to vigorous intensity for at least 60 minutes each day”<sup>22</sup>. In addition, adolescents need to engage in activities that are aimed at maintaining or promoting physical fitness (i.e. strength, flexibility and coordination) twice a week. This guideline is in agreement with international guidelines<sup>1; 23</sup>. It is essential to note that this norm is a “minimum” norm, meaning that higher levels of PA are recommended. Furthermore, not all PA contributes to this norm, because intensity (i.e. “moderate to vigorous”) of the activity is included in the norm. Moderate to vigorous intensity activity is defined as activities with a Metabolic Equivalent (MET) between 5.0 and 8.0<sup>24</sup>. The resting metabolic rate when sitting is 1 MET and 5 METs consists of activities with five times the energy cost of sitting. Examples of moderate-to-vigorous activities for adolescents that are higher than 5 METs are dancing (5.5 METs), playing tennis (7.0 METs) and riding a bicycle at moderate effort (6.2 METs)<sup>25</sup>. Hence, various activities can contribute to compliance with the guideline: active transport, leisure time activities and engaging in sports. Next to the MVPA guideline, the “fit norm” was introduced in the Netherlands, to promote and maintain cardio-vascular health<sup>22</sup>. This norm recommends that individuals participate in vigorous PA at least three times per week<sup>22</sup>. For adolescents this would in general mean engaging in sports.

## 2.2 How physically active are Dutch adolescents?

In 2006, the year in which this project started, in total 26-27% of the Dutch adolescents aged 12-18 years complied with the norm<sup>3; 26</sup>. These low levels of PA are also found in other Western countries<sup>27-30</sup>. In the Netherlands, there is no clear upward or downward trend in PA over the past five years. The Netherlands Organisation for Applied Scientific Research found fluctuating trends between 2006 and 2009, ranging from 19.2% (2007) to 26.9% (2006), with regard to compliance with the norm<sup>26</sup> (Figure 1.1). However, these differences were not statistically significant. In addition only 27.4% of adolescents complied with the fit norm in 2006 (i.e. engaging in vigorous PA at least three times per week); in 2009 this was 31.9%<sup>26</sup>.

Despite the fact that PA levels of various cohorts of Dutch adolescents seem to be stable over the years (i.e. adolescents in 2006 were approximately as active as adolescents in 2009), PA levels tend to decline during adolescence. Pooled analyses in a recent review show that during adolescence the mean percentage decline in PA was 7% per year<sup>31</sup>. This decline was stronger among boys aged 13-16 years than for girls<sup>31</sup>. Also sports participation declines during adolescence<sup>5; 32</sup> and these declines in vigorous PA have found to be higher among boys than among girls<sup>33-34</sup>.

Not all groups of adolescents are equally active. In general, boys are more physically active than girls<sup>35-38</sup>, higher educated adolescents are more active than lower educated



**Figure 1.1** Percentage and 95% confidence intervals of adolescents complying with MVPA guideline from 2006 to 2009 (Source: Netherlands Organization for Applied Research <sup>26</sup>)

adolescents <sup>35;39-40</sup> and adolescents with Western ethnic background are more active than those with a non-Western ethnic background <sup>35</sup>. Hence, there are disparities in PA and sports participation between demographic groups. A worrisome finding is that some studies even show widening gaps in PA between various socio-demographic groups over time <sup>33-34</sup>. So, demographic disparities may get more pronounced during adolescence. Ultimately, this may lead to and be partly responsible for observed disparities in health <sup>41</sup>. To tackle these disparities, insight in the underlying causes is needed. This is however largely lacking to date. The study in Chapter 2 of this thesis is one of the first studies to explore socio-demographic disparities in PA and explanatory factors for this.

### 3. DETERMINANTS OF PHYSICAL ACTIVITY IN ADOLESCENCE: A SOCIO-ECOLOGICAL APPROACH

Given the much lower than recommended levels of PA in the Netherlands, clearly PA levels need to be promoted. The likelihood that an intervention is effective is higher when the most important and modifiable determinants of the behaviour are targeted (i.e. the factors that are associated with, predict and preferably influence levels of PA) <sup>42</sup>. Such determinants of behaviour can be divided into individual level determinants and environmental level determinants. Various theories are available that explain behaviour, among which are 1) motivational models - that focus on intentions as the most proximal determinant of behaviour, 2) models that focus on the volitional phase of the behaviour change process and 3) socio-ecological models, that focus on shared individual and environmental influences on behaviour. These three categories of models will be described hereafter to give an overview of the factors determining PA among adolescents on which this thesis and the YouRAction interventions are based.

### 3.1 Individual level determinants

#### 3.1.1 Motivational models

The Theory of Planned Behaviour (Figure 1.2) <sup>43</sup> is one of the most widely used motivational models, that is also suitable for explaining PA behaviour. This theory postulates that intention (e.g. the intention to engage in one hour of sports on three days of the week) is the most proximal determinant of behaviour. Intention is determined by more distal factors: attitudes (weighing of perceived pro's and con's of a behaviour ), subjective norms (perceptions of important others' expectations regarding the behaviour) and perceived behavioural control (perceived difficulty to perform the behaviour). In addition, perceived behavioural control is directly associated with the behaviour.

A review of correlates of PA among adolescents by van der Horst et al. <sup>38</sup> showed that attitudes and self-efficacy were associated with PA, whereas there is inconclusive evidence for an association between intention and PA behaviour <sup>38</sup>. Other studies have shown that the Theory of Planned Behaviour is suitable for explaining PA behaviour among *adults* <sup>44-45</sup>, but the variance in behaviour explained by intentions is on average approximately 30%. Among *adolescents*, intentions have found to explain less than 10% of self-reported PA <sup>46</sup>. It may thus be that other determinants are of additional importance in promoting adolescent PA. For instance the MODE (Motivation and Opportunities as Determinants) model, suggests that people may act automatically on attitudes that are strong <sup>47</sup>. However, it may also be that a positive intention is certainly not a guarantee for sufficient PA (i.e. the "intention-behaviour gap").

#### 3.1.2 Volitional models

Volitional models describe processes that are important to improve the translation of one's intentions to actual behaviour. Goal setting <sup>48</sup>, implementation intentions <sup>49</sup>, ac-

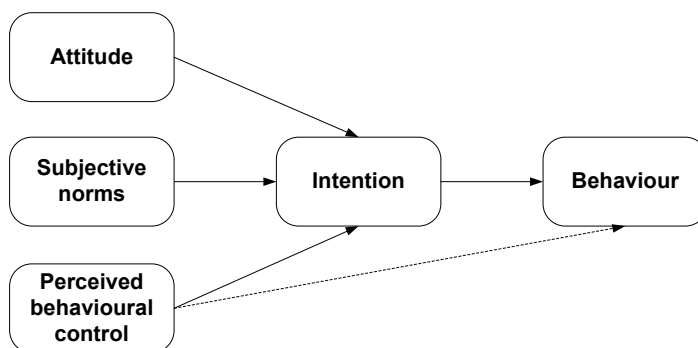


Figure 1.2. Theory of Planned Behaviour <sup>43</sup>

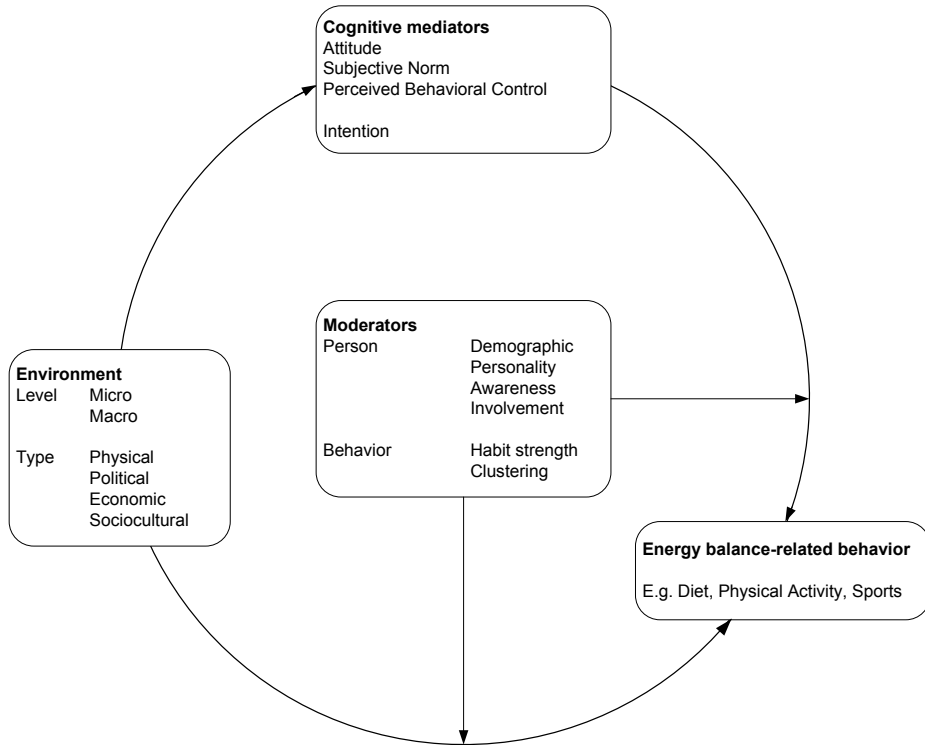
tion planning<sup>50</sup> and coping planning<sup>50</sup> are important strategies that can be used in the volitional phase of the behaviour change process. These are also important steps in self-regulation of behaviour<sup>51</sup>. Self-regulation has been defined as “a goal-guidance process occurring in iterative phases, that requires the self-reflective implementation of various change and maintenance mechanisms that are aimed at task- and time-specific outcomes”<sup>51</sup>. These “change and maintenance mechanisms” may be divided in goal setting, active goal pursuit and goal attainment, maintenance or goal disengagement.

According to self-regulation theory, first a goal needs to be set. It is important that these goals are challenging but feasible<sup>48</sup>. In order to successfully pursue the goal, actions plans and coping plans are of importance. In action plans it is described how to achieve the goal and coping plans describe how to deal with barriers<sup>50</sup>. Implementation intentions are simple action plans, specifying when, where and how persons will start a response that promotes goal realization. For example “I will walk for 20 minutes in the Zuiderpark, after I am back from school on each Wednesday”. For various domains, including health behaviours, the use of implementation intentions has shown to increase the likelihood of performing the health behaviour<sup>49</sup> and more specifically PA<sup>52</sup>. It was found that among adolescents a combination of action planning and coping planning resulted in changes in PA behaviour<sup>53</sup>. Besides the planning strategies monitoring and evaluation of the progress, outcome expectations (guided by personal capabilities) are of importance<sup>51</sup>.

### 3.2 Environmental influences

Many scholars have concluded that a purely individual-level determinant approach to explaining and predicting PA is too narrow and restricted, and that PA is additionally and importantly influenced by environmental-level factors<sup>7,54</sup>. Socio-ecological models posit that individuals do not live in isolation, but in an environment (the environment is defined in these models as the space outside the person<sup>55</sup>) that can both shape behaviour and individual cognitions. In doing so, they assume interactions between the individual and the environment he or she lives in<sup>55</sup>. Various models and theories, such as the Social Cognitive Theory<sup>56</sup>, The EUHPID (European Health Promotion Indicator Development) Health Development Model<sup>57</sup> and the EnRG Framework<sup>7</sup> (Figure 1.3) recognize this and have informed PA determinant research, also among adolescents.

The EnRG Framework was used as a general framework in most studies in this thesis. In the EnRG Framework, individual level theories (i.e. Theory of Planned Behaviour) are combined with environmental level theories; the ANalyses Grid for Environments Linked to Obesity (ANGELO). The ANGELO grid is a 2 x 4 grid and defines two environmental levels (micro-environmental settings and macro-environmental sectors)<sup>58</sup>. These two



**Figure 1.3.** Adapted version of Environmental Research framework for weight Gain Prevention (EnRG) <sup>7</sup>.

levels contain four types of environment: 1) the *political* environment (e.g. rules and regulations), 2) the *economic* environment (e.g. pricing of sports clubs), 3) the *social* environment (e.g. a strong social network in which sports is common) and 4) finally the *physical* environment (e.g. availability of facilities to be active). In the EnRG Framework these aforementioned environmental factors are hypothesized to have direct and indirect (mediated via individual level factors) influences on behaviour (Figure 1.2) <sup>7;59</sup>. For example, it may be that the availability of facilities to be active has a positive influence on self-efficacy to be active, which in turn has a positive influence on behaviour.

Other theories, such as for example an extended version of the Theory of Planned Behaviour <sup>59</sup>, suggests that it is also possible that physical environmental factors play a moderating role in the relationship between intention and behaviour. In addition, it has been theorized that various types of environment interact with each other in shaping behaviour <sup>7;60-61</sup>. It may for instance be that when there are facilities to be active, they will only be used if social support is high enough. In the subsequent paragraphs current evidence with regard to a direct environment-PA relation and mediation/moderation mechanisms are summarized.

### 3.2.1 Evidence of direct and indirect environmental influence on adolescent physical activity

Various reviews have been carried out, investigating a direct influence of factors in the physical environment on PA among adolescents. Some reviews drew the conclusion that availability and accessibility of PA equipment or facilities are in general unrelated to adolescent PA<sup>38,62</sup>. On the other hand, Davison et al. concluded from their review that there is evidence for an association between, both perceived and objectively measured, availability of recreational facilities and PA among children and adolescents<sup>63</sup>. These reviews do not provide conclusive evidence for a direct association between factors in the physical environment and PA among adolescents and thus more research is needed on this issue.

Despite the hypothesized indirect influences of physical environmental factors on PA, through individual cognitions, few studies have examined these among adolescents. There is some evidence that attitude and intention are mediators of the association between perceived availability of sports equipment at home and sports participation<sup>64</sup>; and that perceived behavioural control is a mediator in the association between perceived distance to facilities and PA<sup>65</sup>. However, with regard to the objectively measured environment, findings are less clear. Two studies examined whether objectively measured availability or accessibility of facilities in the home neighbourhood to be active were mediated by individual cognitions, but both did not find evidence for mediation<sup>66-67</sup>. Also moderation mechanisms have not been sufficiently explored for PA in adolescence<sup>68</sup>.

In sum, the way in which factors in the physical environment may shape PA among adolescents is not yet clear. Therefore, the first part of this thesis aims to extend current knowledge with regard to direct, indirect (e.g. through cognitive factors) and moderated (e.g. on cognition-PA associations) pathways in which physical environmental factors influence PA among adolescents. In this part it will be explored whether there are direct relations of the objectively measured and perceived availability of facilities with PA behaviour; whether cognitions can mediate the association between availability and PA behaviour and whether the availability of facilities moderates associations between cognitions and social environmental factors and PA behaviour.

## 4. DEVELOPMENT AND EVALUATION OF THE YOURACTION INTERVENTION

In the second part of this thesis, the development and evaluation of the YouRAction interventions are described. YouRAction aimed to increase compliance to the MVPA guideline by 10%, at six months after intervention usage. Although an extensive descrip-



tion of the intervention development, following the steps of the Intervention Mapping protocol <sup>42</sup>, can be found in chapter 7, a brief introduction of important features of the YouRAAction interventions is outlined below.

#### **4.1 YouRAAction: a computer-tailored intervention**

PA levels can be promoted through modifying important and changeable determinants of PA, using a delivery format that is appealing to the target group <sup>42</sup>. In this respect the use of an intervention delivered through the internet is interesting, as this may fit with adolescents and it can be used to tailor interventions to the unique characteristics (e.g. one's awareness of PA behaviour or attitudes towards behaviour) of the adolescent. Kreuter defined tailoring as *"any combination of strategies and information intended to reach one specific person, based on characteristics that are unique to that person, related to the outcome of interest, and derived from an individual assessment."* <sup>69</sup>. In YouRAAction the technique of tailoring was used to provide individual and environmental feedback to users of the interventions. Computer-tailoring eliminates superfluous information and with increased individualization the message has been found to be more personally relevant. It is thought that tailored interventions increase attractiveness, personal relevance, motivation to think about the message and therewith effectiveness <sup>70-74</sup>. Various reviews indicate that computer-tailoring is indeed more effective in promoting health related behaviours, such as smoking cessation, diet and PA, compared to generic information for adults <sup>70;72</sup>. Haerens et al. found that a school-based computer-tailored intervention together with changes in the physical school environment (more opportunities to be active during breaks) was effective in promoting PA <sup>75</sup>. In the HELENA-LSEI study, the effect of an internet-based computer-tailored PA promotion intervention was evaluated in six European countries. Overall, this intervention showed positive effects on MVPA at one and three months after intervention usage <sup>76</sup>. In addition to its positive promise, web-based computer-tailored interventions have the potential to be implemented in a large population with increasing numbers of people having access to the world wide web <sup>3</sup>. Therefore computer-tailoring is an interesting technique to promote health related behaviours, such as PA, among adolescents.

#### **4.2 YouRAAction: the incorporation of environmental information in computer-tailoring**

Socio-ecological models posit that both individual level and environmental level factors are potentially important determinants to promote PA among adolescents. Conventional computer-tailored interventions targeted only individual level factors such as awareness, self-efficacy and subjective norm <sup>69</sup>. Like previously developed tailored interventions, YouRAAction also provides feedback based on individual level determinants (i.e. attitude, perceived behavioural control, subjective norm, intentions, and awareness of

behaviour). However, in the development of YouRAction a socio-ecological perspective was taken, meaning that also environmental level determinants needed to be targeted. Therefore, an innovative element of YouRAction is that it also targets environmental level determinants (i.e. perceptions of availability of parks, sports facilities, bicycle lanes and sidewalks). In order to do so, the YouRAction intervention gave environmental information by displaying interactive maps with opportunities to be active (e.g. parks and sports facilities). These maps were tailored; the addresses where the adolescents live (“a characteristic that is unique to that person”) was used as input to center the maps. Only facilities within the neighbourhood of that person were displayed on the map. Moreover, to further increase relevance, adolescents could select sports facilities that were of most interest to them by selecting the sport in which they would like to engage.

### **4.3 Structure of the YouRAction intervention – a brief overview**

The computer-tailored YouRAction interventions were designed to be implemented in the classroom, by teachers. The teachers had a facilitating role in delivering the intervention. In order to successfully implement the interventions, teachers were instructed by research staff and received a comprehensive manual on how to use the interventions. An advantage of a computer-tailored intervention is that it can be used without interference of the teacher; therefore it is more likely that the intervention content is delivered as intended. YouRAction was designed to be used in three lessons, one week apart, of approximately 35 minutes effective computer usage.

The intervention content was structured based on self-regulation theory<sup>51</sup>. For YouRAction this meant that adolescents went through five phases of self-regulation in completing the intervention: 1) monitoring of current behaviour, 2) motivational phase, 3) goal setting, 4) active goal pursuit, 5) evaluation of their goals.

### **4.4 Evaluation of the YouRAction interventions**

The effectiveness of computer-tailored interventions aimed at promoting MVPA among adolescents, targeting both individual and environmental level determinants is unknown. Especially the additive value of incorporating feedback on opportunities to be physically active (i.e. environmental information) is unknown. Therefore the effectiveness of the YouRAction intervention on improving levels of MVPA need to be evaluated. In doing so, two versions of the YouRAction intervention were evaluated: one only targeting individual level determinants (YouRAction) and one also targeting environmental level determinants (YouRAction+e). Additionally it was evaluated how the interventions were appreciated and used. This latter process evaluation is important for the interpretation of the findings of the effect evaluation and may give insight in factors that can be improved to increase the effectiveness of the interventions<sup>77</sup>.

## 5. OUTLINE OF THIS THESIS

In the first part of this thesis a series of studies are described aimed to increase our understanding of how the factors in the physical environment may influence PA among adolescents. In the second part the development and evaluation of the YouRAction interventions are described.

### 5.1 First part: the physical environment and adolescent PA

The central research question in the first part of this thesis is: *“How is the physical environment associated with PA behaviour among adolescents?”*

In **chapter 2** it is explored whether differences in stopping to participate in sports and quit complying with the fitnorm according to socio-demographic factors (gender, ethnic background and education) is explained by individual level and environmental level factors. **Chapter 3** explores whether there are differences in the direct associations of perceived and objectively measured physical environmental factors with active transport and compliance with the fitnorm.

The studies in chapters 4 to 6 focus on interplay of the objectively measured availability of facilities to be active with the social environment and cognitions in determining PA behaviour among adolescents. In **chapter 4** it is investigated whether the potential association between the objectively measured availability of sports facilities and parks, within various spatial scales, and objectively measured MVPA is mediated by individual level factors. This chapter is based on data from the Children Living in Active Neighbourhoods( CLAN) study (see for instance <sup>78</sup>), from Deakin University, Australia. **Chapter 5** studies whether the objectively measured availability of sports facilities moderates the intention-sports participation relation. Interactions between social and physical environmental factors on sports participation among Dutch adolescents are explored in **chapter 6**.

### 5.2 Second part: the development and evaluation of the YouRAction interventions

The second part of this thesis aims to answer the research question: *“What are the effects of a computer-tailored intervention that targets individual level factors and of a computer-tailored intervention that targets individual and environmental level factors on compliance with the MVPA guideline among Dutch adolescents?”*

**Chapter 7** describes the process and result of the planned development of the YouRAction interventions. The results of the cluster randomized trial to evaluate the effects of the YouRAction interventions is described in **chapter 8**.

Finally, in the general discussion (**chapter 9**) results are summarized and integrated, methodological issues are discussed and implications of the findings are given.

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# Chapter 2

## Explaining sociodemographic differences in disengagement from sports in adolescence

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## ABSTRACT

**Purpose:** To identify risk groups for disengagement from sports participation during adolescence and to explore which cognitive and environmental factors can explain socio-demographic differences in disengagement from sports.

**Methods:** Data were obtained from the ENvironmental Determinants of Obesity in Rotterdam SchoolchildrEn (ENDORSE) study, and 357 adolescents (mean age at baseline: 13 years) were eligible for analysis. Adolescents completed surveys in 2005/2006 (baseline) and 2007/2008 (follow-up). Sociodemographics (i.e. sex, ethnicity, education) and potential mediators (i.e. individual cognitions and neighbourhood perceptions) were assessed at baseline, and sports participation at baseline and follow-up. Two outcome variables were constructed: 1) disengaging vs. maintaining sports participation, and 2) ceasing compliance vs. maintaining compliance with the “fitnorm” (i.e. engaging in vigorous physical activity at least three times/week). Logistic regression and mediation analyses were used to identify socio-demographic differences and explanatory factors for differences in disengagement from sports in the two outcomes.

**Results:** Girls (OR:2.5, 95%CI:1.5;4.5) were more likely than boys to disengage from sports. Girls (OR:2.5, 95%CI:1.4;4.2), adolescents of non-Western background (OR:1.8, 95%CI:1.0;3.0) and adolescents in lower educational levels (OR:1.7, 95%CI:1.0;2.9) were more likely to cease compliance with the fitnorm. Perceived neighborhood safety partially mediated (8%) the association of gender differences in disengagement from sports. Intention mediated differences in ethnicity (32%) and education (37%) with ceased compliance with the fitnorm.

**Conclusions:** Girls, lower educated, and adolescents of non-Western background showed more pronounced reductions in sports participation and compliance with the fitnorm. Perceived safety could partially explain gender differences in disengagement from sports. Intention could partially explain differences in education and ethnicity in ceased compliance with the fitnorm.

## INTRODUCTION

Regular sports participation has been associated with a reduced risk for various diseases and other negative health outcomes<sup>1-2</sup>. In order to promote and maintain cardio-vascular health, the 'fitnorm' was introduced in the Netherlands<sup>3</sup>. This norm recommends that individuals participate in vigorous physical activity at least three times per week<sup>3</sup>. Engaging in sports in adolescence increases the likelihood of being physically active in adulthood<sup>4</sup>. Despite the fact that in Western countries many adolescents engage in sports activities in early adolescence<sup>5-6</sup>, sports participation declines rapidly during adolescence<sup>5-9</sup>. There is accumulating evidence indicating that girls<sup>8; 10-13</sup>, lower educated adolescents<sup>11; 14-15</sup> and adolescents with a non-Western background<sup>8; 11</sup> are less likely to engage in sports than, respectively, boys, higher educated adolescents and adolescents of Western background. However, it is not known whether there are similar sociodemographic differences in *disengagement* from sports during adolescence. It is relevant to study this topic and identify factors that explain these differences, because socio-economic differences in adolescent physical activity, and hence sports participation, may contribute to socio-economic inequalities in health<sup>16</sup>. Insight into these sociodemographic differences and explanatory factors is lacking, although it is necessary for development and evaluation of interventions and policies aimed to promote and maintain sports participation during adolescence<sup>15</sup>.

Little is known about differential disengagement from sports according to sociodemographic characteristics and potential explanations for these differences among adolescents. Two previous studies on decline in adolescent vigorous physical activity have reported higher drops in minutes spent<sup>9</sup> and engaging in sufficient<sup>17</sup> vigorous physical activity among adolescent boys compared to girls. Evidence from studies among adults shows that there may be differences in disengagement from sports according to educational level<sup>6</sup>; this might also apply to adolescents. However, to date no studies have addressed differences in disengagement from sports according to educational level and ethnic background among adolescents.

Variables of the Theory of Planned Behavior (TPB)<sup>18</sup> may explain sports participation among adolescents<sup>8; 19-20</sup>. The TPB suggests that behavior is determined by attitude, perceived behavioral control (PBC), subjective norm and intention to perform a behavior<sup>18</sup>. Socioecological models<sup>21-22</sup> suggest that, besides individual level factors, environmental factors may play a role in shaping behavior. In addition to the TPB variables, perceived availability of sports facilities<sup>10; 23</sup> and perceived neighborhood safety<sup>24</sup> are also significantly associated with sports participation among adolescents. Individual and environmental level factors were found to be relevant in predicting sports behavior; however,

they may also explain sociodemographic differences in sports participation, as has been demonstrated in adults. Socioeconomic differences in physical activity among adults are reported to be explained by cognitive and perceived environmental variables<sup>25-27</sup>; similar processes may also play a role among adolescents. However, this has not been studied before.

This longitudinal study aims to 1) explore sociodemographic differences in disengagement from sports over a 2-year period, and 2) identify potential protective factors for disengagement from sports, by exploring potential cognitive and perceived environmental mediators of these sociodemographic differences. Gender, ethnic background and level of education are the sociodemographic factors of interest. TPB variables (i.e. attitude, perceived behavioral control, subjective norm and intention) and perceived environmental factors (i.e. perceived neighborhood safety and perceived neighborhood attractiveness) are the potential mediators of interest.

## **METHODS**

This study draws on longitudinal data from the study on ENvironmental Determinants of Obesity in Rotterdam SchoolchildrEn (ENDORSE)<sup>11</sup>. The ENDORSE study was conducted in Rotterdam in 2005-2006 (baseline) and 2007-2008 (follow-up) among adolescents in the first and third year of secondary education. Data were collected at the same time points of year. Rotterdam is the second largest city in the Netherlands, with approximately 600,000 inhabitants, of which 46% are of non-Dutch origin<sup>28</sup>. The Medical Ethics committee of the Erasmus MC issued a 'declaration of no objection' for the ENDORSE study.

### **Sampling and procedure**

At baseline, 56 schools were approached and 24 schools were willing to participate. A random selection of 17 of these schools participated in the study. The schools were selected after stratification according to the area of the city in which they were located (North, South, East or city center), to ensure sufficient variation of physical and cultural environments. At baseline, in each school five first and third year classes were selected for participation. In the follow-up measurement, the third year classes at baseline were removed, because these adolescents could not be followed-up. Parents received written information on the measurements. Parents could prevent their child from participating in the study by signing a decline form (passive consent procedure). If adolescents or their parents indicated that they were not willing to participate, they were excluded from the study. During 1 hour at school the adolescents completed a printed question-

naire on dietary and physical activity behaviors, and potential cognitive and perceived environmental determinants of these behaviors (in the presence of a research assistant and a teacher). Adolescents who were in the first year of secondary education at baseline were invited to participate in the follow-up study 2 years later. At baseline, 13 schools had adolescents in their first year of secondary education. Adolescents with complete data on the variables of interest were eligible for the analyses.

## Measures

### *Sports participation*

Sports participation was assessed at baseline and follow-up. Items on sports frequency during the past seven days were used in the present study to measure sports participation. These items were based on the Activity QUestionnaire for Adolescents & Adults (AQUAA)<sup>29</sup>. The AQUAA showed moderate test-retest reproducibility, with an intra-class correlation of 0.59 for vigorous activities<sup>29</sup>.

Adolescents could write down a maximum of 3 sports in which they had participated during the previous week, and indicate on how many days of the week (0-7 days) they had participated in each sport. An overall measure of sports frequency per week was created by summing the frequencies of the reported sports activities. Two dichotomized variables were created from this overall score, one for sports participation and one for compliance with the fitnorm. Participation in sports was defined as participating at least one time per week in sports (1) or not (0). To study disengagement, adolescents who participated in sports at baseline, but stopped at follow-up were defined as disengagers (1); those who participated in sports at baseline and still participated in sports at follow-up were defined as maintainers (0).

Compliance with the fitnorm was defined as participating at least 3 times per week in sports (1) or not (0). To study cessation of compliance with the fitnorm, adolescents who complied with the fitnorm at baseline, but ceased compliance with the fitnorm at follow-up were defined as disengagers (1); those who complied with the fitnorm at baseline and still complied at follow-up were defined as maintainers (0).

### *Sociodemographic factors*

Date of birth, gender, country of birth (of the adolescent, and the father/mother of the adolescent) was assessed in the questionnaire. School level was obtained from the schools and categorized into higher level education (senior general secondary education) and lower level education (vocational education). A variable for ethnicity was derived from the questions on country of birth of the adolescent and both parents,

according to the standards of Statistics Netherlands<sup>30</sup>. An adolescent was considered to be of Western descent if he/she and both parents had been born in the Netherlands, another European country, Oceania, North America, Indonesia or Japan. If the adolescent or one of the parents had been born in another country, the adolescent was considered to be of non-Western descent. Exact age was calculated by subtracting the reported date of birth from the date of measurements.

#### *TPB measures*

All TPB variables were measured at baseline using a 5-point answering scale. Attitude was assessed by two questions "*I think that sports and leisure time physical activity are...*" [very bad (1) - very good (5) and very unpleasant(1) - very pleasant (5)]. Cronbach's alpha for the attitude items was 0.80 and a mean attitude score was calculated. PBC was assessed by two items. The first item assessed "capability" with the item "*How easy or difficult would it be for you to engage in sports or leisure time physical activity if you want to?*" [very difficult (1)-very easy (5)]. The second PBC item, "control", was assessed by the item "*To what extent do you decide for yourself to engage in sports or leisure time physical activity?*" [I do not decide this by myself at all (1)-I decide it all by myself (5)]. One item was used to assess subjective norm: "*If I engage in sports or physical activity, my parents think that this is...*" [very bad (1)-very good (5)]. Intention was also assessed by one item: "*Do you intend to start/remain engaging in sports and physical activity in the next half year?*" [certainly not (1) - yes certainly (5)].

#### *Perceived neighborhood measures*

The perceived neighborhood measures were assessed at baseline. These measures incorporated perceived neighborhood attractiveness: "*I think my neighborhood is attractive*", perceived safety: "*I feel safe in my neighborhood*" [totally disagree (1)-totally agree (5)] and perceived availability of sports facilities: "*Are there sports facilities in your neighborhood?*" [no (0), yes (1)].

### **Analyses**

School level variance for disengagement from sports (Median Odds Ratio (MOR): 1.48; 95% CI= 0.67;1.98) and ceased compliance with the fitnorm (MOR: 1.63; 95% CI =0.73-2.12) were non-significant. Therefore, multilevel analyses were not warranted. Descriptive analyses were carried out to describe the study sample. Multiple logistic regression analyses were conducted to test whether gender, ethnicity, education, compliance with the fitnorm and participating in sports were associated with dropout from the study between baseline and follow-up. The remainder of the analyses was conducted only for those engaging in sports at baseline or complying with the fitnorm at baseline, because disengagement from sports was the topic of these analyses. Multiple logistic regres-



sion analyses were performed to analyze the associations between sociodemographic factors (adjusted for each other), interaction between the sociodemographic factors and disengagement from sports and ceased compliance with the fitnorm. Univariate logistic regression analyses of TPB determinants and perceived neighborhood measures with disengagement from sports and ceased compliance with the fitnorm were performed to examine which of these factors were related with disengagement from sports participation. Subsequently, mediation analyses were performed to identify which TPB or neighborhood variables could explain the differences between sociodemographic groups. In these analyses only sociodemographic factors and potential mediators that were significantly associated with disengagement from sports and ceased compliance with the fitnorm were put in the mediation models. Single mediator models, adjusted for the other sociodemographic factors were used. In the first step, the association between the independent factors (i.e. demographics) and the dependent factors (i.e. disengagement from sports/ceased compliance with fitnorm) were tested. In the second step the association of the dependent factor with the potential mediator (i.e. TPB variables and perceived neighborhood) was tested. In the third step the association between the mediator and the dependent factor was tested, adjusted for the independent factor.

The mediation analyses were conducted in SPSS using the indirect macro of Preacher and Hayes<sup>31</sup>. This macro carries out the mediation analyses and shows bootstrapped indirect effects of the mediators under study. The percentage mediated effect was calculated by dividing the coefficient of the indirect effect by the coefficient of the association between the sociodemographic factor and the behavior.

All analyses were conducted in SPSS 17.0. A result was considered to be significant if the p-value was lower than 0.05.

## RESULTS

### Participants

A total of 762 adolescents completed the survey at baseline. Of those, 430 (56%) had follow-up data. Main reasons for dropout between baseline and follow-up were absenteeism during the week of measurements in the school, and declining further participation in the study. Adolescents who dropped-out from the study were significantly less likely to participate in sports at baseline than those who did not (78% vs 88%). No differences were found for demographic factors. No significant differences were found between those who were in the follow-up study but did not have complete data on the variables of interest (n=73) versus those in the final sample (n=357).

**Table 2.1.** Characteristics of the study population.

Total (N)	357
Boys	55.2%
Western background	52.4%
Higher education	43.4%
Age at baseline, in years (SD)	13.2 (0.6)
Participating in sports at T1	88.5%
Complying with fitnorm at T1	72.6%
Participating in sports at T2	70.0%
Complying with fitnorm at T2	51.0%

SD=standard deviation; T1 = baseline; T2 = follow-up

A majority of adolescents in the studied sample complied with the fitnorm (72.6%) and participated in sports (88.5%) at baseline (Table 2.1). The overall prevalence of compliance with the fitnorm (51.0%) ( $\chi^2$ : 35.07) and sports participation (70.0%) ( $\chi^2$ : 41.18) was significantly lower after two years.

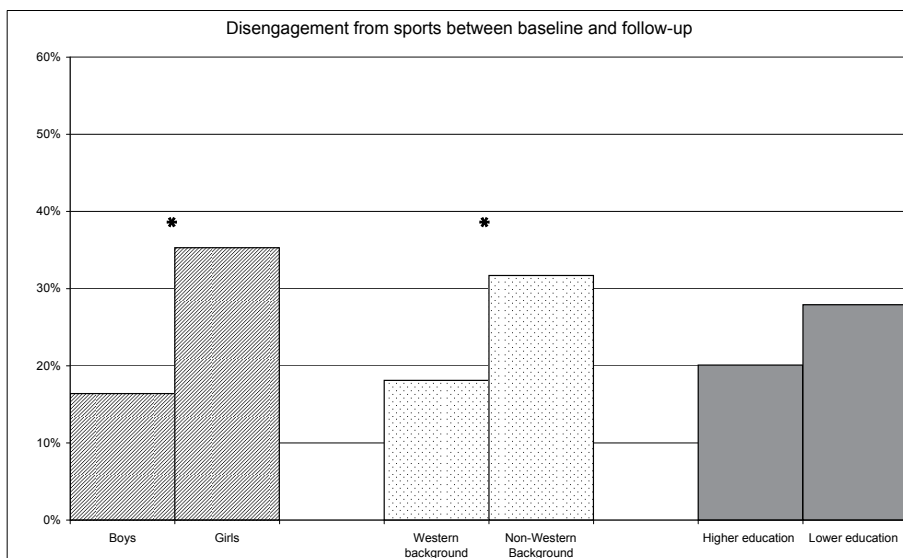
### **Sociodemographic differences in disengagement from sports and ceased compliance with the fitnorm**

Girls compared to boys (53.5% vs 30.4%;  $\chi^2$ : 13.8), adolescents with a non-Western ethnic background compared to adolescents with a Western background (49.2% vs 30.9%;  $\chi^2$ : 9.0) and lower educated compared to higher educated adolescents (45.2% vs 31.9%;  $\chi^2$ : 4.8) were more likely to cease compliance with the fitnorm (Figure 2.1a). Similar patterns were found for disengagement from sports (Figure 2.1b).

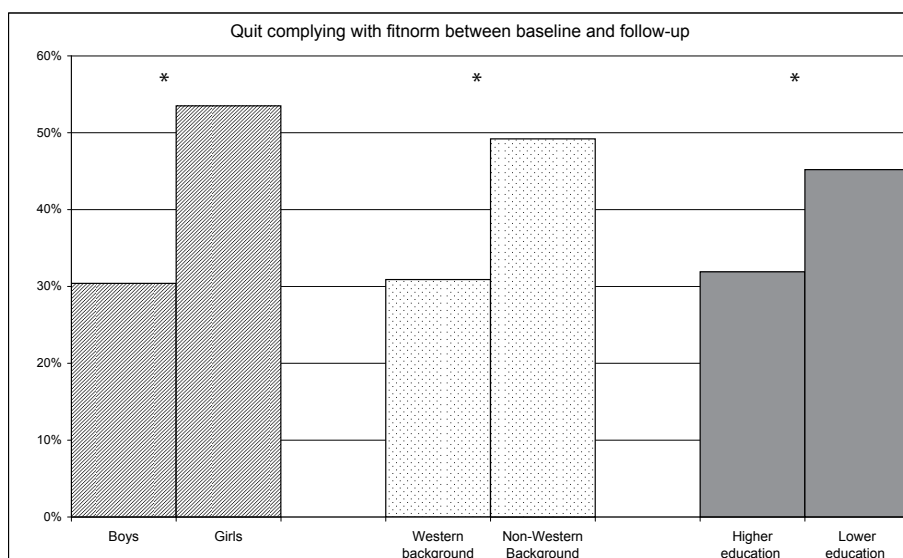
These results were confirmed in logistic regression analyses in which sociodemographic variables were adjusted for each other: girls (OR: 2.5; 95%CI: 1.4-4.2), adolescents of non-Western background (OR: 1.8; 95%CI: 1.0-3.0) and adolescents attaining lower education (OR: 1.7; 95%CI: 1.0-2.9) were more likely to cease compliance with the fitnorm than their counterparts (Table 2.2). Girls (OR: 2.6; 95%CI: 1.5-4.5) were also more likely than boys to disengage from sports (Table 2.2).

### **Univariate associations of potential mediators with ceased compliance with “fitnorm” and sports participation**

Adolescents with a more positive attitude (OR: 0.4; 95%CI: 0.3-0.7) and a higher intention for sports participation (OR: 0.4; 95%CI: 0.2-0.6) were less likely to cease compliance with the fitnorm compared to those with a less favorable attitude and intention (Table 2.2). A more positive attitude (OR:0.5; 95%CI: 0.3-0.7), a more positive intention (OR:0.6; 95% CI:



A.



B.

**Figure 2.1.** Percentage reduction in participation in sports and compliance with fitnrm  
 \* significant difference between the levels in the sociodemographic variable, tested with Chi-squares ( $p < 0.05$ )

0.4-0.8) to engage in sports, higher perceived safety (OR:0.7; 95%CI: 0.5-0.9) and higher perceived attractiveness of the neighborhood (OR:0.7; 95%CI: 0.5-0.9) were associated with a lower odds of disengagement from sports (Table 2.2).

**Table 2.2.** Associations of sociodemographic and cognitive factors on maintenance vs reductions in complying with fitnorm and disengagement from sports

	<b>Quitting to comply with fitnorm</b> (1=quit, 0=maintain) (N=259)	<b>Disengagement from sports</b> (1=disengage, 0=maintain) (N=316)
	<b>OR (95% CI)</b>	<b>OR (95% CI)</b>
Gender (0=male, 1=female)*	<b>2.47</b> (1.44;4.21)	<b>2.58</b> (1.50;4.45)
Ethnicity (0=Western, 1=non Western)*	<b>1.75</b> (1.03;2.97)	1.65 (0.95;2.85)
Education (0=high, 1=low)*	<b>1.72</b> (1.01;2.94)	1.50 (0.86;2.60)
Attitude	<b>0.42</b> (0.26;0.68)	<b>0.48</b> (0.31;0.75)
Subjective norm	0.64 (0.40;1.03)	0.67 (0.42;1.06)
PBC – control	1.02 (0.70;1.49)	1.10 (0.75;1.61)
PBC – capability	0.79 (0.56;1.13)	0.76 (0.55;1.05)
Intention	<b>0.36</b> (0.22;0.59)	<b>0.59</b> (0.42;0.84)
Perceived safety	0.87 (0.65;1.16)	<b>0.69</b> (0.52;0.92)
Perceived attractiveness	0.80 (0.64;1.01)	<b>0.69</b> (0.54;0.86)
Perceived availability of sports facilities	1.17 (0.65;2.11)	0.86 (0.48;1.52)

\* All sociodemographic factors are adjusted for each other. Figures printed **bold** indicate significance of association at  $p < 0.05$

### Sociodemographic differences in potential mediators

Girls perceived their environment as less safe than boys, and adolescents of non-Western background perceived sports behavior to be more under their own control (PBC control component) but had a lower intention than adolescents with a Western background. Higher educated adolescents had a higher intention to engage in physical activity and sports than lower educated adolescents (Table 2.3).

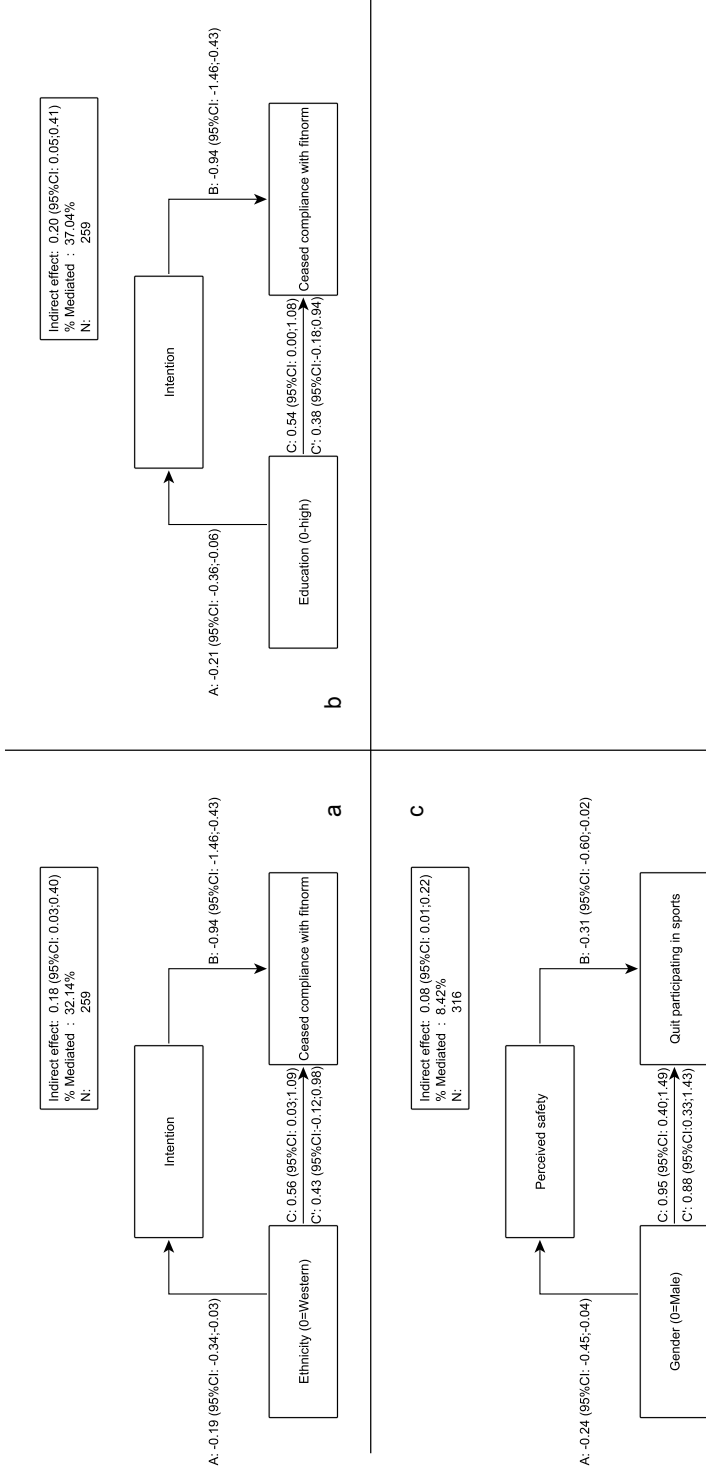
### Mediation analyses

Figure 2.2 shows the statistically significant mediation models (i.e. when no statistically significant mediation was found, the models are not presented but are available upon request). For these models four pathways are shown. Pathway A represents the association between the sociodemographic factor (e.g. ethnicity) and the mediator (e.g. intention). Pathway B represents the association between the mediator and the behavior (e.g. cease compliance with the fitnorm), adjusted for the sociodemographic factors. Pathway C represents the association between the sociodemographic factor and the behavior, unadjusted for the mediator. Pathway C' is the association between the sociodemographic factor and the behavior, adjusted for the mediator.

**Table 2.3.** Mean values for cognitive variables in the sociodemographic groups, among adolescents participating in sports, and being compliant with the fitnorm at baseline.

	<b>Sports participation</b>					
	Boys (n=183)	Girls (n=133)	Western background (n=171)	Non-Western Background (n=145)	Higher education (n=155)	Lower education (n=202)
Attitude (1-5)	4.46 (0.56)	4.41 (0.57)	4.45 (0.52)	4.43 (0.61)	4.51 (0.52)	4.39 (0.59)
Subjective norm (1-5)	4.56 (0.53)	4.56 (0.57)	4.54 (0.53)	4.59 (0.57)	4.58 (0.55)	4.54 (0.55)
PBC – control (1-5 )	4.48 (0.66)	4.41 (0.71)	<b>4.35</b> (0.68)	<b>4.57</b> (0.66)	4.42 (0.66)	4.47 (0.70)
PBC – capability (1-5)	4.46 (0.66)	4.32 (0.89)	4.39 (0.78)	4.42 (0.76)	4.49 (0.76)	4.33 (0.77)
Intention (1-5)]	4.69 (0.69)	4.65 (0.65)	<b>4.78</b> (0.56)	<b>4.55</b> (0.77)	<b>4.82</b> (0.44)	<b>4.55</b> (0.80)
Perceived safety (1-5)	<b>4.26</b> (0.81)	<b>4.03</b> (0.97)	4.18 (0.88)	4.15 (0.90)	4.19 (0.90)	4.14 (0.88)
Perceived attractiveness (1-5)	3.63 (1.08)	3.54 (1.15)	3.60 (1.08)	3.58 (1.15)	3.65 (1.10)	3.54 (1.13)
Perceived availability of sports facilities (%yes)	75%	71%	78%	69%	75%	73%
	<b>Compliance with fitnorm</b>					
	Boys (n=158)	Girls (n=101)	Western background (n=139)	Non-Western Background (n=120)	Higher education (n=113)	Lower education (n=146)
Attitude (1-5)	4.51 (0.53)	4.49 (0.54)	4.50 (0.51)	4.51 (0.58)	4.57 (0.51)	4.46 (0.56)
Subjective norm (1-5)	4.57 (0.53)	4.58 (0.51)	4.56 (0.50)	4.59 (0.56)	4.56(0.53)	4.58 (0.52)
PBC – control (1-5)	4.54 (0.63)	4.42 (0.70)	<b>4.51</b> (0.65)	<b>4.59</b> (0.67)	4.48 (0.61)	4.51 (0.70)
PBC – capability (1-5)	4.52 (0.59)	4.38 (0.86)	4.47 (0.72)	4.45 (0.71)	4.54 (0.72)	4.40 (0.70)
Intention (1-5)	4.74 (0.63)	4.70 (0.63)	<b>4.83</b> (0.47)	<b>4.61</b> (0.75)	<b>4.85</b> (0.40)	<b>4.62</b> (0.74)
Perceived safety (1-5)	<b>4.28</b> (0.78)	<b>4.07</b> (0.96)	4.21 (0.86)	4.18 (0.87)	4.24 (0.88)	4.17 (0.85)
Perceived attractiveness (1-5)	3.68 (1.04)	3.46 (1.17)	3.63 (1.03)	3.55 (1.16)	3.64 (1.07)	3.56 (1.11)
Perceived availability of sports facilities (%yes)	76%	75%	79%	72%	78%	74%

PBC=perceived behavioural control; Figures printed **bold** represent differences between two levels of a sociodemographic factor, tested with t-tests (p<0.05)



**Figure 2.2.** Regression coefficients and percentage mediated effect from mediator models, adjusted for other sociodemographic factors, explaining sociodemographic differences in quitting to comply with the fitnorm and disengagement from sports. All models are adjusted for the other demographic factors.

For compliance with the fitnorm, attitude and intention to engage in sports were explored as potential mediators in the relationship between education and ethnicity and ceased compliance with the fitnorm. Figure 2.2a shows that intention significantly mediates the relation between ethnicity and ceased compliance with the fit norm, since the indirect effect was statistically significant (0.2; 95%CI: 0.0-0.4). In total, 32% of the association between ethnicity and ceased compliance with the fitnorm was mediated by intention (Figure 2.2a). Intention also significantly mediated the association between education and ceased compliance with the fitnorm (indirect effect: 0.2; 95%CI: 0.1-0.4), with a mediated effect of 37% (Figure 2.2b).

Attitude, intention, perceived safety and perceived attractiveness were explored as potential mediators of the associations between disengagement from sports and associated sociodemographics (i.e. gender, ethnicity and education). The results of the mediation analyses show that perceived safety was a significant mediator of the association between gender and disengagement from sports (indirect effect: 0.1; 95%CI: 0.0-0.2), 8% mediated effect (Figure 2.2c).

## DISCUSSION

The results of this study indicate that there are sociodemographic differences in disengagement from sports and compliance with the fitnorm in early adolescence. It was found that girls, adolescents of non-Western background, and adolescents who attend lower level education were more likely to disengage from sports and were more likely to cease compliance with the fitnorm over a 2-year period during adolescence. Intention for sports participation and physical activity mediated the association between ethnicity and education, and ceased compliance with the fitnorm. Perceived neighborhood safety mediated the association between gender and disengagement from sports.

The findings of the present study provide evidence that girls, adolescents from non-Western backgrounds and those attending lower educational levels are more likely to stop participation in sports and cease compliance with the fitnorm during adolescence. It was already known that these sociodemographic groups already engage less in sports in adolescence, but this was not known for disengagement from sports. Therewith the results of this study are alarming, as it implies that sociodemographic differences in sports participation expand during adolescence. Girls, adolescents of non-Western background and lower educated adolescents are, therefore, particularly important target groups for sports promotion interventions. The findings also suggest that sports

promotion activities among adolescents should be targeted not only at initiation of sports participation, but also at maintenance of sports participation.

In contrast to our results, van Mechelen et al. found that reductions in minutes spent in sports during adolescence are stronger among boys than among girls<sup>9</sup>. This difference in results may be due to differences in the definition of the behavior of interest which, in the study of van Mechelen et al. was in *minutes* spent above 4 METs separately for organized sport, non-organized sport and other vigorous activities. We studied sports participation and compliance with the fitnorm based on frequency data; perhaps boys disengage from sports less frequently, but show a decrease in the average time spent in sports per occasion.

Insight into explanatory mechanisms for sociodemographic disparities in disengagement from sports is important to efficiently tackle the observed disparities. Reasons for the observed differential disengagement from sports and ceased compliance with the fitnorm may arise from various situations, including physical, economic and social environmental factors. However, our study suggests that also cognitions, in particular intention in early adolescence, may explain a considerable part of differential dropout in compliance with the fitnorm. This is in line with studies among adults, which found that intention to be physically active was associated with level of education<sup>32</sup>. Other studies among adults found that individual cognitions mediated the association between recreational walking and educational levels<sup>27</sup>. According to socio-ecological models like the EnRG-framework<sup>22</sup>, cognitions are partly shaped through environmental influences. Hence, differences in sociocultural and physical environments in which adolescents from various sociodemographic groups live and grow up may be factors that contribute to the differences in cognitions. For instance, parents may have a different influence on girls than on boys. Indeed, it was found that parents of girls tend to show more avoidance behavior compared with parents of boys<sup>33</sup>, which coincides with findings that parents are more protective of their daughters than of their sons<sup>34</sup>. This difference in raising boys and girls may have shaped the perception of lower neighbourhood safety among the girls.

Previous research has shown that adolescent girls report more barriers<sup>13; 35</sup> and fewer benefits of physical activity as compared to boys<sup>35</sup>. We could not confirm that these factors explained the differences in dropout from sports. However, we did find that a small part of gender differences in sports participation could be explained by perceptions of neighborhood safety. Girls perceive their neighborhoods as less safe, which explains higher rates of withdrawal from sports among girls. These findings are consistent with other studies showing safety to be an important factor associated with physical activity of adolescent girls<sup>24</sup>, and that this factor is more important in influencing physical activ-



ity for girls than for boys<sup>36-37</sup>. In addition it may be that sex differences in physical activity are due to sex related variance in biological maturation, however due to the low number of studies and methodological issues no definitive conclusion can be drawn on this<sup>38</sup>.

We did not identify attitude, subjective norm and perceived behavioral control as mediators of sociodemographic differences in disengagement from sports or cease compliance with the fitnorm, even though these variables were found to be mediators for sociodemographic differences among adults<sup>27</sup>. This might be because studies on adults used a cross-sectional design, whereas we studied disengagement from sports longitudinally. It may very well be that other factors are associated with changes in behavior than with a (cross-sectional) state of behavior. Another explanation for not finding attitude, subjective norm and perceived behavioral control to be mediators, may be that some attitudes regarding physical activity are cultural<sup>39</sup> or gender specific<sup>40</sup>, whereas we measured attitude broadly and did not include culture specific beliefs. It may thus be that we missed some specific beliefs. However, the broad approach taken did allow us to make comparisons between sociodemographic groups. With regard to perceived behavioral control and subjective norm, no evidence was found for an association with dropping out of sports. Therefore these factors were not entered in the mediation analyses.

This study has some strengths and limitations. Major strengths include the longitudinal design and the demographically diverse sample. A limitation is that it was conducted among a selective sample of urban Dutch adolescents; therefore, care should be taken in generalizing these results to other populations. Although this study was not powered to do mediation analyses in small subsamples, we were still able to detect explanatory factors. Larger studies are needed to establish explanatory factors for the specific sociodemographic groups at risk for disengagement from sports. Finally, self-reported data on physical activity were employed; even though a reliable instrument was used the reports may not have been completely accurate. Also, although the measures for cognitions were broad (measuring both sports and physical activity) and not culturally sensitive, this allowed us to make comparisons between the groups.

To conclude, there are sociodemographic differences in reductions in sports participation and compliance with the fitnorm. Girls, adolescents who are lower educated and of non-Western background show more pronounced reductions in sports participation. Differences in education and ethnicity could partly be explained by intention to engage in sports. Gender differences could partly be explained by perceived safety. Interventions to promote sports participation should be directed at those groups most likely to disengage from sports participation, should focus on maintenance of sports participation, and should use intention and perceived safety as target points for intervention.

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# Chapter 3

## **Objective and perceived availability of physical activity opportunities: differences in associations with physical activity behavior among urban adolescents**

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*Int J Behav Nutr Phys Act* 2009;6:70



**ABSTRACT**

**Background:** This study examined the associations of the perceived and objective environment with adolescent engagement in sports activities and walking and cycling in leisure time. It also explored the degree of agreement between objective and perceived availability of physical activity (PA) facilities in neighborhoods.

**Methods:** Cross-sectional data on physical activity, the perceived availability of physical activity opportunities (perceived physical environment) was assessed through a questionnaire and the objective availability of PA opportunities (objective physical environment) was obtained through GIS data. The final sample included 654 adolescents with a mean age of 14.1 (SD = 1.2) years.

**Results:** Perceived availability of sports facilities and parks was significantly associated with engaging in sports (OR: 1.73; 95% CI: 1.16-2.56) and with walking and cycling in leisure time (OR: 1.66; 95% CI: 1.07-2.57) respectively. Agreement between objective and perceived environment was low to moderate with Kappa values ranging from -0.005 to 0.053.

**Conclusion:** The perceived environment was the stronger correlate of PA behavior among adolescents. There were substantial differences between assessments of objective and perceived physical environment.



## BACKGROUND

Insufficient physical activity (PA) is one of the major risk factors for chronic diseases such as cardiovascular diseases, cancer and obesity<sup>1-2</sup>. The Dutch PA guidelines state that adolescents have to engage in moderate-intensity PA for at least one hour each day<sup>3-4</sup>, and to engage at least three times a week for at least 20 minutes in vigorous intensity activities such as sports (“fit norm”)<sup>5</sup>. Only 27% of Dutch adolescents meet this guideline<sup>6</sup>, and 34% meet the “fit norm”. Similar figures have been found in other Western countries<sup>5; 7-10</sup>. Increasing PA is therefore important for population health. Adolescents are a particularly important group to target, since sufficient PA can result in considerable health gains for this group. The health benefits of regular PA for adolescents include a lower risk of becoming overweight or obese<sup>2; 11</sup>, higher bone density<sup>2; 11</sup>, a lower risk of depression<sup>2</sup> and healthier cardiovascular risk profiles<sup>11</sup>. These benefits may be experienced earlier as well as later in life<sup>12</sup>. Furthermore, physically active adolescents are somewhat more likely to become physically active adults<sup>12</sup>. To be able to increase PA levels, it is important to develop interventions that target the most important determinants of PA.

Although socio-ecological models of health behavior have suggested that the physical environment (such as the availability and accessibility of PA opportunities such as parks, sport facilities, bicycle lanes and sidewalks) may be a potent determining factor for PA<sup>13-15</sup>, recent reviews of the literature among adolescents<sup>16</sup> as well as adults<sup>17</sup> show that the evidence is not consistent. This indicates that more research is warranted, and that special attention should be directed at studying these associations among adolescents, since their patterns of activity and use of facilities differ from those of adults. Moreover, different conceptualizations of the environment may apply to different population groups<sup>18</sup>. Therefore care should be taken in translating findings from the adult literature to adolescents.

An important issue related to the study of environmental influences on PA behavior is the measurement of the physical environment, such as availability and accessibility of physical activity opportunities and barriers in the relevant environment. In recent years more detailed objective measures of PA opportunities have become available, for example, those documented in geographic information systems (GIS). Objective measures are generally regarded as being superior to subjective self-reports. However, adolescents may perceive their environments differently even if they live in the same “objective” environment. For example, a person who is motivated to be physically active may be more likely to perceive more opportunities to be physically active than someone

who is less motivated. Also, adolescents who are physically active may be more knowledgeable about the available opportunities than an inactive person.

Earlier research has indicated that there are indeed differences between perceived and objectively measured environments, and both may have different associations with health behaviors. Previous studies have found associations between objective availability of parks<sup>16</sup>, recreational facilities<sup>17</sup>, commercial PA-related facilities<sup>19</sup> with moderate-to-vigorous PA (MVPA) among adolescents. No associations were found between objective measures of accessibility and walkability and MVPA<sup>20</sup>. Objective measures of walkability<sup>21</sup> and features of school routes<sup>22</sup> were associated with active commuting to school; no associations were found for intersection density<sup>21</sup> and land use<sup>21</sup>. Studies that examined associations between perceived environmental factors and PA behavior have found that perceived availability of recreational facilities<sup>23-25</sup> and perceived access<sup>20</sup> were not associated with MVPA. Perceived availability of walking and bicycle facilities such as sidewalks and bicycle lanes (by parents) aesthetics<sup>21</sup> and street connectivity<sup>21</sup> were, and parental perceived traffic safety was not related to active commuting to school<sup>21-22</sup>.

Most of the above-mentioned studies did not explicitly explore differences between the objective and the perceived environment. A recent paper by Ball et al.<sup>26</sup> found a mismatch between the objective and perceived environment in adults. Another study<sup>25</sup> did compare the perceived environment and the objective environment in an adolescent population and found significant associations between objective and perceived environmental factors. However, for adolescent girls only the perceived environment was related to MVPA. These studies were conducted in an older population<sup>26</sup> or a female-only sample of adolescents<sup>25</sup> and not a general sample of adolescents in Europe. Better insight into these differences between the perceived and objective environment and their associations among adolescents could have important consequences for intervention development, because changing people's perceptions requires other strategies than modifying the actual environment. Perceptions of the environment may be changed by health education techniques by making adolescents aware of possibilities to be active, whereas modifying the actual environment may involve building new parks or sports facilities or enhancing accessibility.

In studying how physical environmental factors influence PA, it is important to study *PA sub-domains* instead of total PA, since environmental factors may be specific to particular sub-behaviors<sup>18</sup>. Hence, the availability of sports facilities may be important for engaging in sports, but not important for engaging in active transportation. The present study focuses on engagement in sports activities and walking and cycling during leisure time,

as these are both important contributors to adolescent PA<sup>27</sup>. The environmental factors examined in relation to these PA sub-domains were objectively measured and perceived availability of facilities for being physically active – such as parks, sports facilities, bicycle lanes and sidewalks – in the neighborhoods where adolescents live.

The aims of the present study are to 1) examine associations of objective and perceived availability of PA facilities with engagement in two leisure time activities: sports and walking and cycling during leisure time, and 2) to explore the degree of agreement and associations between objective and perceived availability of PA facilities.

## **METHODS**

This study used cross-sectional data on PA from a larger study on ENvironmental Determinants of Obesity in Rotterdam SchoolchildrEn (ENDORSE). Rotterdam is the second largest city of the Netherlands, with approximately 600.000 inhabitants of which 46% are of non-Dutch origin<sup>28</sup>. A detailed description of the study protocol is published elsewhere<sup>29</sup>. The ENDORSE study aims to investigate psychosocial and environmental determinants of overweight- and obesity-related behaviors among adolescents from 12 to 15 years of age. The data were collected in 2005-2006. The medical ethics committee of the Erasmus University Medical Center in Rotterdam issued a “declaration of no objection” for the study.

### **Sampling and procedure**

Schools participating in a health surveillance system (n = 56) conducted by the Rotterdam Public Health Service were invited to take part in the ENDORSE study. Of the 56 schools, 24 schools were willing to participate. These 24 schools were stratified according to the area of the city in which they were located (north, south, east or city centre), to ensure a range of physical and cultural environments. Of the 24 schools willing to participate, 17 were randomly selected for participation. In each selected school, approximately five classes were randomly selected for the study. All adolescents in a class participated, unless they or their parents indicated they were unwilling to do so. A total of 1668 adolescents were invited to take part in the ENDORSE study. In the present study, only the adolescents who lived in neighborhoods of the city of Rotterdam which were not adjacent to other municipalities were eligible for analyses, because objective environmental data was available for them.

A total number of 654 adolescents were included in the present study. Data of the other adolescents who were initially invited to participate were not available due to various

reasons. The ENDORSE questionnaire was completed by 1361 adolescents (82%) from 71 classes in 16 schools. During questionnaire completion, 187 adolescents were absent. Data from another 120 adolescents from one school were lost due to a printing mistake. A total of 817 adolescents met the criterion of living in neighborhoods not adjacent to other municipalities. Of these 817 adolescents, 654 (80%) had complete questionnaire data. Compared to the sample with complete questionnaire data, adolescents with missing questionnaire data were significantly older. A significantly higher percentage of adolescents with missing data were of non-Western descent and attended the lower school levels.

During one school hour, the adolescents completed a printed questionnaire on dietary and PA behaviors and potential determinants in the presence of a research assistant and a teacher.

## Measures

### *Background characteristics*

Date of birth, gender, country of birth (of the adolescent and the father and mother) and zip code of the home address were assessed in the questionnaire. School level was provided by the school and was categorized into senior general secondary education (i.e. preparatory education for university) and vocational education. A variable for ethnicity was calculated from the questions on country of birth according to the Statistics Netherlands standard. An adolescent was considered to be of Western descent if he or she and both parents were born in the Netherlands, another European country, Oceania, North America, Indonesia or Japan. If the adolescent or one of the parents was born in another country, the adolescent was considered to be of non-Western descent. Exact age was calculated by subtracting the reported date of birth from the date of measurements.

### *Physical activity*

PA was assessed by means of an adapted version of the Activity QUESTIONnaire for Adolescents & Adults (AQUAA)<sup>30</sup>. The AQUAA is a 7-day recall questionnaire that consists of items on frequency and time engaged in PA at school and during leisure time, active transport to school and during leisure time and sedentary behaviors during leisure time. This questionnaire showed fair to moderate test-retest reproducibility, with intra-class correlations ranging from 0.46 to 0.59.

The present study used the questionnaire items for assessing sports and walking and cycling during leisure time. Engagement in sports was assessed by asking adolescents to write down up to three sports activities in which they participated regularly and to

indicate on how many days of the week they engaged in this activity. An overall measure for frequency of engagement in sports activities was created by summing up the number of days reported for the three sports activities. This variable was dichotomized into a variable for “engaging in sports at least three times a week” yes (1) or no (0). The cutoff point used is in agreement with the criteria for complying with the fit norm (engaging in sports activities at least three times a week<sup>34</sup>). Leisure-time walking and cycling were assessed by two items that determine the frequency in days and average time spent on the activity per occasion (e.g. “How many days a week do you walk during leisure time?” and “On a day that you walk, how long do you walk on average during leisure time?”). For both variables, the average minutes per day spent on doing these activities was calculated using the following formula:

$$(\text{time} \times \text{frequency}) / 7$$

A composite variable for walking and cycling in leisure time was calculated by adding up the average time spent walking and cycling. This variable was dichotomized, using a cutoff value of 30 minutes a day. This cut-off seems sensible, since spending 30 minutes or more a day on walking and cycling during leisure time constitutes 50% of the recommended level of at least 60 minutes of PA a day.

#### *Perceived physical environment*

Perceived and objective availability of PA facilities were assessed for the neighborhood in which an adolescent lived. Availability of sidewalks and bicycle lanes was assessed with the items “In my neighborhood most of the streets have a sidewalk” and “There are a lot of bicycle lanes in my neighborhood” with a 5-point scale answering format (completely agree – completely disagree). Because of skewness, these two variables were dichotomized with the median as the cut-off value. The availability of parks and sports facilities was measured using a yes/no answering format, with the questions “Is there a park in your neighborhood?” and “Are there sports facilities in your neighborhood?”. We chose to assess facilities in the home neighborhood, since it is likely that adolescents spend a significant part of their leisure time close to their homes<sup>31</sup>.

#### *Objective physical environment*

Objective data on the availability of environmental opportunities to be active in the neighborhood in which the adolescents lived was retrieved from two separate databases, both managed by the municipality of Rotterdam. The objective availability of PA facilities was retrieved from a GIS database. This database contains the geographical coordinates of parks and public sports facilities (including sports halls, skate parks, fitness centers and swimming pools). Addresses of participants were “geocoded” using the

centroid of their 6-digit zip codes. Crow-fly distances were used to assess the number of facilities within a 1500-meter radius of the centroid of the 6-digit zip codes, based on recommendations by Colabianchi et al.<sup>32</sup> The number of parks and sports facilities within this radius was counted using ArcGIS 9.3 to form separate continuous variables. Availability of parks was defined as having a border of the park within a 1500 meter radius of the adolescents' home address. In addition to the continuous variables, new dichotomous variables for availability (0 = not present; 1 = present) were subsequently calculated from these counts.

Information for calculating an objective measure for availability of sidewalks and bicycle lanes was retrieved from another municipal database containing information on the total area of sidewalks and bicycle lanes per zip code defined neighborhood as well as the total land area per zip code defined neighborhood. The percentage of the area of sidewalks and bicycle lanes of the total land area in a neighborhood was calculated for the zip code defined neighborhoods. These variables were linked to the adolescents' home address zip code. In addition to these continuous variables, new dichotomized variables were created with the median as cut-off value. Complete environmental data was available for adolescents for which the 1500-meter radius was within the municipality borders of Rotterdam.

## Analyses

Descriptive statistics were used to describe the study population. Multi-level multivariate logistic regression analyses (MLwiN 2.02) were used to examine the associations between objective and perceived environment and PA. A two-level structure was used, with zip-code defined neighborhood and adolescent as the levels. The zip-code defined neighborhood was chosen as a level to account for clustering within the neighborhoods. Objective and perceived environmental factors were entered in separate regression analyses. Engaging in sports more than three times a week was regressed on objective and perceived measures of availability of sports facilities, parks, sidewalks and bicycle lanes. Engaging at least 30 minutes a day in walking and cycling during leisure time was regressed on objective and perceived measures of the availability of parks, sidewalks and bicycle lanes in two separate models. All models were adjusted for age, gender, ethnicity and educational level.

Cohen's kappa and percentage agreement between objective and perceived availability of PA facilities were calculated using the dichotomized environmental variables, to explore the level of agreement between these variables. Kappa values higher than 0.40 were considered to reflect a fair agreement.<sup>33</sup> Percentage agreement higher than 75% was considered to reflect a good agreement. Associations of the continuous objective

environmental factors with perceived environmental factors were assessed by univariate logistic regression analyses, with perceived environment as dependent variable. The above-mentioned analyses were conducted in SPSS 11.

For all tests, a result was considered significant if the p-value was lower than 0.05 for a two-sided test.

## RESULTS

### Participants

The mean age of the participants in this study was 14.1 (+/- 1.2), 48.9% was male, 53.8% attended vocational education (Table 3.1). See Table 3.1 for more background data.

**Table 3.1.** Description of the final sample

N	654
Male (%)	48.9%
Average age (SD)	14.1 (1.2)
Western ethnic background (%)	41.1%
Educational level	
Vocational education (%)	53.8%
Senior general secondary education (%)	46.2%
Engaging in sports at least three times a week (%)	62.2%
Engaging in walking and cycling during leisure time at least 30 minutes a day (%)	80.3%
<i>Perceived environment</i>	
Parks available (% yes)	73.5%
Sports facilities available (% yes)	73.4%
Sidewalks available (% a lot)	94.3%
Bicycle lanes available (% a lot)	35.5%
<i>Objective environment</i>	
Availability of parks <sup>a</sup> (SD)	1.0 (0.8)
Availability of sports facilities <sup>a</sup> (SD)	14.7 (7.5)
Availability of sidewalks <sup>b</sup> (SD)	13.2 (5.8)
Availability of bicycle lanes <sup>b</sup> (SD)	1.1 (0.5)

<sup>a</sup> Number within a radius of 1500 meters of a participants' home; <sup>b</sup> percentage of neighborhood land area. SD = standard deviation.

**Table 3.2.** Odds ratios (OR) and 95% confidence intervals (CI) for engaging in sports activities at least three times a week

	<b>Model 1: Demographics</b>	<b>Model 2: Perceived environment</b>	<b>Model 3: Objective environment</b>
N = 654	<b>OR</b> (95% CI)	<b>OR</b> (95% CI)	<b>OR</b> (95% CI)
Gender (referent = male)	<b>0.30</b> (0.21-0.42)	<b>0.27</b> (0.19-0.38)	<b>0.28</b> (0.20-0.40)
Age	<b>0.81</b> (0.71-0.94)	<b>0.78</b> (0.68-0.91)	<b>0.82</b> (0.70-0.95)
Ethnicity (referent = Western)	1.01 (0.72-1.42)	1.08 (0.76-1.53)	1.13 (0.76-1.67)
Educational level (referent = high)	1.06 (0.76-1.48)	1.08 (0.77-1.53)	1.04 (0.73-1.48)
<i>Environment</i>			
Parks <sup>a,b</sup>		1.13 (0.76-1.67)	1.06 (0.83-1.35)
Sports facilities <sup>a,b</sup>		<b>1.73</b> (1.16-2.56)	0.98 (0.96-1.01)
Bicycle lanes <sup>a,c</sup>		1.08 (0.76-1.54)	1.15 (0.78-1.70)
Sidewalks <sup>a,c</sup>		1.08 (0.53-2.21)	0.99 (0.96-1.03)

<sup>a</sup> For perceived environment, reference is "not available;" <sup>b</sup> for objective environment, the number counted within a radius of 1500 meters; <sup>c</sup> for objective environment, the percentage of neighborhood land area; OR = odds ratio; CI=confidence intervals; models 2 and 3 are independent of each other; bold values are significant.

**Table 3.3.** Odds ratios (OR) and 95% confidence intervals (CI) for engaging in walking and cycling during leisure time at least 30 minutes a day

	<b>Model 1: Demographics</b>	<b>Model 2: Perceived environment</b>	<b>Model 3: Objective environment</b>
N = 654	<b>OR</b> (95% CI)	<b>OR</b> (95% CI)	<b>OR</b> (95% CI)
Gender (referent = male)	<b>0.53</b> (0.35-0.80)	<b>0.51</b> (0.34-0.76)	<b>0.53</b> (0.36-0.80)
Age	1.01 (0.86-1.19)	1.01 (0.85-1.20)	1.02 (0.87-1.21)
Ethnicity (referent = Western)	<b>1.98</b> (1.32-2.97)	<b>2.03</b> (1.36-3.04)	<b>1.75</b> (1.13-2.72)
Educational level (referent = high)	1.32 (0.89-1.97)	1.35 (0.91-2.01)	1.30 (0.88-1.95)
<i>Environment</i>			
Parks <sup>a,b</sup>		<b>1.66</b> (1.07-2.57)	0.97 (0.74-1.27)
Bicycle lanes <sup>a,c</sup>		1.16 (0.76-1.77)	1.01 (0.64-1.60)
Sidewalks <sup>a,c</sup>		1.58 (0.73-3.40)	1.03 (0.99-1.07)

<sup>a</sup> For perceived environment, reference is "not available;" <sup>b</sup> for objective environment, the number counted within a radius of 1500 meters; <sup>c</sup> for objective environment, the percentage of neighborhood land area; OR=odds ratio; CI=confidence interval; models 2 and 3 are independent of each other; bold values are significant.



### Associations of environmental factors with sports and with walking and cycling in leisure time

Multivariate analyses (Table 3.2) show that adolescents who perceived that sports facilities were available in their neighborhood had higher odds to engage in sports activities more than three times a week (OR:1.7, 95% CI: 1.2-2.6). Table 3.3 shows that adolescents who perceived that there were parks in their neighborhood had higher odds to walk and/or cycle at least 30 minutes a day in leisure time (OR: 1.7, 95% CI: 1.1-2.6). No associations were found between objective measures of the environment and sports or walking and cycling during leisure time.

### Agreement between objectively measured and perceived environmental factors

Kappa values for agreement between objective and perceived availability of parks, sports facilities, bicycle lanes and sidewalks were low (0.00 – 0.08) (Table 3.4). The percentage agreement between objective and perceived environment was low to moderate, ranging from 53.8% for sidewalks to 73.0% for sports facilities. Univariate regression analyses showed that the odds of perceiving parks to be available was higher when more parks were present (OR: 1.5, 95% CI: 1.2-1.9) (Table 3.4).

## DISCUSSION

This study explored associations between adolescent perceptions and objectively assessed availability of PA facilities in the neighborhood in which they lived with sports and walking and cycling in leisure time among an adolescent sample in the Netherlands. The results show that adolescents who perceived higher availability of sports facilities in their home neighborhood were more likely to report engaging in sports at least three times a week. Adolescents who perceived a higher availability of parks in their neighborhood were more likely to engage in walking and cycling during leisure time for at least

**Table 3.4.** Kappa statistics and % agreement between perceived and objective environmental measures and odds ratios for perceiving availability of facilities

Facility	Kappa	% Agreement	% Over-reporting	% Under-reporting	OR (95% CI) <sup>c</sup>
Parks <sup>a</sup>	0.045	62.3%	19.6%	18.2%	<b>1.51</b> (1.18-1.93)
Sports facilities <sup>a</sup>	-0.004	73.0%	0.6%	26.5%	0.99 (0.97-1.01)
Sidewalks <sup>b</sup>	-0.005	53.8%	43.0%	3.2%	1.02 (0.97-1.08)
Bicycle lanes <sup>b</sup>	0.053	54.1%	18.3%	27.5%	1.40 (0.98-1.99)

<sup>a</sup> For objective environment, the number counted within a radius of 1500 meters; <sup>b</sup> for objective environment, the percentage of neighborhood land area; OR = odds ratio; CI=confidence interval; bold values are significant; <sup>c</sup> associations perceived environment with objective environment

30 minutes a day. No associations were found between objectively assessed availability of sports facilities and parks and PA. This study also explored the degree of agreement between “perceived” and “objective” availability of PA facilities in adolescents’ home neighborhoods. Agreement between objective and perceived availability of facilities was low. It may be that both measures of the environment are truly different constructs, but it may also be partly attributed to the measurement of both constructs.

The present study indicates that perceptions of PA facilities may be more strongly related to PA than objective measures of such opportunities. This finding is consistent with the results of Scott et al.<sup>25</sup>. In a sample of adolescent girls, they found that perceived availability of recreational facilities was related to MVPA but objective availability was not. Maddison et al. found comparable results in that perceived environmental measures were related to self-reported MVPA, but objective measures were not related to MVPA in adolescents<sup>20</sup>. Based on socio-ecological models such as the EnRG framework, also a direct relation between the objective ‘real’ environment and behavior would be expected, through a more or less ‘mindless’ or automatic response triggered by environmental cues and opportunities<sup>13; 34-35</sup>. However, the findings of this study and previous studies do not indicate that such a mindless or automatic response is triggered by the PA facilities in the home neighborhood that we included in our study. Nevertheless, the objective environment is expected to play a role, since perceptions of availability are likely to be the result of an interpretation and cognitive processing of what is actually out there. Therefore, it may be that the objective environment facilitates behavior but is not sufficient to let people actually perform the behavior<sup>36</sup>. Another explanation for finding an association between perceived availability and not objective availability and behavior is that perception of the environment is in the cognitive domain, just like other cognitions such as attitude and intention that may be associated with behavior. Perception of facilities could then be considered as a more proximal correlate of behavior than the objective environment. Another important issue to note is the low agreement between perceptions and objective measures of the PA facilities. This low agreement may indicate that there is a mismatch between objective and perceived availability of facilities. This may also partly explain why we found an association of the aspects of the perceived environment with behavior, while we did not find these associations for objective environment and behavior. Even though there are no studies to confirm these findings for adolescents, these results are in line with the findings of studies conducted among adults<sup>26; 37-39</sup>, and adds to the notion of McGinn et al.<sup>37</sup> that objective and perceived environmental factors are different constructs. It may therefore be that people living in the same objective environment have different perceptions of the same environment. Indeed, studies in adult populations showed that perceptions of the

environment may depend on individual and environmental characteristics<sup>18</sup> e.g. access to vehicles and public transportation<sup>40</sup> and peoples' willingness to travel.

It is important that future studies examine in more detail which factors influence perceptions of the physical environment among adolescents and which factors may potentially moderate or confound the associations between environment and behavior. For adolescents, other aspects of the environment, such as the social or cultural environment (i.e., what their friends do, what is accepted), the information environment, the organizational environment (what sports activities are organized for adolescents in the available sports facilities) and their interactions<sup>41</sup> may play a role in forming perceptions and influencing PA behavior. Another issue of relevance that needs to be addressed in future research among adolescents is the potential interaction between availability of facilities (objective and perceived) and motivation and the influence on PA behavior. For instance, an interaction with motivation can be expected as has been observed with the perceived environment x intention interaction in adults<sup>42</sup>. There may also be interaction between perceived environment and other cognitions, such as for example demonstrated in a study by Haug and colleagues<sup>43</sup> that showed interactions between cognitions (i.e. adolescents' interests in participating in physical activity) and perceived availability of facilities. If future research further confirms that perceptions are more important in directly predicting adolescent PA behavior than the actual environment, interventions to promote adolescent PA should take this into account.

This study also provides some evidence for the postulation that the environment has behavior-specific associations with PA<sup>18</sup> and that it is important to study environmental factors related to specific PA sub-domains. In this study, we found that different perceived environmental factors were associated with sports than with walking and cycling during leisure time. The importance of studying relevant environmental factors for specific PA sub-domains has previously been suggested for studies among adults<sup>44-45</sup>. It may even be that the relevant distance to certain destinations is behavior-specific, as was found among adults<sup>46</sup>. Future studies should examine if this is also the case among adolescents.

This study has some limitations. One important limitation is the cross-sectional design. It is thus not possible to draw causal inferences. Therefore, it may be the case that adolescents who engage more in sports or walking and cycling perceive more PA facilities because they use them more often. Longitudinal studies and (natural) experiments are needed to gain a better understanding of prediction and causal pathways. Cross-sectional studies are an efficient manner to explore issues to help to define hypotheses for further studies using stronger research designs, and that is what this study aimed

for. Another limitation is the reliance on self-reported measures of PA, which may have introduced bias. The analyses were conducted in an urban sample of adolescents. Of them, adolescents of non-Western background, lower educational levels and those who were older were more likely to have missing data. Therefore, care should be taken in translating these results to other populations. The explorative analysis, comparing the objective and perceived environment, has some limitations as well. The availability of parks and sports facilities was analyzed using crow-fly distances and the availability of bicycle lanes and sidewalks was analyzed using zip code defined neighborhoods. These measures may not fully match the perceived environment of adolescents in this study<sup>47</sup>. Differences between the perceived and objective environment found in this study may be due to this possible discrepancy.

To conclude, we found that the perceived availability of parks was associated with leisure time walking and cycling and the perceived availability of sports facilities was associated with engaging in sports. The objectively assessed availability did not show associations with walking and cycling in leisure time or self-report frequency of sports participation. Modifying the perception of the availability of parks and sports facilities may be a useful strategy in interventions aimed at improving PA among adolescents. This study also suggests that the objective and perceived physical environment are different constructs. Future research should use better conceptualizations of the perceived and objective neighborhood to confirm these explorative findings.

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# Chapter 4

## **Associations between availability of facilities within three different neighbourhood buffer sizes and objectively assessed physical activity in adolescents**

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**ABSTRACT**

This study aims to explore whether objectively measured availability of parks and sports facilities within three different buffer sizes is associated with moderate-to-vigorous physical activity (MVPA) among adolescents, and to identify potential cognitive mediators of this association. Data were obtained from adolescents (N=209, mean age: 14.5 (SD: 0.6) years) at the follow-up measurement of the Children Living in Active Neighbourhoods study in 2004. MVPA was measured using accelerometers. Availability of parks and sports facilities were measured within 400, 800 and 2000 meter buffers around participants' residential homes. Potential mediators (self-efficacy, attitude and the perceived availability of parks and sports grounds) were measured by self-administered questionnaires. No direct association was found between the objectively measured availability of facilities and objective assessments of MVPA and no evidence for mediation by cognitions was found in any of the buffer sizes. More specific and sensitive measures may be needed to understand environmental correlates of MVPA.

## INTRODUCTION

Physical activity (PA) has been shown to be associated with health and quality of life<sup>1-4</sup>. Adolescents are an important group to target in PA promotion programs, since many adolescents in Western cultures are not sufficiently physically active<sup>5-8</sup>. As PA levels decline during adolescence<sup>9-11</sup> and PA behaviour in adolescence appears to track into adulthood<sup>12</sup>, the potential health impacts of adolescent PA are considerable.

In order to promote PA in adolescent populations, it is important to understand its determinants. Research to date has focused mainly on cognitive correlates of physical activity, like attitude<sup>13</sup> or self-efficacy<sup>14</sup> and found cognitive constructs such as these to be associated with adolescent PA behaviour<sup>15</sup>. However, the more recently developed socio-ecological models like the Environmental Research framework for weight Gain prevention (EnRG) framework<sup>16</sup> suggest that besides cognitive factors, environmental factors (e.g. availability of parks and sports or recreation facilities) may influence physical activity levels. According to the EnRG framework, the effects of the environment on behaviour may be mediated through individual cognitions. Hence, the environment may have an influence on behaviour through factors such as one's perceptions of the environment, attitudes towards PA and self-efficacy to engage in PA.

Few studies have examined the proposed mediated pathways of environmental influence through individual cognitions on behaviour. Those that have did not find evidence that cognitive constructs mediated the objectively measured environment-PA association in adolescents<sup>17-18</sup>. One of the reasons for not finding evidence of mediation may be the choice of buffer size (i.e. spatial scale) in which physical environmental factors are captured, which was acknowledged in both studies. That is, many studies may not capture resources within distances typically accessed by adolescents. To gain more insight into this, it is important to study environmental influences on PA at various spatial scales<sup>19</sup>. In considering different buffer sizes, it is possible that features further from home are not important because they are less accessible and because people may be less aware that they are there. However, larger buffer sizes may also be positively associated with PA because more facilities of interest to the individual, and thus more opportunities to be active, may be captured. It has been pointed out that not only proximity to a park, but also its features, conditions and aesthetics are important for visiting a park<sup>20</sup>. In sum, associations of environmental factors with behaviour and potential mediators (e.g. attitudes, perceived environmental factors, self-efficacy) may differ between buffer sizes chosen, because in larger buffer sizes a larger number of facilities and potentially more facilities that fit with adolescents interests are captured as compared to smaller

buffer sizes. However, it may also be that facilities in smaller buffer sizes are of more importance for PA, because adolescents are likely to be more exposed to these facilities.

Several studies have confirmed that buffer size is an important factor in PA research among adolescents. While the buffer size around a participant's home is often arbitrary, Timperio and colleagues found that parents of Australian youths aged 10-12 reported that 1600 meters was an appropriate walking distance for their child (which would be an 800 meter return trip from home)<sup>21</sup>. Colabianchi et al. found that a 15 minute walk (approximately 1200 meters) would be an easy distance to walk for adolescent girls<sup>22</sup>. In qualitative work, Ries et al.<sup>23</sup> found that adolescents identified proximity of facilities as a major determining factor with regard to facility use, with facilities within walking distance being preferred. However, in the same study it was noted that most small neighbourhood parks are designed for young children and do not have facilities that attract adolescents<sup>23</sup>. Scott et al.<sup>24</sup> found that perceived access to facilities was more strongly associated with objectively measured number of facilities when a smaller buffer was used. In addition, facilities in smaller buffer sizes were shown to be more strongly associated with moderate-to-vigorous physical activity (MVPA)<sup>25-26</sup>. Few studies have used different spatial scales to study mediated pathways. Dowda et al.<sup>18</sup> studied the associations between self-reported PA and commercial PA facilities using two buffers (0.75 miles and 2.0 miles) among adolescent girls, but found no mediation through self-efficacy in any of the buffer sizes. However, to date no studies have examined the mediation of cognitive constructs on the availability of parks and sports facilities with objectively assessed adolescent MVPA at multiple buffer-sizes. The advantage of using an objective measure of MVPA is that it overcomes important limitations of self-reported MVPA, such as recall- and reporting biases.

The aim of this paper was to examine mediation of the relation between availability of sports facilities and parks, operationalized at different buffer sizes (400, 800 and 2000 m), and MVPA through perceived environmental factors, attitude and self-efficacy toward MVPA. We hypothesised that: 1) facilities assessed using smaller buffers would be more strongly associated with MVPA than those assessed using larger buffers (because adolescents are more exposed to proximal environments); 2) cognitive variables would show stronger associations with facilities assessed using smaller buffers than with facilities assessed using larger buffers; 3) cognitive variables would mediate the objective environment-MVPA association.

## METHODS

### Procedure

Cross-sectional follow-up data from the Children Living in Active Neighbourhoods (CLAN) collected in 2004 were used. In the CLAN study, 2096 grade 5 and 6 (10-12 years old) children attending 19 state elementary schools recruited from high and low socio-economic areas of Melbourne, Australia were invited to take part in a cross-sectional study in 2001<sup>27</sup> and data were collected from 919 of them (44% response rate). At that time, 698 families agreed to be recontacted in the future for further research and in 2004 were invited to participate in the follow-up study (i.e. three years after baseline measurements). Of these, 415 adolescents (45% of the older cohort at baseline) participated in the follow-up study. Only adolescents with accelerometer data available in 2004 for four or more weekdays including at least one weekend day and with objectively measured environmental data were eligible for analyses. In total, 67% of the 415 adolescents met these criteria, leaving a sample of 277 (45.1% boys, mean age=14.5 +/- 0.6 years) eligible for analyses. Only follow-up data were analysed in the present study, because adolescent self-reported data on attitude towards physical activity were not collected at baseline. There were no statistically significant differences in gender, parental education or baseline MVPA between adolescents who participated in the follow-up and those who did not, or between those who were included in the final sample for analyses and those who participated in the follow-up but were excluded from these analyses. Adolescents who were followed up had fewer parks within 800 meter and 2000 meter buffers at baseline than those who were not followed up. Those who were eligible for analyses had more parks at 800 and 2000 meter buffers at follow-up than those who were followed up but excluded. Complete data (i.e. eligible adolescents with information on all cognitions, and confounders) was available for 209 adolescents and these adolescents were included in the analyses.

### Measures

#### *Moderate to vigorous physical activity (MVPA)*

MVPA was defined as activities of  $\geq 3$  Metabolic Equivalents (METs). The resting metabolic rate when sitting is 1 MET and 3 METs consists of activities with three times the energy cost of sitting. In 2004, each adolescent was asked to wear an accelerometer (Actigraph GT1M) on his or her right hip, for one week, to measure physical activity. This accelerometer detects vertical accelerations. The accelerometers recorded activity in one minute epochs, summing the total number of accelerations that occurred in each minute. A higher number of accelerations per minute, means that the average activity in that minute is performed at a higher intensity. For each minute, counts per minute

corresponding to 3 METs were determined using an existing age-adjusted regression equation<sup>28-29</sup>. For this study, only physical activity after school hours (i.e. from the end of the school day to 9 p.m) and on weekend days was examined, as neighbourhood facilities are most relevant during discretionary time. Therefore, the average minutes spent in MVPA after school hours on school days was calculated, excluding days on which accelerometer counts were <10,000 or >20 million or vigorous-intensity activity ( $\geq 6$  METs) was >6 h as these unlikely values may indicate insufficient wear-time or malfunction<sup>27</sup>. Average MVPA per school day was multiplied by five to compute a summary measure for MVPA during the school week (i.e. Monday to Friday). MVPA during the average weekend day was multiplied by two to compute a score of MVPA during the weekend. Both scores were summed to create a measure of MVPA during a total week. To overcome skewness, the MVPA measure was log transformed, using the natural logarithm.

#### *Objective measures of the environment*

Objective measures of the environment were determined using the Geographic Information Systems (GIS) software package, ArcView version 3.3 (Environmental Systems Research Institute, Redlands CA, 2002). Spatial data provided by the State of Victoria was used to geocode (i.e. map) residential locations (addresses). Addresses were initially geocoded using a script and VicMap Address (2004). Addresses that could not be matched automatically (30%) were geocoded manually by assigning a geographic point against the base of either VicMap Address 2004 or VicMap Property 2004.

The total number of parks and sports facilities were computed within three different Euclidean buffers around each participants residence: 400 m (small-sized buffer), 800 m (medium-sized buffer), and 2000 m (large-sized buffer). The 800 m buffer was based on previous research by Timperio et al., who found that 1600 m (roundtrip; i.e. 800 m each way) was a reasonable distance to travel for children<sup>21</sup>. In light of this, the selection of 400, 800 and 2000 m provided a range covering both a smaller and larger-sized zone around what has been established as acceptable for 10-12 year olds. The locations of parks were determined from the Open Space 2002 spatial data set (a GIS dataset provided by the Australian Research Centre for Urban Ecology that includes maps of open spaces across Melbourne). For this study, 'parks' included all open spaces classified as reserves/parks, open spaces, managed reserves and reserves managed by Parks Victoria, and included both formal, informal and natural open spaces of all sizes (ranged from 201m<sup>2</sup> to 8.1km<sup>2</sup>) and parks with full public access and with restricted access (e.g. entry fees, regulated hours of entry or restricted access to a subset of the population). Parks were counted if any part of the edge of the park was within the buffer. Sports facilities included the unique locations where sports popular among Australian youth can be participated in formally (structured sport) or informally/unstructured (eg. club or competition location,

venue for hire, free access, etc). Locations where basketball, tennis, cricket, football, soccer, netball, skateboarding and squash could be engaged in and locations of playing courts (indoor and outdoor), purpose-built BMX tracks, swimming pools, leisure centres and gyms were identified through on-line searches, local government, community directories and electronic telephone directories and were geocoded. Locations within each buffer where multiple sports could be played were only counted once.

#### *Perception of the environment*

Adolescents were asked how strongly they agreed with the statement, "There are no parks or sports grounds near where I live" on a scale ranging from Strongly agree (1) – Strongly disagree (5) and including the option 'Don't know' (6)). The 'Don't know' response category was recoded as missing values. One week test-retest reliability of this item was moderate (ICC: 0.41; N=65). This measure was treated as a continuous measure in the analysis.

#### *Physical activity attitude and self-efficacy*

The attitude items were adapted from Kendzierski & DeCarlo 1991<sup>30</sup>. Attitude was measured by four items ("How much does physical activity bore you or interest you?", "How much do you like or dislike physical activity?", "How energising or tiring is physical activity?", and "How pleasant or unpleasant is physical activity?") with 5-point Likert response scales, such as for instance (Bore me a lot (1) – Interests me a lot (5)). A total attitude score was created by averaging the four attitude items into an overall attitude item (Cronbach's alpha of 0.76). One week test-retest showed moderate to almost perfect agreement (ICC ranging from 0.50 to 0.86 for individual items, N=63). The test-retest ICC of the scale was 0.65, indicating substantial agreement (N=63).

The self-efficacy measure was adapted from a study by Saunders et al.<sup>31</sup> and was assessed by nine items with the stem item "I could be active even...". The nine items assessed were "...if others make fun of me", "...if there is no-one to be active with", "...if I don't have the energy to be active", "... if I am not good at it", "...if I had no one to take me to training", "...if my friends don't take part", "...if the weather is bad", "...if I had a lot of homework to do" and "...if I were busy going out with my friends". All items had the 5-item Likert response scale ranging from "not at all sure" (1) to "very sure" (5). These items had a Cronbach's alpha of 0.88 and an overall score was created by averaging these items. Test-retest reliability of individual items over a one week period among 61 children/adolescents was fair-to-moderate (ICC=0.25-0.64) and the test-retest reliability of the scale indicated substantial agreement (ICC=0.73). The cognitive measures were treated as continuous measures in the analysis.

### *Control variables*

Information on socio-demographic variables was assessed in a parental questionnaire, including gender and education. Either parent completed the questionnaire and reported their own and their partners highest level of education (response categories: never attended school, primary school, some high school, completed high school, technical or trade school, university or tertiary qualification). These categories were collapsed into three categories: some education (never attended school, primary school or some high school), high school education (completed high school, technical school or trade school) and university or tertiary qualification. Subsequently, a variable was created indicating the highest level of education attained by either parent. If data were available for only one parent (i.e. 72%), this was considered to be the highest educated parent. Population counts were used to calculate population density for residential postcode. This information was derived from census data and are also available from the same database as the Socio-Economic Indexes for Areas 2001 (SEIFA 2001) <sup>32</sup>.

### **Analyses**

STATA 10.0 was used for all analyses and results were considered to be significant if the p-value was lower than 0.05 in a two-sided test. Descriptive statistics of the time spent in MVPA, the number of sports facilities and the number of parks at three different Euclidean buffers (i.e. 400, 800 and 2000 meters) were calculated. Associations of the availability of sports facilities and parks at the three different buffers with MVPA were examined using multilevel linear regression analyses with school and individual as levels. Mediation analyses were conducted to investigate whether cognitive variables (i.e. attitude, self-efficacy and the perceived environment) mediated the association between the objective environment and MVPA. These mediation analyses were conducted using multilevel linear regression analyses with school and individual as levels. All mediation analyses were conducted using a single-mediator model and were adjusted for gender, parental education and population density. The conceptual mediation model is depicted in Figure 4.1. In this model, pathway A ( $X \rightarrow M$ ) represents the association between the availability of facilities with cognitive mediators. Pathway B ( $M \rightarrow Y$ ) represents the association of the cognitive mediators, adjusted for availability of facilities, with MVPA. Pathway C ( $X \rightarrow Y$ ) represents the association between the availability of facilities with MVPA. If Pathway A and Pathway B are both significant, the mediated effect could be calculated by multiplying the estimated coefficients of Pathway A with the estimated coefficients of Pathway B.



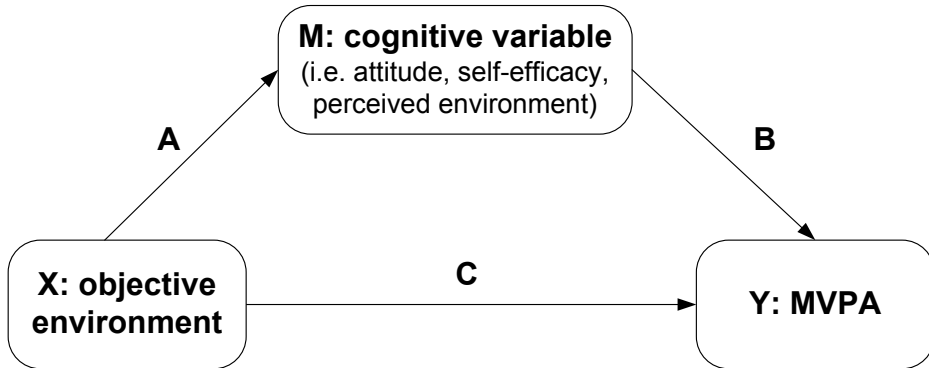


Figure 4.1. Conceptual mediation model

## RESULTS

### Descriptive statistics

Of the final sample ( $n = 209$ ), 45.9% were male and the average age was 14.5 ( $\pm 0.6$ ) years at follow-up. On average participants spent 290 minutes/week in MVPA out of school hours (Table 4.1). Mean scores on the cognitive mediations and the mean number of sports facilities and of parks available within each buffer is shown in Table 4.1.

Table 4.1. Demographic and environmental descriptives of the study sample

	Mean (SD)
N = 209	
Age	14.5 (0.6)
Gender (% male)	45.9%
Weekly minutes MVPA	289.5 (154.9)
Mean perceived availability of parks and sports grounds <sup>a</sup>	4.30 (0.84)
Mean attitude <sup>a</sup>	4.21 (0.69)
Mean self-efficacy <sup>a</sup>	3.36 (0.92)
Mean number of sports facilities within 400 m	0.46 (0.86)
Mean number of sports facilities within 800 m	2.34 (1.85)
Mean number of sports facilities within 2000 m	14.47 (8.10)
Mean number of parks within 400 m	2.91 (1.96)
Mean number of parks within 800 m	8.93 (3.99)
Mean number of parks within 2000 m	41.07 (12.60)

<sup>a</sup> 5 point scales, ranging from 1 (low) to 5 (high); MVPA=moderate-to-vigorous physical activity; SD=standard deviation

### Associations of the availability of facilities with MVPA (pathway C)

The results show that the availability of sports facilities (Table 4.2 – pathway C) or parks (Table 4.3 – pathway C) at different buffer sizes were not significantly associated with MVPA.

### Associations of the availability of facilities with cognitive mediators (pathway A)

Table 4.2 shows that the availability of sports facilities at 800 and 2000 m was found to be significantly positively associated with the perceived availability of parks and sports grounds. No associations were found for availability of sports facilities at 400 m or availability of parks in 400, 800 and 2000 m buffer sizes with perceived availability of parks and sports grounds. Attitudes and self-efficacy were not statistically significant associated with availability of sports facilities or parks in 400, 800 and 2000 m buffer sizes (Tables 4.2 and 4.3).

**Table 4.2.** Regression coefficients and confidence intervals for the mediation pathways of cognitive mediators of the objectively-measured availability of sports facilities – MVPA association (N=209)

Objective environment (X)	Mediator (M)	Pathway A	Pathway B	Pathway C
		(X→M)	(M→Y)	(X→Y)
		Regression coefficient (95%CI)	Regression coefficient (95%CI)	Regression coefficient (95%CI)
Number of sports options within 400 m	Perceived availability of parks/sports grounds	0.07 (-0.07,0.21)	0.09 (-0.02,0.19)	0.00 (-0.10,0.10)
	Self-efficacy	-0.04 (-0.17, 0.08)	<b>0.13</b> (0.04,0.22)	0.00 (-0.10,0.10)
	Attitude	-0.06 (-0.22, 0.11)	<b>0.25</b> (0.13,0.36)	0.00 (-0.10,0.10)
Number of sports options within 800 m	Perceived availability of parks/sports grounds	<b>0.44</b> (0.18,0.71)	0.09 (-0.01,0.19)	-0.00 (-0.05,0.05)
	Self-efficacy	0.06 (-0.18,0.31)	<b>0.13</b> (0.04,0.22)	-0.00 (-0.05,0.05)
	Attitude	0.05 (-0.27,0.37)	<b>0.25</b> (0.13,0.36)	-0.00 (-0.05,0.05)
Number of sports options within 2000 m	Perceived availability of parks/sports grounds	<b>0.94</b> (0.02,1.87)	0.08 (-0.03,0.18)	0.01 (-0.00,0.02)
	Self-efficacy	0.24 (-0.60, 1.08)	<b>0.13</b> (0.04,0.22)	0.01 (-0.00,0.02)
	Attitude	0.78 (-0.34, 1.91)	<b>0.24</b> (0.12,0.36)	0.01 (-0.00,0.02)

Pathway A represents the association between the objective availability and the cognitive mediator. Pathway B is the association between the cognitive mediator and MVPA, adjusted for X. Pathway C is the unadjusted association between the objective availability and MVPA. MVPA=moderate-to-vigorous physical activity; CI=confidence interval. Bolded numbers indicate a statistically significant association (P<0.05).

**Table 4.3.** Regression coefficients and confidence intervals for the mediation pathways of cognitive mediators of the objectively-measured availability of parks – MVPA association (N=209)

Objective environment (X)	Mediator (M)	Pathway A (X→M)	Pathway B (M→Y)	Pathway C (X→Y)
		Regression coefficient (95%CI)	Regression coefficient (95%CI)	Regression coefficient (95%CI)
Number of parks within 400 m	Perceived availability of parks / sports grounds	0.10 (-0.22,0.43)	0.08 (-0.02,0.18)	0.03 (-0.02,0.07)
	Self-efficacy	-0.05 (-0.34,0.24)	<b>0.13</b> (0.04,0.22)	0.03 (-0.02,0.07)
	Attitude	0.04 (-0.36,0.43)	<b>0.24</b> (0.13,0.36)	0.03 (-0.02,0.07)
Number of parks within 800 m	Perceived availability of parks / sports grounds	0.27 (-0.35,0.89)	0.09 (-0.01,0.19)	-0.00 (-0.02,0.02)
	Self-efficacy	-0.30 (-0.85,0.26)	<b>0.13</b> (0.04,0.22)	-0.00 (-0.02,0.02)
	Attitude	-0.12 (-0.87,0.63)	<b>0.24</b> (0.13,0.36)	-0.00 (-0.02,0.02)
Number of parks within 2000 m	Perceived availability of parks / sports grounds	1.10 (-0.54, 2.74)	0.08 (-0.02,0.18)	0.01 (-0.00, 0.02)
	Self-efficacy	-0.32 (-1.80,1.16)	<b>0.13</b> (0.04,0.22)	0.01 (-0.00, 0.02)
	Attitude	0.16 (-1.84,2.15)	<b>0.25</b> (0.13,0.36)	0.01 (-0.00, 0.02)

Pathway A represents the association between the objective availability and the cognitive mediator. Pathway B is the association between the cognitive mediator and MVPA, adjusted for X. Pathway C is the unadjusted association between the objective availability and MVPA. MVPA=moderate-to-vigorous physical activity; CI=confidence intervals. Bolded numbers indicate a statistically significant association (P<0.05).

### Associations of cognitive mediators with MVPA (pathway B)

Of the potential mediators, attitude and self-efficacy were consistently found to be associated with MVPA (Tables 4.2 and 4.3 – pathway B) after adjustment for gender, parental education, population density and the objective availability of sports facilities or parks. No association between perceived availability of parks and sports grounds and MVPA was found (Tables 4.2 and 4.3).

### Mediation of cognitive variables on the objective environment –MVPA association

Since none of the potential mediators met the criteria for mediation (i.e. both the Pathway A and Pathway B associations need to be significant), no mediated effects were calculated (Tables 4.2 and 4.3).

## DISCUSSION

In contrast to expectations, we did not detect associations between the physical environmental factors measured at different buffer sizes and objectively assessed MVPA. However, we did find associations between objectively measured availability of sports facilities and perceived availability of parks and sports grounds. The associations between the objectively measured availability of sports facilities and the perceived availability of parks and sports grounds were present only in the larger buffer sizes. Consistent findings in this study were the associations between attitude and self-efficacy with MVPA. Finally, there was no indication of mediation of the cognitive factors in the objectively measured environment-MVPA association for any of the buffer sizes, since there was no relation between the environmental factors and the cognitive mediators.

Our finding that the objectively measured environment was not associated with MVPA at different buffer sizes adds to the growing body of equivocal literature on the associations of the environment and adolescent MVPA. Some studies have found positive associations between the objectively measured environment and physical activity in adolescents<sup>26; 33-35</sup>. Others have found no significant associations<sup>17; 24; 36</sup>, similar to the present study. Two<sup>17; 24</sup> of the three prior mentioned studies that did not find a significant association between the physical environment and physical activity used objective measures of MVPA. In contrast, only one<sup>26</sup> of the four prior mentioned studies that did find a significant association between the physical environment and physical activity used objective measures of physical activity. In sum, relatively more of the prior mentioned studies using self-reported measures, as compared to objective measures, of physical activity have found a significant association between the physical environment and physical activity. The findings of this study are therewith consistent with those studies that used an objective measure of MVPA, in which associations between environmental factors tend to be absent.

A potential explanation for the lack of associations observed between the objectively measured environment and MVPA may relate to the specificity of measures needed to show associations between the physical environment and behaviour. Objectively assessed MVPA captures a range of different activities, such as brisk walking, playing football and running, summing them into one overall measure of MVPA. The fact that MVPA is a summary measure may prevent finding associations between specific activities (such as playing football) and specific facilities (such as football ovals), or perceptions of their availability, as previously highlighted by Giles-Corti et al.<sup>37</sup>. Hence, in examining behaviour-environment relationships, more specific behaviours need to be studied, which indicates that valid and reliable instruments for measuring specific activities are

required. More advanced accelerometers and processing of accelerometer data that can distinguish between different types of PA that are currently under development<sup>38</sup>, may be useful tools for studying more associations between specific types of PA and specific aspects of the objectively measured environment. The same holds for assessment of environmental factors, which should be refined and match well with the activities under study. It may be that the environmental factors used in this study did not match MVPA, and that walking or cycling tracks/paths or other environmental features are more important for overall MVPA in adolescents. Moreover, we may not have found an association between environmental factors and MVPA because the presence of facilities alone may not be sufficient to promote higher levels of physical activity, with other factors like the quality of public open spaces also being important<sup>33</sup>. In addition, it may be that there is a non-linear effect of the physical environment on MVPA. In other words, after some point, increasing units of facilities may not continue to increase MVPA.

We observed that associations between the objectively measured environment and cognitive variables, such as the perceived environment, varied according to the buffer size used and the cognition under study. In contrast to our hypotheses, we found stronger associations between the environmental factors and perceived environment in the larger buffer sizes than in the smaller buffer sizes. This may be because there is a higher likelihood in a larger buffer area that there is at least one facility which suit adolescents' needs and which they take into account in their perceptions of their environment. Moreover, as noted before, presence of facilities may not be enough: accessibility and quality may be of greater importance and in a larger buffer size one may be more likely to find such a facility. Our findings may imply that adolescents' perceptions of opportunities to be active are shaped by facilities within relatively large buffer sizes. It may be that adolescents in this study have access to a larger area, or are willing to walk or cycle further than their parents reported at age 10-12 years (i.e. 800 meters<sup>21</sup>). In a study by Veitch et al. it was indeed found that children usually visit parks on an average distance of 1736 (SD=2196) metres, which was almost three times as far as the nearest park to their home (590 m, SD=964 m)<sup>39</sup>. Moreover, the adolescents in this study are more likely to have more independent mobility<sup>39</sup> than they did at age 10-12 years<sup>21</sup>.

That no associations were observed between the objectively measured environment and attitude and self-efficacy may be due to the environmentally insensitive questionnaire items on these constructs collected. For instance, the self-efficacy scale used did not contain items on potential environmental barriers such as confidence they could identify places to play or could reach a facility. Future studies could incorporate constructs which are more environmentally sensitive.

A reasonably consistent finding in this study is that established cognitive variables such as attitude and self-efficacy are associated with behaviour, but the perceived environment is not. Work by Prins et al.<sup>36</sup> has shown that perceptions of the environment are associated with specific behaviours. The perceived availability of sports facilities was for instance associated with sports behaviour but not with leisure-time walking or cycling. The broad measure of MVPA used in this study may have prevented us from finding these associations.

This study has some limitations. As cross-sectional analyses were conducted, it is not possible to draw any causal inferences. For instance, there may be reverse causality in the association between cognitions and behaviour. Theoretical models like the Social Cognitive Theory<sup>14</sup> also suggest that some cognitions like self-efficacy may be increased by enactive learning, which indicates that cognitions indeed can be formed based on previous behaviour. In addition, Ries et al. showed that two interventions that aimed to increase PA, but that did not aim to change perceptions of the environment, may increase perceived availability of PA facilities<sup>40</sup>. Another limitation was the relatively small sample size, which may have impacted on the power of this study. The students that were included in the sample were a selective sample, that may have more facilities available and therefore the findings may not generalize to other groups. A further limitation is that the Open Space 2002 dataset, containing geographic information on parks, was not validated, nor were the locations of facilities, which were obtained from multiple sources. Major strengths of this study are its reliance on objectively-assessed indicators of both MVPA and of the physical environment. We further used a number of different sized buffers to conceptualise the objective environment, however different results may have been found if network buffers were used.

In conclusion, we found that objectively measured availability of sports facilities and parks at each of the three buffer sizes applied were not associated with MVPA. However, the objectively measured availability of sports facilities was associated with perceived availability of parks and sports grounds at larger buffer sizes (800 and 2000 m). Criteria for mediation analyses were not met. Hence, the results of this study indicate that mediation of cognitive factors of the physical environment-physical activity association may not occur when availability of facilities is considered as the environmental indicator. Future studies should conduct mediation analyses by taking into account specificity of the environment, behaviour and cognitions and may wish to consider non-linear effects. Further, future studies may wish to explore the potential moderating role of the environment on relationships between cognitions and MVPA.

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# Chapter 5

## **Availability of sports facilities as moderator of the intention- sports participation relationship among adolescents.**

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**ABSTRACT**

**Objective:** This longitudinal study aimed to identify individual and environmental predictors of adolescents' sports participation and to examine whether availability of sports facilities moderated the intention–behaviour relation.

**Methods:** Data were obtained from the ENDORSE study (2005/2006 – 2007/2008). A total of 247 adolescents (48% boys, mean age at follow-up 15 years) completed the surveys at baseline and follow-up. At baseline, adolescents completed a survey that assessed engagement in sports participation, attitude, subjective norm, perceived behavioural control and intention toward sports participation. Availability of sports facilities (availability) was assessed using a geographic information system. At follow-up, sports participation was again examined. Multiple logistic regression analyses were conducted to test associations between availability of sports facilities, theory of planned behaviour variables, and the interaction of intention by availability of sports facilities, with sports participation at follow-up. Simple slopes analysis was conducted to decompose the interaction effect.

**Results:** A significant availability\*intention interaction effect (odds ratio: 1.10; 95% CI: 1.00-1.20) was found. Simple slopes analysis showed that intention was more strongly associated with sports participation when sports facilities were more readily available.

**Conclusions:** The results of this study indicate that the intention-sports participation association appears to be stronger when more facilities are available.

## INTRODUCTION

Promoting physical activity (PA) is an important public health priority<sup>1-3</sup>. Besides daily activities of moderate intensity, more intensive sport activities to increase physical fitness are also recommended, especially for children and adolescents<sup>4</sup>. Moderate and higher intensity activities are beneficial for health, quality of life and social integration during adolescence, as well as later in life<sup>2-3;5-7</sup>. Furthermore, continuous PA throughout youth increases the probability of becoming an active adult<sup>8</sup>. However, even though many adolescents in Western countries engage in sports activities when they are younger<sup>9</sup>, engagement in sports declines rapidly during adolescence<sup>9-10</sup>. Thus, it is important to promote sports participation in adolescence. To do this efficiently, interventions should be theory- and evidence-based<sup>11</sup> and intervene on important, modifiable behavioural determinants<sup>12</sup>. The present study aims to identify individual and environmental determinants of sports participation and their potential interplay.

According to socio-ecological models<sup>13-15</sup> and extended motivational models<sup>16</sup> behaviour is not only determined by predictors at the individual level (i.e. cognitions), but also by environmental factors, such as availability of sports facilities. These models also assume an interplay between individual cognitions and environmental factors through mediation<sup>14</sup> or moderation<sup>16</sup>. Until recently, most studies, exploring determinants of PA and sports participation focused on the individual level correlates, such as derived from the Theory of Planned Behaviour (TPB)<sup>17-18</sup>. According to the TPB, behavioural intention (i.e., the decision to engage in a specific behaviour), is the most proximal determinant of behaviour<sup>19</sup>. Intention in turn is determined by attitudes, subjective norm and perceived behavioural control (PBC). Attitudes refer to a person's evaluation of the advantages and disadvantages of engagement in a specific behaviour. Subjective norm is related to the perception of what important others think you should do. Perceived behavioural control refers to the perceived ease or difficulty of performing a specific behaviour. The few studies available that used the TPB for explaining sport participation did not find consistent results with regard to the predictability of intention on sports behaviour. Other studies have focussed on built environmental factors, such as the availability and accessibility of PA opportunities, as potential determinants of sports participation among adolescents<sup>20-21</sup>. There are, however, few studies that take both individual and environmental determinants of sports participation and their interrelationship into account, and the studies that have done so mainly have relied on a cross-sectional design, weakening the interpretation of the relationships.

In the present study, the potential moderating effect of environmental-level predictors on the intention-behaviour relation as suggested by Fishbein in the extended TPB

model<sup>16</sup> is examined. According to this model, the environment, such as the availability of sports facilities, can act as a facilitator for behaviour. Hence, when sports facilities are available people are more likely to act on their positive intention, suggesting a stronger intention-behaviour association in circumstances of high availability. Insight into these mechanisms may help shape PA promotion interventions for adolescents and may contribute to the explanation of the intention-behaviour gap, as has been observed for PA and other behaviours<sup>18;22</sup>.

Few studies have examined the role of environmental factors on the intention-behaviour association. One study found that the proximity to recreational facilities moderates the intention-walking behaviour association in adults<sup>23</sup>, while another found no evidence of moderation of active transportation among students<sup>24</sup>. Both studies used a self-report measure of the built environment, which was seen as an important limitation<sup>23</sup>.

The aim of the present longitudinal study was to identify individual and environmental predictors of adolescent sports participation and to examine if the objective availability of sports facilities moderates the intention-behaviour relationship. We hypothesized that 1) intentions are significantly associated with sports participation; 2) objectively measured availability of sports facilities is associated with sports participation; 3) objectively measured availability of sports facilities moderates the association between intention at baseline and sports participation at follow-up, with more facilities contributing to a stronger intention-behaviour relationship.

## **METHODS**

This study draws on longitudinal data from the study on ENvironmental Determinants of Obesity in Rotterdam SchoolchildrEn (ENDORSE). The ENDORSE study was conducted in Rotterdam in 2005-2006 (baseline) and 2007-2008 (follow-up) among adolescents in the first and third year of secondary education. This is an age period in which considerable declines in sports participation can be expected<sup>25-26</sup>. Rotterdam is the second largest city of the Netherlands, with approximately 600,000 inhabitants, of which 46% are of non-Dutch origin<sup>27</sup>. The medical ethics committee of the Erasmus University Medical Center in Rotterdam issued a "declaration of no objection" for the study. A detailed description of the study protocol is published elsewhere<sup>28</sup>.

### **Sampling and procedure**

At baseline, 56 schools were approached to take part in the study and 24 schools were willing to participate. A random selection of 17 of these schools participated in

the study. These schools were selected after stratification according to the area of the city in which they were located (north, south, east or city centre) to ensure a range of physical and cultural environments. Approximately five classes within each school were selected for the study. Thirteen schools had classes with adolescents in their first year of secondary education at baseline, and these schools were included in the present study. During one school hour, the adolescents completed a printed questionnaire on dietary and PA behaviours and potential determinants of these behaviours in the presence of a research assistant and a teacher.

In this paper we analysed the data on sports behaviour from ENDORSE and additional objective measures of availability of sports facilities in the local neighbourhood. Only adolescents who lived in neighbourhoods within the city of Rotterdam which were not adjacent to other municipalities were eligible for analyses, because objective environmental data was only available for Rotterdam. A total of 488 adolescents met this inclusion criterion at baseline.

## Measures

### *Physical activity*

An adapted version of the Activity QUESTIONNAIRE for Adolescents & Adults (AQUAA)<sup>29</sup> was used to assess PA levels at baseline and follow-up. The AQUAA showed a fair to moderate test-retest reproducibility, with intra-class correlations ranging from 0.44 to 0.59. Items related to frequency of sports participation were used in this paper.

Adolescents were asked to name up to three sports they had participated in during the previous week and indicate on how many days of the week (0–7 days) they had participated in each sports activity. An overall measure of frequency of sports participation per week was created by summing the frequencies of the reported sports activities at baseline and at follow-up, respectively. These variables were collapsed into two categories (yes (1), participated in some sports; no (0), did not participate in any sports) due to the skewed distribution.

### *Theory of Planned Behaviour (TPB) measures*

All TPB variables were measured at baseline using five point response scales. Attitude was assessed by two items using semantic differential response scales "I think that sports and leisure time physical activity are..." (very good (5) – very bad (1) and very pleasant (5) – very unpleasant (1)). Cronbach's alpha of the attitude items was 0.80 and a mean attitude score was calculated. Perceived behavioural control was assessed by two items, assessing perceived capability and control (Cronbach's alpha=0.27). However, as

the Cronbach's alpha was low, it was decided to use these items as separate scales in the analyses. Capability was assessed by the item "How easy or difficult would it be for you to engage in sports or leisure time physical activity if you want to?" (very easy (5) -very difficult (1)). Control was assessed by the item "To what extent do you decide for yourself to engage in sports or leisure time physical activity?" (I decide it all by myself (5) – I do not decide this by myself at all (1)). One item was used to assess parental subjective norm: "If I engage in sports or physical activity, my parents think that this is..." (very good (5) -very bad (1)). Intention was also assessed by one item: "Do you plan to start/remain engaging in sports and physical activity in the next half year?" (yes certainly (5) – certainly not (1)).

#### *Objective physical environment*

Geographical Information System (GIS) data on the availability of sports facilities at baseline was retrieved from a database managed by the municipality of Rotterdam. This database contains geographical coordinates of sports facilities (including sports halls, skate parks, fitness centers, sporting grounds and swimming pools). Addresses of adolescents' homes were geo-coded by using the centroid of the 6-digit zip codes of their home address. ArcGIS 9.3 was used to count the number of sports facilities within a crow-fly buffer of 1600 m (i.e. approximately 1 mile) from the adolescents' home. This radius was based on a study by Colabianchi et al. in which an average acceptable travel time of 15 min was found<sup>30</sup>. Given that cycling is a common mode of transport in the Netherlands, 1600 m can be easily reached within 15 minutes.

#### *Demographics*

The baseline ENDORSE questionnaire provided information on gender and country of birth of the adolescents, their mothers and fathers and from these variables an ethnic background variable (Western or Non-western) was constructed according to the standards of Statistics Netherlands<sup>31</sup>.

In the Netherlands, secondary education is provided at different levels, ranging from lower vocational to senior general secondary education schools preparing for universities. School level was categorised into higher general secondary education (i.e. preparatory education for university) and vocational education.

### **Analyses**

Descriptive statistics were used to describe the study population. Clustering of behaviour in neighbourhoods was tested in MLwiN 2.02 by calculating the intracluster coefficient (ICC) of the null-model of sports participation (i.e. only the intercept was in the model) and by testing significance of variation. No significant clustering in neighbourhoods was observed (ICC: 0.06, neighbourhood level variance 0.30, 95%CI: -0.36-0.81). Therefore, it



was decided to conduct all analyses in SPSS 15.0 without adjustments for clustering at the neighbourhood level.

Bivariate Spearman correlations were calculated to analyze univariate associations between the cognitive, environmental and behavioural variables. Subsequently, multiple logistic regression analyses were conducted to test associations between TPB variables and availability of sports facilities at baseline with sports participation at follow-up. All analyses were adjusted for gender, age, school level, ethnicity and sports participation at baseline. Variables were entered stepwise: in the first step demographics and sports participation at baseline, in the second step availability of sports facilities, in the third step attitude, subjective norm and perceived behavioural control, in the fourth step intention, and in the last step the intention\*availability of sports facilities interaction term. If the interaction term proved to be significant ( $p < 0.10$ ), simple slope analyses were conducted to visualize the moderation effect by using a SPSS script developed by Hayes et al.<sup>32</sup> Due to severe skewness and therewith problematic interpretation of the simple slopes analyses, intention was dichotomized based on median split. The dichotomized intention variable was used in all analyses.

For all association – except for the interaction terms, a result was considered significant if the p-value was lower than 0.05 for a two-sided test.

## RESULTS

### Participants and drop-out

Adolescents eligible for the analyses at baseline ( $N=488$ ) were significantly more likely to be girls and of non-Western origin than those not eligible at baseline for analyses ( $N=211$ ). Follow-up data was available for 288 of the adolescents included for analysis (59%). The other 41% could not be traced, because they had left school, declined to participate or were absent during the week that follow-up measurements took place. Adolescents with follow-up data were significantly more likely to participate in sports at baseline (72% vs 62%;  $p < 0.01$ ) and were on average 0.14 years younger than those without follow-up data. Of the adolescents with follow-up data, 41 (14%) did not have complete data on the variables of interest. The sample available for analyses thus consisted of 247 adolescents.

### Descriptive statistics

The average age of the final sample at baseline was 13.2 (SD: 0.6) years and at follow-up 15.2 (SD: 0.6) years; 57.6% of the adolescent sample had a non-western ethnicity and

**Table 5.1.** Means, standard deviations and bivariate Spearman correlations of Theory of Planned Behaviour availability of sports facilities at baseline and sports participation at 2 year follow-up (N=247)

Study variables	Mean (SD)	1	2	3	4	5	6
1. availability of sports facilities	14.9 (8.1)	-					
2. attitude	4.4 (0.6)	0.24 **	-				
3. PBC – control	4.3 (0.8)	0.18 **	0.24 **	-			
4. PBC – capability	4.5 (0.7)	0.08	0.43 **	0.24 **	-		
5. Subjective Norm	4.6 (0.6)	0.08	0.27 **	0.08	0.13	-	
6. Intention (%high)	68%	0.07	0.55 **	0.04	0.36 **	0.23 **	-
7. Sports participation at follow-up (%)	48%	0.05	0.36 **	0.05	0.12	0.17 **	0.32 **

Small effect size:  $r > 0.10$ ; medium effect size:  $0.30 < r < 0.50$ ; large effect size  $r = > 0.50$ .

\*\*  $p < 0.01$ , SD=standard deviation, PBC=perceived behavioural control

47.9% were male. A majority of adolescents reported to participate in sports at baseline (74.1%). At follow-up, however, sports participation had declined to 47.9%. On average, adolescents in the final sample had 14.9 (SD: 8.1) sports facilities available within a radius of 1600 m (Table 5.1). At baseline, adolescents reported on average a positive attitude (mean: 4.4; SD: 0.6; range: 2.5-5), subjective norm (mean: 4.6; SD: 0.6; range: 3-5), control dimension of perceived behavioural control (mean: 4.3; SD: 0.8; range: 1-5), the capability dimension of perceived behavioural control (mean: 4.5; SD: 0.7; range: 2-5) and intention (68% in high-category) towards sports and PA (Table 5.1).

### Univariate analyses

Bivariate correlations showed positive associations between availability of sports facilities and attitudes towards sports and the control dimension of perceived behavioural control, but not with behaviour at follow-up. Positive correlations were also found between attitude, subjective norm, the capability and control dimension of perceived behavioural control and intention to participate in sports (Table 5.1). Intention at baseline was positively correlated with sports participation at follow-up. Most effect sizes were small or medium<sup>33</sup>.

### Multivariate analyses of intention and availability of sports facilities with sports participation

The results of the multivariate logistic regression analyses are shown in Table 5.2. The number of sports facilities available at baseline was not associated with participation in sports at follow-up, after adjustment for demographics and sports participation at baseline. Of the TPB variables entered in step 3, attitude and subjective norm were significantly associated with sports participation. Attitude remained significant in the subsequent and final model. Subjective norm was also significantly associated with

**Table 5.2.** Hierarchical multivariate logistic regression of Theory of Planned Behaviour and availability of sports facilities at baseline and the intention x availability interaction term on sports participation at follow-up

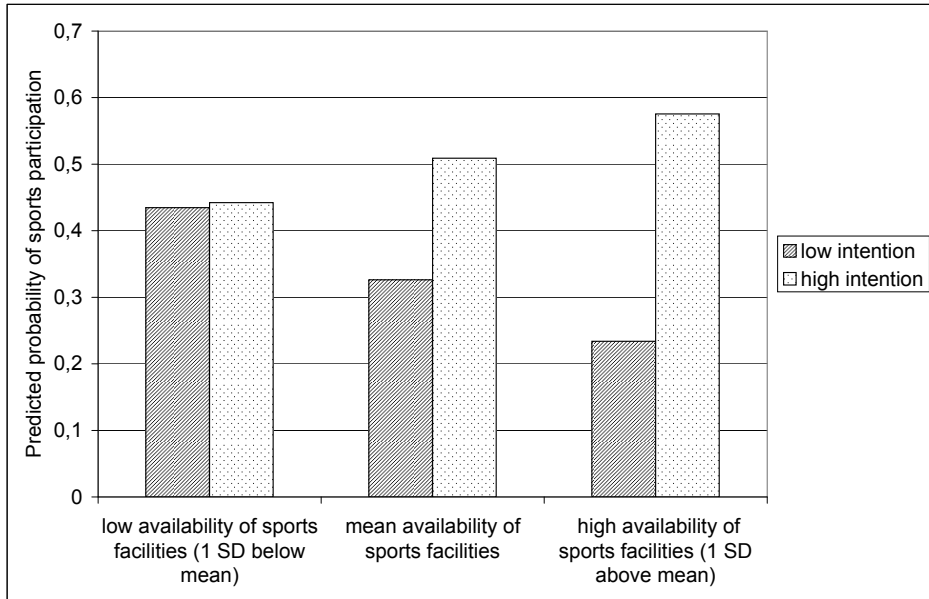
	<b>Step 1</b> OR (95% CI)	<b>Step 2</b> OR (95% CI)	<b>Step 3</b> OR (95% CI)	<b>Step 4</b> OR (95% CI)	<b>Step 5</b> OR (95% CI)
<i>N</i> =247					
Education <sup>a</sup>	0.63 (0.34;1.17)	0.66 (0.35;1.22)	0.67 (0.35;1.29)	0.72 (0.37;1.41)	0.66 (0.34;1.31)
Gender <sup>b</sup>	<b>0.28</b> (0.16;0.50)	<b>0.29</b> (0.16;0.51)	<b>0.26</b> (0.14;0.48)	<b>0.24</b> (0.13;0.46)	<b>0.24</b> (0.13;0.45)
Ethnicity <sup>c</sup>	<b>0.50</b> (0.27;0.90)	<b>0.46</b> (0.25;0.84)	<b>0.48</b> (0.26;0.92)	<b>0.52</b> (0.26;0.99)	<b>0.51</b> (0.26;0.98)
Age	1.09 (0.67;1.78)	1.05 (0.64;1.73)	0.92 (0.55;1.53)	0.93 (0.56;1.57)	0.97 (0.57;1.65)
Sports participation at baseline <sup>d</sup>	<b>4.78</b> (2.30;9.91)	<b>5.01</b> (2.39;10.5)	<b>3.77</b> (1.71;8.33)	<b>3.68</b> (1.66;8.18)	<b>3.80</b> (1.68;8.59)
Availability of sports facilities		1.03 (0.99;1.06)	1.01 (0.97;1.05)	1.01 (0.97;1.05)	0.95 (0.88;1.02)
Attitude			<b>2.89</b> (1.51;5.53)	<b>2.20</b> (1.08;4.45)	<b>2.36</b> (1.15;4.88)
PBC – control			0.87 (0.54;1.42)	0.90 (0.55;1.47)	0.87 (0.53;1.42)
PBC – capability			0.97 (0.61;1.54)	0.90 (0.56;1.44)	0.93 (0.58;1.50)
Subjective Norm			<b>1.90</b> (1.06;3.41)	1.77 (0.97;3.19)	<b>1.86</b> (1.02;3.40)
Intention <sup>e</sup>				2.18 (0.97;4.90)	0.56 (0.12;2.60)
Intention x Availability					<b>1.10</b> (1.00;1.20)
<b>Nagelkerke R-square</b>	0.30	0.30	0.39	0.41	0.42

<sup>a</sup> reference is high education, <sup>b</sup> reference is male, <sup>c</sup> reference is western background, <sup>d</sup> sports participation at baseline or not (1/0), <sup>e</sup> dichotomized measure (0=low, 1=high). PBC=perceived behavioural control. Bold figures represent significant values.

sports participation at follow-up in the final model. Intention at baseline, entered in step 4, was not significantly associated with sports participation at follow-up. The availability\*intention interaction term was significantly associated with sports participation at follow-up, indicating moderation of availability on the intention-sports participation relation.

### Moderation of the availability of sports facilities on the intention-behaviour relation

Simple slope analyses were conducted to interpret the availability\*intention interaction effect (Figure 5.1). In this figure the predicted probability of participating in sports is



**Figure 5.1.** Visual presentation of interaction of intention at baseline with availability of sports facilities within 1600 m at baseline on sports participation at follow-up. (SD = standard deviation.)

plotted for two levels of intention (low and high) for three levels of availability (low availability, 1 SD below mean; mean availability; high availability, 1 SD above mean). Figure 5.1 shows that the intention–sports participation relationship is stronger with increasing availability of sports facilities.

## DISCUSSION

This study aimed to identify individual and environmental predictors of adolescent sports participation and to examine whether availability of sports facilities moderated the intention–behaviour relation. In summary, we found that attitude and subjective norm were associated with sports participation at follow-up. Intention was associated with sports participation in the univariate analyses, but not in the multivariate models. Availability of sports facilities was not associated with sports participation. However, the availability of sports facilities significantly moderated the intention–sports participation association, with the intention–behaviour relationship being stronger when there were more facilities available. The study also confirmed results of earlier studies<sup>9-10</sup>, showing large declines in sports participation during adolescence.

This study is amongst the first to examine aspects of the physical environment as a moderator of the intention-behaviour relationship for PA among adolescents. Further strengths of the study include its longitudinal design and the objective assessment of sport facilities availability. In line with our hypothesis, we found that the availability of sport facilities moderates the intention-sports participation relation in such a way that a higher availability of sports facilities contributes to a stronger intention-behaviour relationship. Similar results were found by Rhodes et al.<sup>23</sup> for neighbourhood recreation facilities and walking among adults. Our findings support the proposition that the environment is a relevant prerequisite for being physically active, but is not sufficient to promote PA levels<sup>34</sup>. When sufficient facilities are available, intention to be more active appear to be of additional importance. Availability of sports facilities may facilitate sports participation for those with a positive intention, which is in line with the assumptions in Fishbein's model<sup>16</sup> in which it is postulated that the environment may provide the opportunity to act on positive intentions. Thus, lack of appropriate availability of sports facilities may be one of the reasons for the intention-behaviour gap. The inconsistent findings in the literature<sup>17-18</sup> on the relationship between intentions and sports participations can potentially be explained by the present findings.

In contrast to what we had hypothesized, we did not observe a significant direct association of sports facilities at baseline on sports participation at follow-up. Even though such relationships are assumed in ecological models such as the EnRG framework<sup>14</sup>, so far empirical evidence does not show consistent results. Some studies have shown associations between objectively measured availability and PA behaviour among adolescents<sup>35-37</sup>, while others have not<sup>20;38</sup>. Most of these studies had a cross-sectional design. Reasons for inconsistent findings may be methodological issues in the measurement of environmental influences, such as the buffer sizes used to objectively capture the environment.

Additionally, it is noteworthy that we did find direct associations between attitude, subjective norm and sports participation that were not specifically hypothesized. The direct attitude-behaviour relationship has also been shown for other health-related behaviours<sup>39</sup>, and could potentially be explained by the MODE (Motivation and Opportunity as DEterminants) model<sup>40</sup>, which suggests that when attitudes are strong (i.e., easily accessible from memory), people may automatically act on them. The direct effect of the subjective norm may be explained by its measurement as parental norm. Whereas norms are normally operationalised as the expectations of others, the influence of parents may go beyond that of a motivational drive and may reflect actual support. Hence, within adolescence the role of parents is likely to be important, both indirectly as a motivator and directly as a facilitator of various health-related behaviours.

There are limitations that have to be taken into account in interpreting the results. Firstly, the time span between baseline and follow-up measurements was 2 years, which may be too long to find a strong association between determinants and behaviour, especially since the intention item was framed as intention to do PA or sports within 6 months. Secondly, the TPB constructs are measured with a limited number of items which might question the validity of the operationalization. However, the inter-item correlations and relationship of TPB variables with intention (data not shown) and behaviour are comparable to other studies <sup>41</sup>. Third, adolescents who did not participate in sports at baseline were less likely to be included in the study, since they were more likely to have no follow-up data. Furthermore, this study was conducted among a sample of urban Dutch adolescents. Care should be taken in generalizing these results to other populations. A final limitation is that PA was self-reported. Although the instrument was reliable, reporting of PA behaviour may not have been completely accurate.

In conclusion, this study indicates that objectively measured availability of sports facilities moderates the longitudinal association between intention and sports participation among adolescents. If confirmed in further research, the implication may be that motivating adolescents to engage in sports is indeed more useful when sufficient opportunities are present.

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# Chapter 6

## **Are Neighbourhood Social Capital and availability of sports facilities related to sports participation among Dutch adolescents?**

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*Submitted*



## ABSTRACT

**Background:** The aim of this study is to explore whether availability of sports facilities, parks, and neighbourhood social capital (NSC) and their interaction are associated with leisure time sports participation among Dutch adolescents.

**Methods:** Cross-sectional analysis of complete data from the last wave of the YouRAction evaluation trial. Adolescents ( $n=852$ ) completed a questionnaire asking for sports participation, perceived NSC and demographics. Ecometric methods were used to aggregate perceived NSC to zip code level. Availability of sports facilities and parks was assessed by means of geographic information systems within the zip-code area and within a 1600 meter buffer. Multilevel logistic regression analyses, with neighborhood and individual as levels, were conducted to examine associations between physical and social environmental factors and leisure time sports participation. Simple slopes analysis was conducted to decompose interaction effects.

**Results:** NSC was significantly associated with sports participation (OR: 3.51 (95%CI: 1.18;10.41)) after adjustment for potential confounders. Availability of sports facilities and availability of parks were not associated with sports participation. A significant interaction between NSC and density of parks within the neighbourhood area (OR: 1.22 (90%CI: 1.01;1.34)) was found. Decomposition of the interaction term showed that adolescents were most likely to engage in leisure time sports when both availability of parks and NSC were highest.

**Conclusions:** The results of this study indicate that leisure time sports participation is associated with levels of NSC; but not with availability of parks or sports facilities. In addition NSC and availability of parks in the zipcode area interacted in such a way that leisure time sports participation is most likely among adolescents living in zipcode areas with higher levels of NSC, and higher availability of parks. Hence, availability of parks appears only to be important for leisure time sports participation when NSC is high.

## INTRODUCTION

Sports participation among adolescents is a public health priority<sup>1-2</sup> and increases the likelihood of being physically active in adulthood<sup>3</sup>. Despite the fact that levels of sports participation are relatively high among Western adolescents, a steep decrease during adolescence has repeatedly been reported<sup>4-8</sup>. For example, in the Netherlands it was found that 74% of the adolescents engaged in sports in the first year of secondary education, but this dropped to 48% two years later<sup>4</sup>. In order to promote sport participation, deeper understanding of the factors that are associated with sports participation among adolescents is needed. In this respect, environmental factors, such as the availability of sports facilities or living in a supportive social environment, are of particular interest, as environmental factors may have an influence on the behaviour of large groups of people. Recently, there has been a call for studies to simultaneously study the social and the physical environment, in order to find their independent relation and potential synergy in facilitating physical activity (PA)<sup>9-10</sup>. That is what the present study aims for.

For this purpose, the concept of *behaviour setting*, defined as “those social and physical situations in which behaviours take place, by promoting and sometimes demanding certain actions and by discouraging or prohibiting others”<sup>11</sup>, is important. This implies that both social and physical environmental factors may influence PA, as also conceptualized in socio-ecological models<sup>12-13</sup>. For example, the EnRG framework postulates that both, the physical and social environment may influence PA behaviour<sup>12</sup>. In addition, a model suggested by Franzini et al. elaborates more on the interplay between social and physical environmental factors and suggests that the social environment can moderate the relation between factors in the physical environment and outdoor PA<sup>13</sup>. In this view it is very well possible that, when facilities to be active are available, they will be used more often if the social environment is supportive instead of unsupportive.

Thus far, most empirical studies have focused on physical environmental factors, but studies have not yet been able to nail down which physical environmental factors are directly associated with PA. Some studies have found positive associations between the objectively assessed availability of facilities to be active and PA behaviour<sup>14-16</sup>, whilst others did not find this association<sup>4, 17-18</sup>. It may be that the physical environment facilitates behaviour to a certain extent, but is not sufficient to motivate or enable most people sufficiently to actually engage in PA<sup>19</sup>. Various scholars have proposed to include other environmental factors and study their interaction in relation to PA<sup>20-21</sup>.

Social capital is a social environmental factor that may have an influence on sports participation. The origin of social capital states that “social networks have value”<sup>22</sup> and

that social capital is a resource that “inheres in the structure of relations between actors and among actors.”<sup>23</sup> In the present study, social capital is defined as the resources (e.g. norms, trust) that are available to all members of a community (in our case a neighbourhood)<sup>24</sup>. Crucial to social capital on the community level is having common norms, behavioural reciprocity and mutual trust<sup>22</sup>. Neighbourhood social capital (NSC) is thought to affect health related outcomes via maintenance of healthy norms and access to social support<sup>25-26</sup>. Moreover, neighbours live close to each other, and therefore, it is likely that neighbours observe and learn from each other’s behaviour<sup>27-28</sup>, especially if the individuals involved are strongly socially connected. Indeed, various studies confirmed that higher levels of *perceived* social capital (i.e. individual level) were associated with higher levels of PA among children<sup>29</sup> and adolescents<sup>9-10</sup>, even after being adjusted for physical environmental factors<sup>9;30</sup>.

Despite the fact that social and physical environmental factors may determine sports participation in adolescents, they have thus far hardly been studied simultaneously. In the interaction between NSC and the physical environment, two mechanisms seem plausible. Firstly, it has been proposed that a supportive social environment may help to overcome an unsupportive physical environment<sup>13</sup>. Hence, individuals may decide to be physically active even when some physical environmental variables are not favourable. Secondly, social capital may “add value” to the physical environment. For instance, when more people are physically active in their neighbourhood, parks and sport facilities may be more attractive places to go to. As formal amenities such as sports facilities may require memberships and informal amenities such as park do not require this, it is likely that the proposed interactions are stronger for regarding informal amenities. There are only few studies that have examined these interaction mechanisms; Broyles et al.<sup>31</sup> have found that parks with higher levels of social capital are visited more often and the total volume of energy expenditure was also significantly higher in those parks<sup>31</sup>. Seaman and co-workers concluded that in order to promote access to green space in urban communities there is an interaction between physical availability of green space and urban community contexts<sup>32</sup>.

The present study aims to explore the direct and adjusted associations of NSC (social environment), availability of sports facilities and parks (physical environment) with leisure time (LT) sports participation. In addition moderation of NSC on the physical environment- LT sports participation association will be explored.

We hypothesize that 1) NSC is positively and significantly associated with LT sports participation, 2) the availability of sports facilities and parks are positively and significantly associated with LT sports participation, 3) NSC and availability of sports facilities and

parks interact in such a way that NSC is stronger related with LT sports participation when availability of parks and sports facilities are higher and that this effect will be more pronounced in freely available facilities such as parks.

## **METHODS**

### **Study design**

The data used in this study are derived from the final post measurement of the YouRAction study (2009-2010, Rotterdam and surroundings, the Netherlands), because information on NSC was only collected in this measurement. YouRAction was a three-armed cluster randomized trial in which two versions of a computer-tailored PA promotion intervention were evaluated against a generic information control group. In the first arm, adolescents (12-13 years) received generic information about PA and diet. In the second and third arm of the trial adolescents received a computer-tailored advice to promote their PA levels. The interventions are extensively described elsewhere<sup>33</sup>. In the trial, measurements were conducted at baseline, one month and six months post intervention (last measurement). School classes were randomly assigned to one of the study arms using block randomization. The evaluation study showed that the interventions were not effective in promoting moderate-to-vigorous PA among adolescents [see: Chapter 8] and additional analyses showed that there was no effect on changes in sports participation between baseline and final post intervention measurement.

The Medical Ethics committee of the Erasmus Medical Center issued a “declaration of no objection” for the YouRAction study.

### **Sampling and procedure**

Schools were contacted to inform whether they were willing to participate in the trial. Classes which received general secondary education were eligible for inclusion in the study. Adolescents received information and passive consent forms for themselves and their parents (i.e. if adolescents and/or parents rejected to participate, they were removed from trial).

Of the 1240 adolescents invited for YouRAction, in total 27 (2.2 %) adolescents or their parents declined study participation. In the final follow-up measurement, in total 1129 adolescents participated. Self-administered data was collected in classrooms, in the presence of a research assistant and a teacher.

Adolescents with complete data on the variables of interest and living in neighbourhoods in which at least 5 respondents lived were eligible for analyses. In total 852 adolescents met these criteria. Higher educated adolescents were more likely to be in the final sample.

## Measures

### *LT sports participation*

Sport participation was assessed using the sports participation questions from an adapted version of the Activity QUEStionnaire for Adolescents & Adults (AQUAA)<sup>34</sup>. The AQUAA showed moderate test-retest reproducibility, with an intra-class correlation of 0.59 for vigorous activities<sup>34</sup>.

Adolescents could write down a maximum of 3 sports in which they had participated during the previous week, and indicate on how many days of the week (0-7 days) they had participated in each sport. Moreover, they could indicate the context in which this took place: school, neighbourhood, sports club and at home.

If sports only took place at school, the sports frequency for that particular sport was set to 0 (i.e. not participating in sports), because this does not add to LT sports participation. A dichotomized variable was created to indicate whether an adolescent participated in LT sports at least once a week (1) or not (0).

### *Neighbourhood Social Capital*

Adolescents filled in two items in the questionnaire on social capital: 1) "the people in my neighbourhood get along with each other well", and 2) "I live in a close-knit neighbourhood with a lot of solidarity". Response categories ranged from 'totally disagree' (1) to 'totally agree' (5) (Cronbach's Alpha: 0.87). A measure for NSC was constructed by aggregating the individual responses from the questionnaire to the neighbourhood (defined as 4 digit zip code) level. On average 15.2 adolescents per neighbourhood answered the two NSC questions.

An econometrics approach was used for creating the aggregated measure of social capital (for extensive information see<sup>35-37</sup>). In this approach, the two items measuring social capital were the dependent variables (i.e. a long dataset was created and a dummy variable indicates the item number). A linear three-level multilevel model (neighbourhoods, individuals, items), that accounts for the nesting of social capital items within individuals and neighbourhoods, was used. The model was adjusted for six individual characteristics that may influence the perception of NSC: gender, ethnicity, age, education, type



of housing the adolescent lives in and years living in the current home. The residuals from this analysis (i.e. the part that cannot be attributed to individual response patterns) constitutes the NSC variable. Positive values indicate higher than average levels of NSC. The reliability of the econometric scales depends on the variance at the three levels, i.e., items nested within respondents, and respondents nested within neighbourhoods<sup>38</sup>. In our sample we found a reliability of the NSC variable (based on Hox, 2002<sup>38</sup>) which was acceptable at 0.57 (see appendix A for more details on calculation). The construction of the NSC variable was done in MLwiN 2.02.

#### *Availability of sports facilities and parks*

Geographic information system (GIS) data on the availability of sports facilities and parks were retrieved from municipal databases. Addresses of adolescents' homes were geocoded by using the centroid of the six-digit zip codes of their home address.

Two measures of availability of sports facilities and parks were constructed. Directly matching with the scale used for NSC, a variable indicating the density (i.e. the number of facilities per square kilometer) of sports facilities and parks within each neighbourhood (i.e. 4 digit zip code area) was constructed. In addition, using open source Quantum GIS software, crow-fly buffers were used to count the number of sports facilities and parks within 1600 meters from the participants' home addresses. The chosen spatial scale is in line with previous research<sup>4</sup> and based on a study by Colabianchi et al.<sup>39</sup>. This latter method of measuring the physical environment is more common in the study of physical environmental influences on PA than measuring the availability of facilities within the neighbourhood.

#### *Covariates*

Ethnicity was based on questionnaire information on country of birth of the adolescent and their parents, according to the standard definition of Statistics Netherlands<sup>40</sup>. An adolescent was considered to be of Western descent if he or she and both parents were born in the Netherlands, another European country, Oceania, North America, Indonesia or Japan. If the adolescent or one of the parents was born in another country, he/she was considered to be of non-Western descent.

Adolescents could indicate which level of education they attended in the questionnaire, which was categorized into higher level education (preparatory education for university) and lower level education (vocational education).

Adjustment for neighbourhood wealth is useful to mitigate area-level confounding<sup>41</sup>. Therefore neighbourhood wealth was considered to be a potential area-level con-

founder. Neighbourhood wealth was retrieved from the WoON '09 database which is managed by the Dutch ministry of the Interior and Kingdom Relations. In this database 40.000 households are sampled and incomes per 4-digit zip code were averaged to create an overall variable of neighbourhood wealth. In addition, urbanity was considered to be an area-level confounder. Information about urbanity, measured on a zip code level was retrieved from Statistics Netherlands. The urbanity index ranges from 1 to 5, with 1 being the most rural areas and 5 being the most urban areas.

## Analyses

Descriptive statistics were used to describe the study population. Univariate two-level random intercept multilevel logistic regression (with neighbourhood and individual as levels) analyses were conducted to assess associations of demographics, NSC, availability and density of parks and sports facilities, with LT sports participation.

In order to study the association of NSC and availability/density of parks and sports facilities with LT sports participation, multiple multilevel logistic regression analyses were conducted with neighbourhood and individual as levels. In an empty model (i.e. model 0) we found that LT sports participation clusters within neighbourhoods (Median Odds Ratio: 1.69, 95%CI: 1.42;2.20). In model 1, covariates, the intervention group (to adjust for potential intervention effect) and NSC were regressed on LT sports participation. In model 2, density of sports facilities and confounders were added to the empty model. The relative influence of NSC and density of sports facilities was tested by adding NSC to model 2 (model 3). In the final model (model 4), the NSC\*density of sports facilities interaction term was added. The same approach was used with availability of sports facilities measured within 1600 meters and to study the influence of park density and availability on explaining LT sports participation. A significance level of  $p < 0.10$  was applied for the interaction terms. If the interaction term between the NSC and physical environment is statistically significant, simple slope analyses were conducted to decompose the interaction effect. In order to prevent multi-collinearity in the interaction model, the availability/density of sports facilities and parks were mean centered. The NSC measure is per definition mean centered.

For all associations (except for the interaction term) a result was considered statistically significant if the p-value was lower than 0.05 for a two-sided test. All analyses were conducted in STATA 11.0.

**Table 6.1.** Descriptives and univariate associations of demographics and environmental correlates with LT sports participation

Factor	Mean (SD)/%	Univariate association with LT sports participation (OR, 95% CI)
N=852		
Age	13.25 (0.45)	1.06 (0.77;1.46)
Gender (% girls)	46.2%	<b>0.64</b> (0.48;0.86)
Education (%high)	42.4%	1.33 (0.98;1.81)
Ethnic background (%non-Western)	19.6%	0.90 (0.62;1.30)
Number of sports facilities within 1600 m	4.00 (3.63)	0.98 (0.93;1.03)
Density of sports facilities within	1.45 (7.82)	0.98 (0.96;1.01)
Number of parks within 1600 m	1.77 (1.26)	1.13 (0.97;1.32)
Density of parks within neighbourhood	0.98 (1.26)	1.01 (0.98;1.05)
NSC	0.00 (5.72)	<b>3.69</b> (1.19;11.45)
% participating in LT sports	54.7%	N/A

LT=leisure time; SD= standard deviation; OR=odds ratio; CI=confidence interval; NSC=neighbourhood social capital; N/A = not applicable. Bold values represent statistically significant values ( $p<0.05$ )

## RESULTS

### Descriptives and univariate associations

The sample comprised of 852 adolescents (mean age: 13.2 (SD: 0.5) years, 46.2% girls , 42.4% attaining higher levels of education and 80.4% were of Western ethnic background) (Table 6.1). In total 54.7% participated in LT sports. On average, there were 4.0 (SD: 3.6) sports facilities within a radius of 1600 meters and 1.8 (SD: 1.3) parks. Univariate analyses indicated that availability of parks and of sports facilities were not associated with LT sports participation (Table 6.1). NSC was positively associated with LT sports participation (OR: 3.7; 95%CI: 1.2-11.5) (Table 6.1).

### NSC, availability of sports facilities and LT sports participation

Model 1 in Tables 6.2 and 6.3 show that NSC was positively associated with LT sports participation (OR: 3.5; 95%CI: 1.2-10.4), after being adjusted for confounder. No association was found for density of sports facilities in the neighbourhood (Table 6.2 / Model 2) and availability within 1600 meter buffers (Table 6.3 / Model 2) with LT sports participation.

In the third model, which also includes density/availability of sports facilities, NSC remained significantly associated with LT sports participation for both density in the neighbourhood (OR: 3.4; 95%CI 1.1-9.9) and availability in a 1600 meter buffer size (OR:3.2; 95%CI: 1.1-9.5), while density or availability of sports facilities was not significantly associated (Tables 6.2 and 6.3). In the final model, the interaction terms, NSC\*availability/

**Table 6.2.** Associations of neighbourhood social capital and density of sports facilities in the neighbourhood with LT sports participation (OR, 95% confidence intervals)

N=852	<b>Model 1</b>	<b>Model 2</b>	<b>Model 3</b>	<b>Model 4</b>
<i>Environmental factors</i>	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
NSC	<b>3.51</b> (1.18;10.41)		<b>3.37</b> (1.14;9.92)	<b>3.28</b> (1.10;9.75)
Density of sports facilities in neighbourhood		0.99 (0.96;1.01)	0.99 (0.97;1.01)	0.99 (0.96;1.01)
<i>Interaction term</i>				
NSC * Density of sports facilities				1.08 (0.96;1.22)
<i>Variation of clustering</i>				
Area level variance	0.19 (0.06;0.59)	0.24 (0.09;0.63)	0.18 (0.06;0.58)	0.17 (0.05;0.57)
PCV	0.36	0.21	0.41	0.42
Median Odds Ratio	1.52 (1.27;2.08)	1.59 (1.33;2.14)	1.50 (1.25;2.07)	1.49 (1.25;2.06)

All models are adjusted for intervention group, education, ethnicity, neighbourhood wealth and urbanity. NSC=Neighbourhood Social Capital, OR=odds ratio, CI=confidence interval, PCV = Proportional change in variance relative to null-model. Bold values represent statistically significant associations ( $P<0.05$ ); italic values show significant interaction terms ( $P<0.10$ ).

density of sports facilities, were not significantly association with LT sports participation (Tables 6.2 and 6.3).

**Table 6.3** Associations of neighbourhood social capital and availability of sports facilities within 1600 meter Euclidian buffers with LT sports participation (OR, 95% confidence intervals)

N=852	<b>Model 1</b>	<b>Model 2</b>	<b>Model 3</b>	<b>Model 4</b>
<i>Environmental factors</i>	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
NSC	<b>3.51</b> (1.18;10.41)		<b>3.16</b> (1.05;9.53)	2.86(0.92;8.90)
Availability of sports facilities within 1600 m buffers		0.97 (0.91;1.02)	0.98 (0.93;1.03)	0.99 (0.93;1.05)
<i>Interaction term</i>				
NSC * Availability of sports facilities within 1600 m buffers				1.10 (0.87;1.37)
<i>Variation of clustering</i>				
Area level variance	0.19 (0.06;0.59)	0.23 (0.09;0.62)	0.18 (0.06;0.58)	0.18 (0.06;0.57)
PCV	0.36	0.23	0.41	0.40
Median Odds Ratio	1.52 (1.27;2.08)	1.58 (1.33;2.12)	1.50 (1.25;2.07)	1.50 (1.26;2.06)

All models are adjusted for intervention group, education, ethnicity, neighbourhood wealth and urbanity. NSC=Neighbourhood Social Capital, OR=odds ratio, CI=confidence interval, PCV = Proportional change in variance relative to null-model. Bold values represent statistically significant associations ( $P<0.05$ ); italic values show significant interaction terms ( $P<0.10$ ).

**Table 6.4.** Associations of neighbourhood social capital and density of parks in the neighbourhood with LT sports participation (OR, 95% confidence intervals)

N=852	<b>Model 1</b>	<b>Model 2</b>	<b>Model 3</b>	<b>Model 4</b>
<i>Environmental factors</i>	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
NSC	<b>3.51</b> (1.18;10.41)		<b>3.52</b> (1.19;10.45)	<b>3.95</b> (1.34;11.59)
Density of parks in neighbourhood		1.02 (0.98;1.05)	1.02 (0.98;1.05)	1.00 (0.97;1.04)
<i>Interaction term</i>				
NSC * Density of parks				1.22 (0.99;1.50)
<i>Variation of clustering</i>				
Area level variance	0.19 (0.06;0.59)	0.25 (0.10;0.64)	0.19 (0.06;0.58)	0.16 (0.05;0.54)
PCV	0.36	0.16	0.37	0.47
Median Odds Ratio	1.52 (1.27;2.08)	1.62 (1.35;2.15)	1.52 (1.27;2.07)	1.47 (1.23;2.02)

All models are adjusted for intervention group, education, ethnicity, neighbourhood wealth and urbanity. NSC=Neighbourhood Social Capital, OR=odds ratio, CI=confidence interval, PCV = Proportional change in variance relative to null-model. Bold values represent statistically significant associations ( $P<0.05$ ); italic values show significant interaction terms ( $P<0.10$ ).

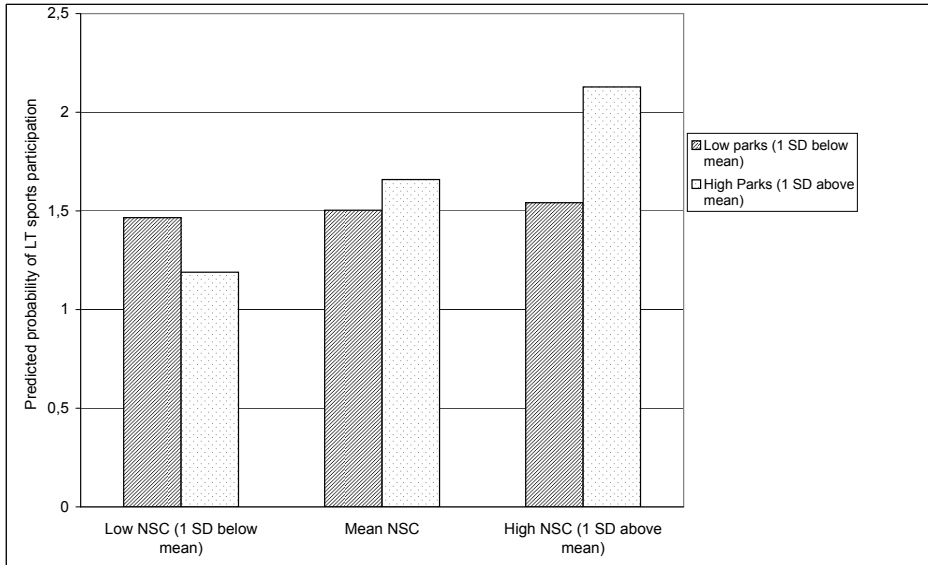
### NSC, availability of parks and LT sports participation

Density of parks in the neighbourhood (Table 6.4 / Model 2) and availability of parks within 1600 meter buffers (Table 6.5 / Model 2) were not statistically significantly associated with LT sports participation.

**Table 6.5.** Associations of neighbourhood social capital and availability of parks within 1600 meter Euclidian buffers with LT sports participation (OR, 95% confidence intervals)

N=852	<b>Model 1</b>	<b>Model 2</b>	<b>Model 3</b>	<b>Model 4</b>
<i>Environmental factors</i>	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
NSC	<b>3.51</b> (1.18;10.41)		<b>3.45</b> (1.16;10.29)	<b>3.18</b> (1.09;9.29)
Availability of parks in 1600 meter buffers		1.07 (0.88;1.29)	1.05 (0.88;1.26)	1.06 (0.88;1.26)
<i>Interaction term</i>				
NSC * Availability of parks in 1600 m buffers				1.64 (0.66;4.05)
<i>Variation of clustering</i>				
Area level variance	0.19 (0.06;0.59)	0.26 (0.10;0.65)	0.19 (0.06;0.59)	0.14 (0.04;0.54)
PCV	0.36	0.15	0.36	0.52
Median Odds Ratio	1.52 (1.27;2.08)	1.62 (1.35;2.15)	1.52 (1.27;2.08)	1.44 (1.21;2.02)

All models are adjusted for intervention group, education, ethnicity, neighbourhood wealth and urbanity. NSC=Neighbourhood Social Capital, OR=odds ratio, CI=confidence interval, PCV = Proportional change in variance relative to null-model. Bold values represent statistically significant associations ( $P<0.05$ ); italic values show significant interaction terms ( $P<0.10$ ).



**Figure 6.1.** Visual presentation interaction intention at density of parks \* neighbourhood social capital on LT sports participation. NSC=Neighbourhood social capital, SD = standard deviation.

When adjusted for density of parks in the neighbourhood (OR: 3.5; 95%CI: 1.2-10.5) or availability in a 1600 meter buffer size (OR: 3.5; 95%CI: 1.2-10.3), NSC was still statistically significant associated with LT sports participation (Tables 6.4 and 6.5).

In the final model, no statistically significant interactions were observed between NSC and availability of parks at 1600 meter buffer sizes in their association with LT sports participation (Table 6.4). However, density of parks within the neighbourhood did interact with NSC (OR: 1.2; 95%CI: 1.0-1.5, Table 6.4). Simple slope analyses show that when both availability of NSC and density of parks are highest, the probability of participating in LT sports was highest (Figure 6.1).

## DISCUSSION

In this study we found that NSC was significantly associated with LT sports participation, whereas the objectively observed availability and density of parks or sports facilities was not. When both NSC with availability/density of sports facilities or parks are put in one model, NSC remained associated with LT sports participation. Hence, in its direct association NSC seems to be of more importance than availability/density of facilities to be active. In addition we found that when NSC was high, availability of parks were stronger associated with LT sports participation, which was in line with our hypotheses.

NSC was consistently associated with LT sports participation. This finding fits with our hypotheses and various theoretical models<sup>12-13</sup> that NSC would be associated with PA and is similar to previous research<sup>9-10</sup> that have used a measure of perceived NSC (i.e. not aggregated to the neighbourhood level). The present study extends on this, as we used an aggregated measure of NSC. With regard to the physical environment, we did not find an association of availability and density of sports facilities or parks with LT sports participation in both conceptualizations of the neighbourhood. These results add to the current, equivocal, literature on the associations of the physical environment with adolescent PA<sup>42</sup>. It may be that these inconclusive findings are due to various conceptualizations of the neighbourhood. Therefore various authors have called upon reporting results in various environmental scales (i.e. buffer sizes)<sup>43-44</sup>. We have conceptualized the physical environment in two scales; one that is evidence based (1600 meter buffer size) and one that matches the NSC measure (neighbourhood level), but found no differences in associations between these two conceptualizations. However, it may also be that the physical environment in itself is not enough to promote PA, but may act more as a barrier or facilitator of PA behaviour<sup>19</sup>. This is what we examined in the current study.

We showed that density of parks at the neighbourhood level interacted with NSC in such a way that when density of parks was high, a stronger association with sports participation was found under higher levels of NSC. Thus, indeed, density of parks is important in promoting sports participation; if high levels of NSC are present. Our results that both the physical and social environment are of importance in promoting PA, are in line findings of a systematic review of qualitative studies by McCormack et al. They found that the presence of a park gives important opportunities to engage in PA, but other features of that park such as the social environment may promote park usage<sup>45</sup>. Seaman et al. also found in a qualitative study that for promoting park use not only the presence of a park, but also factors like social cohesion are of importance<sup>32</sup>. Finally Broyles et al, found that in parks with more "Park level social capital" the overall intensity of activities done in that park were higher<sup>31</sup>. However, it should be noted that the social capital on a park level is not equal to NSC as we have conceptualized it.

For promoting a healthy lifestyle (e.g. sports participation) on a population level, it is important to identify important and changeable determinants of that lifestyle<sup>46</sup>. We have identified NSC as a potentially important factor associated with LT sports participation, especially when density of parks is high. If our results can be replicated by others, NSC may be an important factor in relation to sports promotion. In addition, to be suitable to incorporate in interventions and policy to promote LT sports participation, it is also important to know how NSC can be promoted. Wood et al. found that various factors, such as availability of facilities like nearby shops, are positively associated with higher

levels of NSC<sup>47</sup>. This may give valuable target points for developing interventions and policies that aim to promote NSC. In addition, various studies suggest that PA can successfully be promoted by building NSC by cooperating closely with citizens in developing policies<sup>48-49</sup>.

Although the aim of this study was not to fully explain neighbourhood variance in LT sports participation, even in the most extended models there was unexplained neighbourhood variance. This indicates that other factors may be of interest that may explain neighbourhood variation in LT sports participation; for instance environmental factors such as presence of sidewalks and bicycle lanes (increasing opportunities to access parks or sports facilities), quality of these facilities, crime or aesthetics. Studies that are aimed at explaining neighbourhood differences in LT sports participation should thus, additionally, incorporate other factors than we did.

There is some criticism on the concept of social capital in that it is a fuzzy concept. According to Kawachi et al. this may have to do with two conceptualizations of social capital. On the one side there is a conceptualization that is more individual level social capital (e.g. networks) and on the other side social capital may be conceptualized as resources available to the community<sup>24</sup>. We used the latter definition and therefore aggregated data to the neighbourhood level. To aggregate individual data to a neighbourhood level, it is most common to calculate the average of the items measured at the individual level per neighbourhood<sup>50</sup>. However, this aggregation procedure has several drawbacks. First, variables measuring social capital are based on individual perception, and it is likely that this perception is influenced by the characteristics of the respondent (e.g. time living in a neighbourhood, cultural values). Second, since the number of respondents differs per neighbourhood, the reliability of the aggregated social capital variable also differs between the neighbourhoods. Finally, the items that measure social capital are not independent of each other but nested within respondents; that is, answers on one item are likely to be associated with answers on the other item. In summary, an approach that accounts for individual differences in response to certain items, for differences in numbers of respondents on which the estimation is based, and for dependency among the items that measure social capital is needed. The econometrics methodology is an approach that does this. And we have applied this in our study, which can be regarded as a major strength in this study.

Another strength of this study is that the behaviour (LT sports participation) studied is relevant for its context (the neighbourhood environment), because it is less likely that the home neighbourhood affects inside school sports participation than LT sports participation. In contrast to other studies, the neighbourhood perception of adolescents



instead of adults was used to estimate NSC, which is another strength of this study. However, as this is the first study to use adolescent perceptions of NSC, our results need to be replicated to draw more definitive conclusions. Our study has also some limitations. Firstly, the current study is the reliance on self-reported measures of PA. Objective measures, such as accelerometers, may give more valid data on minutes spend in PA. However, accelerometers do not measure important information on the type of activity (e.g. cycling, walking, sports), which is relevant to study the influence of environmental factors on behaviour, as different factors in the environment, such as availability of facilities are likely to be associated with different types of PA behaviour specific (e.g. sports facilities may be of importance for sports, but not for walking to school)<sup>51</sup>. Another limitation is the cross-sectional design and no conclusions on causality can be drawn. To draw conclusions on causal relationships future research, using longitudinal and experimental designs need to be carried out. Finally, the data was retrieved from the YouRAction trial, which aimed to promote MVPA among adolescents. However, the implementation of the study encountered major problems, which did not allow us to assess its effects. We have checked whether the interventions were associated with the outcome of interest in this study and seen that there was no effect of the interventions. In addition, we have adjusted for intervention group. In sum, it is not likely that the interventions have affected the results of this study.

To conclude, in this study we found evidence for NSC as a potentially important correlate of LT sports participation among adolescents. We did not find a direct association between availability of sports facilities or parks with LT sports participation among adolescents. When both NSC and availability of parks or sports facilities were entered in a model, NSC remained significant and thus seems to be a relatively more important correlate of LT sports participation. The interaction between density of parks in the neighbourhood and NSC showed that when NSC was high, presence of parks became stronger associated with LT sports participations. In sum, when both, the NSC and density of parks in the neighbourhood area are high, the predicted probability of LT sports participation is highest.

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# Chapter 7

**Systematic Development of the  
YouRAction program, a computer-  
tailored Physical Activity promotion  
intervention for Dutch adolescents,  
targeting personal motivations and  
environmental opportunities.**

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## ABSTRACT

**Background:** Increasing physical activity (PA) among adolescents is an important health promotion goal. PA has numerous positive health effects, but the majority of Dutch adolescents do not meet PA requirements. The present paper describes the systematic development of a theory-based computer-tailored intervention, YouRAction, which targets individual and environmental factors determining PA among adolescents.

**Design:** The intervention development was guided by the Intervention Mapping protocol, in order to define clear program objectives, theoretical methods and practical strategies, ensure systematic program planning and pilot-testing, and anticipate on implementation and evaluation. Two versions of YouRAction were developed: one that targets individual determinants and an extended version that also provides feedback on opportunities to be active in the neighbourhood. Key determinants that were targeted included: knowledge and awareness, attitudes, self-efficacy and subjective norms. The extended version also addressed perceived availability of neighbourhood PA facilities. Both versions aimed to increase levels of moderate-to-vigorous PA among adolescents. The intervention structure was based on self-regulation theory, comprising of five steps in the process of successful goal pursuit. Monitoring of PA behaviour and behavioural and normative feedback were used to increase awareness of PA behaviour; motivation was enhanced by targeting self-efficacy and attitudes, by means of various interactive strategies, such as web movies; the perceived environment was targeted by visualizing opportunities to be active in an interactive geographical map of the home environment; in the goal setting phase, the adolescents were guided in setting a goal and developing an action plan to achieve this goal; in the phase of active goal pursuit adolescents try to achieve their goal and in the evaluation phase the achievements are evaluated. Based on the results of the evaluation adolescents could revise their goal or choose another behaviour to focus on. The intervention is delivered in a classroom setting in three lessons. YouRAction will be evaluated in a cluster-randomized trial, with classes as unit of randomization. Evaluation will focus on PA outcomes, cognitive mediators/moderators and process measures.

**Discussion:** The planned development of YouRAction resulted in two computer-tailored interventions aimed at the promotion of PA in a Dutch secondary school setting.

Trial registration: NTR1923



## BACKGROUND

Sufficient physical activity (PA) contributes to the prevention of a range of conditions such as overweight and obesity, cardiovascular diseases, cancers, depression and low bone mineral density<sup>1-2</sup> and is associated with improved quality of life<sup>3-4</sup>. However, physical activity levels are low in most Western countries, across all phases in the life course, including adolescence. The most recent Dutch PA recommendations are that adolescents should engage in moderate to vigorous PA (MVPA) for at least one hour per day to promote cardiovascular and general health, and to engage at least twice a week in vigorous PA to help enhance and maintain physical fitness, including flexibility, muscular strength and bone health<sup>5</sup>. In the Netherlands approximately one quarter of the adolescents comply with the MVPA norm<sup>6</sup>. These figures demonstrate that there is a need for physical activity promotion interventions for adolescents and that large numbers of adolescents need to be reached with such interventions. Since there are not many PA promotion interventions available that meet these requirements, we developed a new and innovative e-health promotion intervention.

A planned approach to intervention development is likely to increase the effectiveness of interventions<sup>7</sup>, given that it assures an optimal fit with the most important determinants of the targeted behaviour, inclusion of behaviour change strategies that fit with those determinants, and a delivery format that is appealing and suitable for the target population<sup>8</sup>. E-health promotion interventions using a web based delivery format may have specific advantages; (1) the format may be appealing for adolescents and (2) it can be used to tailor interventions to unique characteristics of a person<sup>9-10</sup>, which is likely to increase intervention attractiveness, personal relevance and effectiveness. Classically, most tailored interventions focused on cognitive individual determinants of health behaviours such as awareness, attitude and self-efficacy. Socio-ecological models, however, also suggest an influence of environmental factors, on behaviour, including factors in the physical environment<sup>11-12</sup>. To take these environmental factors into account we incorporated tailored feedback on the opportunities to be physically active in the neighbourhood in which the adolescent lives in the intervention; which is a novelty in the field of tailoring research.

To evaluate the additional effect of this environmental information, two versions of the computer-tailored intervention were developed. Both interventions are identical and provide personalised feedback on individual determinants and change processes. In addition, the extended version provides feedback on the availability of PA opportunities in the home environment.



in the development of interventions on promotion of a wide range of health behaviours/ health states, including the prevention of overweight and obesity in adults<sup>13</sup> and adolescents<sup>14-15</sup> and promotion of physical activity in adults<sup>16</sup>. Below the results of each step in IM, which formed the basis for the two versions of the intervention, are described.

### **Step 1. Needs assessment**

Carrying out a needs assessment is the first step in intervention development. In a needs assessment the discrepancy between the current situation and the desired situation in a given group of people is studied. Key points of the information generated in the needs assessment have already been described in the introduction section. To summarize, a sufficient level of MVPA is an important determinant for various diseases and health outcomes. MVPA may consist of activities such as brisk walking or cycling, leisure time physical activity (such as active ball games or dancing) or (organized) sports. However, a majority of the adolescents living in the Netherlands do not meet the Dutch MVPA guideline. Levels of MVPA in adolescents vary according to socio-economic status, gender and ethnicity, with in general lower levels of PA among lower educated groups<sup>17-18</sup>, girls<sup>17-20</sup> and ethnic minorities<sup>18;20</sup>.

Based on the results of the needs assessment, we decided that the aim of this intervention was to achieve that an additional 10% of the adolescents meet the PA guidelines for moderate intensity PA for at least 60 minutes per day, at 6 months after exposure to the intervention." We deliberately stated this goal in such general terms, because it can be reached by engaging in a range of different PA sub-behaviours such as active transport, leisure time physical activity or participation in (organized) sports, recognizing the complexity and diversity of PA behaviour.

### **Step 2. Matrices of performance and change objectives**

Once the overall health behavioural aim of the intervention was set, we defined what adolescents actually would need to do to achieve the overall intervention goal. Basically, adolescents need to comply with the MVPA guideline. Therefore, the intervention was developed to increase MVPA among adolescents in such a way, that adolescents engage in moderate intensity PA for 60 minutes per day on 7 days per week. This can be achieved by engaging in the previously defined PA sub-behaviours.

Behaviours, especially complex behaviours – such as MVPA - can mostly not be changed directly, but have to be broken down in smaller, specific actions to be taken, for instance "identifying sub-behaviour which can be improved" or "setting challenging goals". These more specific actions required in the process towards overall PA behaviour change are called, "performance objectives" in IM. Performance objectives were stated for the three

identified sub-behaviours, sports, active transport and leisure time physical activity. All performance objectives in our intervention were based on theories of self-regulation. Self-regulation has been defined as *“a goal-guidance process, occurring in iterative phases, that requires the self-reflective implementation of various change and maintenance mechanisms that are aimed at task- and time-specific outcomes.”*<sup>21</sup>. We distinguished five phases toward successful goal pursuit: 1) a monitoring phase, 2) a motivational phase, 3) a goal setting phase, 4) a phase of active goal pursuit and 5) an evaluation phase (Table 7.1). In each phase other actions (i.e. performance objectives (PO)) are expected from the adolescents (Table 7.1). For instance, in the monitoring phase adolescents monitor their current behaviour (PO1a, Table 7.1), in the motivational phase, adolescents decide to increase the selected PA activity (PO2c, Table 7.1), in the goal setting phase adolescents set a goal to increase the selected PA activity (PO3a, Table 7.1) and in the phase of active goal pursuit, adolescents engage in activities to achieve this goal (PO4a, Table 7.1). These proceedings are monitored in the last phase, in which adolescents evaluate their achievements in terms of goal attainment (PO5a, Table 7.1). Based on the outcome of the evaluation adolescents can decide to maintain their goal or, in case of failure to attain their goal, to choose new strategies to reach their goal or select a new goal (PO5b, Table 7.1). Finally, adolescents have to set a long-term goal and create a plan to achieve this (PO5c, Table 7.1). Because the performance objectives were based on self-regulation theory, they also serve as a general outline of the intervention. A complete list of performance objectives is displayed in Table 7.1.

Another main task in the phase of developing specific intervention objectives is that important and changeable determinants of the target behaviours and sub-behaviours are identified. These important and modifiable determinants of physical activity in ado-

**Table 7.1.** Performance objectives per “self-regulation” phase

<b>Self-regulation phase</b>	<b>Performance objectives</b>
Monitoring	Adolescents monitor current state of PA (PO1a) Adolescents identify sub-behaviours which can be improved (PO1b)
Motivational phase	Adolescents decide to increase PA (PO2a) Adolescents select a PA activity that fits with their personal preference (PO2b) Adolescents are decide to increase the PA activity of personal preference (PO2c)
Goal setting	Adolescents set challenging, but feasible PA goal (PO3a) Adolescents create an action plan to achieve PA goal (PO3b)
Action	Adolescents engage in activities to accomplish PA goal (PO4a)
Evaluation	Adolescents monitor their achievements (PO5a) Adolescents decide, based on their achievements, to proceed pursuing their goal or state a new goal (PO5b) Adolescents make a long-term planning (PO5c)

PO=performance objective, PA=physical activity

lescents were selected based on a review of the literature and identification of additional constructs from theories. For the identification of additional constructs we consulted theories that are predominantly used in the field of PA and other health related behaviours, including the Theory of Planned Behaviour (TPB)<sup>22</sup>, the Social Cognitive Theory (SCT)<sup>12</sup>, the EnRG Framework<sup>11</sup> and the Precaution Adaptation Process Model (PAPM)<sup>23</sup>. Attitude<sup>24-27</sup>, subjective norm<sup>24-26; 28</sup>, self-efficacy/perceived behavioural control<sup>24-26; 29-33</sup> and intention were identified as important determinants of PA behaviour among adolescents in the scientific literature. Derived from theory and studies among adolescents, we identified awareness of one's own behaviour as an important additional determinant for complex behaviours such as physical activity<sup>23</sup>.

In addition, one of the recent developments in the field physical activity is the interest in socio-ecological models to explain health behaviour. Some of these models propose an effect of the physical, socio-cultural, political and economic environment on PA directly or indirectly via cognitive variables<sup>11-12</sup>. Research to date indicates that there is often a mismatch between the objective and perceived environment<sup>19; 34</sup>. Frequently, people underestimate the existence of physical activity opportunities in their environment. Adolescents may not be aware of all the opportunities for PA in their home neighbourhood. Thus, we identified perceptions of the environment as another additional determinant to be addressed in the intervention.

As a final task in this step of IM, the selected determinants and performance objectives were integrated in matrices to define change objectives. Change objectives define what the participants need to learn or do, in order to achieve the performance objectives. For instance, in order to achieve the performance objective "Adolescents decide to increase sports participation", an important determinant is self-efficacy. One of the change objectives in terms of self-efficacy is "Adolescents identify difficult situations which may prevent them from participating in sports". In the intervention development process, the change objectives were used to select appropriate behaviour change methods and to produce the right content of the intervention. A selection of all the change objectives is shown in Table 7.2. For all three sub-behaviours, separate matrices of change objectives were created.

### Step 3. Methods and strategies in a general outline

In the next step of Intervention Mapping, appropriate methods, derived from literature, to modify the determinants were selected for each specific change objective. These theoretical methods were translated into practical strategies that can be delivered in the intervention, by taking their parameters for use (i.e., important criteria that need to be met for a strategy to be effective<sup>8</sup>) into account. In the description of the methods

**Table 7.2.** Matrix of change objectives: an example for selected determinants of the sub-behaviour sports

<b>Performance objective</b>	<b>Attitude</b>	<b>Subjective norm</b>	<b>Self-efficacy/ Perceived behavioural control</b>	<b>Awareness</b>	<b>Perceived environment</b>
Adolescents decide to increase sports participation (PO2A)	Adolescents feel sports is enjoyable  Adolescents see the health benefits of engaging in sports	Adolescents comply with the norm to engage in sports on a regular base	Adolescents identify difficult situations which may prevent them from participating in sports  Adolescents are confident that they can cope with barriers	Adolescents monitor their current sports behaviour  Adolescents compare their sports behaviour with the “fitness norm”  Adolescents compare their sports behaviour with peers	Adolescents know where facilities to engage in the sports they want to are in their neighbourhood

PO=performance objective

**Table 7.3.** Most used methods in YouRAction, their parameters for use and examples of strategies

<b>Determinant</b>	<b>Technique/ Method (theory)</b>	<b>Parameters for use</b>	<b>Strategy</b>
Perceived environment	Facilitation		Providing sports clubs on an interactive map, tailored around the adolescents’ home;
	Facilitation		Providing walking and cycling routes  Providing visual representation of walking and cycling possibilities in neighbourhood
	Active learning		Adding places to be active on maps
Knowledge	Provide information about behaviour-health link (PAPM)	Adding helpful information	Adolescents first fill in a practice quiz, which gives feedback. Subsequently they fill in a quiz which will be marked.

		Schematic representations of the content or guided to what is to be learned	Schematic on levels of PA, with colors
Attitude	Modeling	Reinforcement of the model	Web movie with models who decided to be active. Models smile and name the pro's they experienced of activity.
	Provide information on consequences (TPB, SCT)	Investigation of the current beliefs of the individual before choosing the belief on which to intervene	Feedback based on pros and cons of specific behaviour
Awareness	Provide information about behaviour-health link (PAPM)	Messages should be presented as individual, undeniable, on the same dimension, congruent with actual risk, and cumulative rather than for one occasion messages presented with qualitative and quantitative examples	Feedback based on PA questionnaire on overall PA and sub-behaviours. Feedback consists of individual and normative feedback in text and graphs.
Subjective norm	Building skills for resistance to social pressure (SCT)	Skill building for refusal skills; commitment to earlier intention; relating intended behaviour to values; psychological inoculation against pressure	Simulation of roleplays by making use of interactive webmovies.
Self-efficacy / PBC	Prompt barrier identification (SCT)	Choosing barriers which are important to adolescents	List of barriers in which adolescents can select barriers
	Model or demonstrate the behaviour (SCT) / Set graded tasks (SCT)	Subskill demonstration, instruction and enactment with feedback	Web movies and comics in which in steps a solution to a problem is presented.
	Relapse prevention (relapse prevention therapy)	Identification of high-risk situations and practice of coping response	Selection of barriers to be active in a predefined list. Followed by guided practice to cope with barrier and a homework assignment to practice this
Planning	Prompt specific goal setting (CT)	Commitment to the goal; goals that are difficult but achievable	Setting goals using a step-by-step application.
	Relapse prevention (relapse prevention therapy)	Identification of high-risk situations and practice of coping response	Selection of barriers. Followed by form to fill in strategy to overcome barrier.
	Prompt practice (OC)	Encourage adolescents to carry out their plan	Practice in achieving goals for one week. Daily feedback on achievement and barriers that occurred during that day

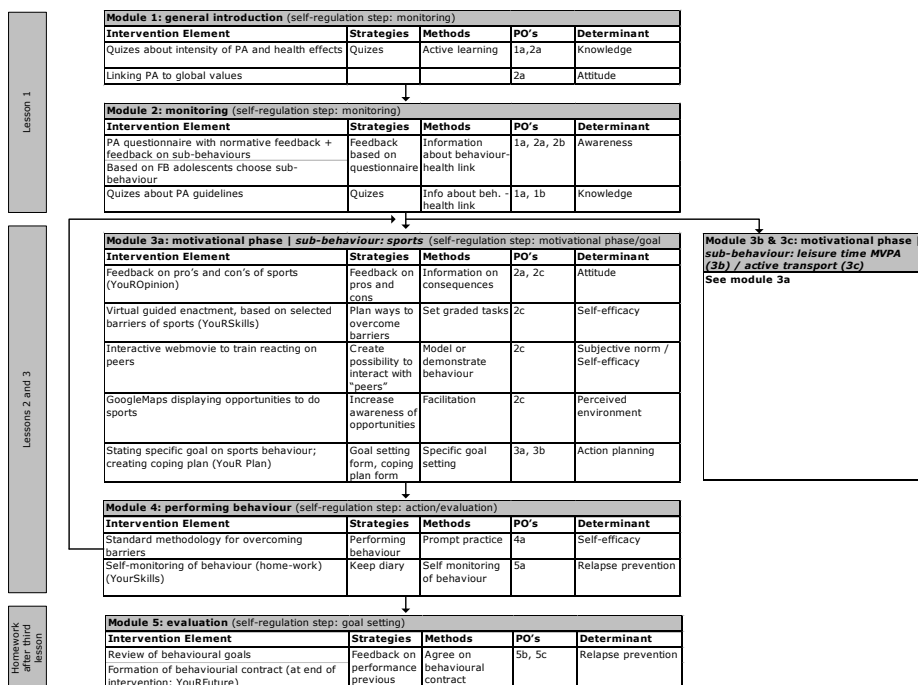
Relapse prevention	Prompt self-monitoring of behaviour (CT) / Provide feedback on performance (CT)	Can use feedback and confrontation; however raising awareness must be quickly followed by increase in problem-solving ability and self-efficacy	After goal setting, daily monitoring of behaviour with feedback on achievement.  Daily feedback on progress to achieve goal. If adolescents fail, feedback makes them aware that behavioural change goes hand in hand with occasional failure.
	Agree on behavioural contract	Creating of behavioural contract which will be signed by adolescent and teacher	Step-by-step creation of behavioural contract, containing goal, plan to achieve this goal and reward when achieving this goal. This control can be printed to be signed by adolescent and teacher
	Prompt review of behavioural goals (CT)	First guided monitoring, then self-monitoring. Feedback based on this self-monitoring in terms of behavioural goal.	Guided monitoring after second lesson; adolescents monitor their achievements. After third lesson they will be stimulated to this by their own in their diary. Based on these results resetting behavioural goals or progress with current goal.

TPB = theory of planned behaviour; SCT = social-cognitive theory; CT=control theory, PAPM = precaution adoption process model.

we used the taxonomy of behaviour change techniques as suggested by Abraham and Michie<sup>35</sup>. Since the intervention is computer-tailored, all methodologies were tailored to the adolescents needs. An overview of the main methods and strategies applied in the intervention and the theories from which they were derived is shown in Table 7.3. The self-regulation phases were the basis for the outline of the program. Program development was part of the next step of Intervention Mapping (step 4), but because of comprehensibility and readability of this paper we decided to integrate the description of the program outline in the methods and strategies section.

The program consists of three lessons of approximately 35 minutes, with homework assignments to be completed between the lessons. All lessons consist of one or more sections in which specific determinants were targeted. These sections are based on the general theme of the intervention: "YouR". The name of the intervention, YouRAction, is an acronym of Youths of Rotterdam in Action. Examples of section names include You-





**Figure 7.2.** Schematic Presentation of the YouRAction+e intervention

ROpinion (targeting attitudes) and YouRSkills (targeting self-efficacy). A general outline of the intervention is shown in Figure 7.2.

### First time use

The program is introduced by the teacher, after which the adolescents sign in to the program. They can then choose their personal guide, to increase attention for the messages throughout the program. Adolescents can choose between two "personal guides": Armin and Anna. This guide appears in movies, comics and throughout the program, mostly in an animated format.

### Monitoring phase

In the monitoring phase of self-regulation, adolescents are first made familiar with the terminology used throughout the intervention and learn about various levels of PA. Knowledge is targeted in the section "YouRKnowledge", by making use of the methodology of active learning. In practice, this means that interactive quizzes and feedback are used to test, and increase, their knowledge on concepts of PA and terminology used throughout the intervention. Before the actual monitoring starts, attitudes towards PA in general are addressed by linking physical activity with general values. Adolescents

can pick two important values from a predefined list (e.g. "Nature and the environment important for me") on which feedback is provided how physical activity fits with that value.

The section *YouRBehaviour*, deals with monitoring and awareness of personal PA levels. Personal feedback on behaviour and normative feedback are the main methods used to increase awareness of PA levels. A detailed questionnaire on PA sub-behaviours is used to monitor current PA status and is used to generate individualized tailored feedback on PA level and how this relates to the PA norms and PA level of peers. This feedback is shown in bar charts, with a textual explanation. Subsequently, more detailed feedback on performance in the three PA sub-behaviours (i.e. sports, active transport and leisure time physical activity) is provided, to indicate in which sub-behaviours improvements can be made.

After completing the *YouRBehaviour* section, adolescents proceed to *YouRMove*, in which they have to make a decision whether or not to improve their PA-level and on which sub-behaviour they would like to focus, i.e., active transport, leisure time activity or sports (PO1b, Table 7.1). This decision is made at the end of the first lesson.

#### *Motivational phase*

The second and third lesson both start with further motivating the adolescents for making changes in the chosen behaviour (Figure 7.2). Attitude, self-efficacy, subjective norm and the perceived environment were identified as important determinants to be addressed in this phase.

In *YouROpinion*, attitude is addressed by means of two methods: modelling/demonstrating behaviour and providing information on consequences of the behaviour. This means that, in the program, attitude is targeted by means of a web movie in which models tell about the positive sides of the chosen behaviour, emphasizing the fun and positive feelings associated with this behaviour (method: model or demonstrate the behaviour / provide information on consequences). Subsequently, adolescents select their own pro's and con's of the sub-behaviour. For instance, adolescents may perceive as pro's for sports "I will have a relaxed feeling after playing sports", "Sports is healthy" or "I can meet (new) friends". Whereas, con's of sports may include "Sports makes me feel sweaty", "Sports causes muscle soreness" or "Sports is too time consuming". When this balance is positive, the advantages of the behaviour are reinforced. In the case that this balance is negative, the con's are hypothetically discussed by a virtual panel of adolescents, aimed to shift the perspective of the adolescent (method: provide information on consequences). The initiation of these texts is from the initial perspective of the adoles-

cent, meaning that the adolescent of the panel initially experienced the disadvantage too, but is now convinced that this perceived disadvantage is not a real disadvantage.

The section in which self-efficacy is the central theme is called YouRSkills. Self-efficacy is targeted by three main methods: prompting identification of barriers, model or demonstrate behaviour and setting graded tasks<sup>8; 35</sup>. First adolescents select barriers which may prevent them from performing the selected sub-behaviour (method: prompt barrier identification). For example, bad weather, time, not knowing how to get to places and travelling alone are barriers that may prevent adolescents from travelling by active transport. The program contains interactive assignments, web movies or comics to overcome the selected barriers. In all assignments, problem solving strategies are incorporated: 1) what is the problem, 2) what can you do about it, 3) try it! Examples of these interactive assignments include interactive web movies to learn how to react on peer pressure (methods: model or demonstrate the behaviour / set graded tasks). Or, when bad weather is a barrier, adolescents are taught how to figure out what the weather forecasts are for the rest of the day – using web based weather forecasts and TV based weather forecasts. Finally, they plan coping responses on what to do in the case of bad weather, or any of the other barriers identified.

Feedback on the availability of PA facilities was used as the method to target self-efficacy and perceptions of the physical environment, in the section YouR'Hood. This was done by showing which PA facilities are available in an adolescent's neighbourhood environment using GoogleMaps. Environmental feedback was provided in various ways, depending on the PA sub-behaviour of interest. One of the applications is that adolescents can point out on the map where they can do the activity of their choice, e.g., where they can play tennis; this is applied to promote sports participation and leisure time physical activity. Another application is that adolescents can create routes to different places; this is applied to promote active transport. In the third strategy applied, all facilities in the neighbourhood are displayed on the map to give adolescents an overview of what is available in their neighbourhood; this is used to promote sports participation (i.e. sports facilities and sports clubs), leisure time physical activity and active transport (i.e. parks). Facilities can be selected and additional information about the location pops up, such as of contact details and web addresses of sports clubs, or information on quality of a park when a park was selected. Examples of these strategies can be viewed on several demo movies (see Appendix B for URLs). All maps are tailored to the home address, meaning that the map is centred on the home address. This means that an adolescent will immediately see which opportunities to be active are present in his or her neighbourhood.

### *Goal setting phase*

The section “YouRGoal” is designed to achieve the performance objective “Adolescents set challenging, but feasible PA goal” (PO3a, Table 7.1). Important prerequisites for goal setting are that the goals are challenging, but feasible<sup>36</sup>. To make sure this is the case, we used a closed ended format for setting a goal. First a goal is set by selecting one goal out of four pre-defined goals, such as “In the next week I am going to cycle to school four times”. If the goal an adolescent wants to set is not in the predefined list, there is an option to set a goal using a step-by-step guide<sup>36</sup>. In that case, adolescents first choose what to do, for instance “Playing basketball”. Then adolescents select how many times they want to do this in the next week and on which days they plan to do this.

Once the goal is set, adolescents enter “YouRPlan” and plan their activities in a calendar for seven consecutive days (method: prompt specific goal setting). They can click on the activity and a pop-up occurs in which they can state with whom and where they plan to do the activity (i.e. implementation intentions<sup>37</sup> are created). In the same pop-up window adolescents can plan coping responses to selected barriers. Such a coping response may look like: “When it rains, I will take my rain gear with me.” The adolescent can choose to have the complete plan sent to his or her e-mail address, or to print it directly from the web page.

### *Phase of active goal pursuit*

In the phase of active goal pursuit, adolescents work on executing their plans to achieve their goals. Every day, during one week after the second lesson, the adolescents log in to the website and fill in what activities they did, which difficult situations occurred and whether they managed to overcome these barriers (method: prompt self-monitoring of behaviour). If they did not manage to overcome these barriers, the adolescents enter a problem solving module, in which failure when trying to do something new is attributed to something that may occur occasionally. Subsequently, they are stimulated to try to think of a way to overcome this barrier the next time and write it down in the program (method: relapse prevention). In the third lesson this part is slightly modified, as adolescents are stimulated to monitor their behaviour on their own; for instance by making use of their (school) agenda.

### *Evaluation phase*

At the beginning of the third lesson, adolescents receive feedback on their performance during the past week, in YouRWeek (method: feedback on performance). Based on this feedback adolescents can choose either to 1) try to reach the same goal again 2) state a new goal on the same sub-behaviour 3) work on another sub-behaviour. Subsequently

adolescents enter the motivational phase again, as can be seen in the feedback loop from Module 4 to Module 3 (Figure 7.2) (method: prompt review of behavioural goals).

In YouRFuture, which is homework after the third lesson and therewith the very last part of the intervention, attention is paid to long term goals, by means of the methods prompt specific goal setting, relapse prevention, prompt self-monitoring and agree on behavioural contract. Adolescents set long-term (half year) goals on MVPA and sports, using pre-defined goals. Subsequently, they create an action plan and explicitly state when they monitor their behaviour and which incentive they give themselves, when they are doing well in reaching their goal. These plans are synthesized to a behavioural contract. This contract will be signed by themselves and their teacher.

#### **Step 4. Producing program components and materials**

The general program outline has already been described in the previous section. Therefore the focus of this section is on the very last part of intervention development: the production of the final materials and pretesting of the developed materials.

##### *Technical development*

YouRAction was developed in Tailorbuilder software. This software enables intervention developers to create their own webbased computer-tailored interventions. In order to be able to provide environmental feedback (i.e. show geographic information), extensions to the Tailorbuilder software had to be made. Building a system able to show geographic information from scratch would be very expensive. Instead, the Application Programming Interface (API) of GoogleMaps, provided by Google was used. This proved to be a reliable and efficient way to extent our Tailoring program.

For incorporation of environmental information in our system, the same tailoring principle was used as in other tailoring. A score on a tailoring variable is used to select the relevant feedback messages from a computer database, which is subsequently shown on the screen. In other words, environmental feedback had to be tailored to the relevant tailoring variable: the postal code of the home address. The tailoring algorithms defined that all the PA facilities in a 5000 meter radius around the home address had to be selected from the message library and plotted on a map. Thus the geographic locations of opportunities to be active formed the tailored environmental feedback. The environmental information in the database/message library was retrieved from municipal websites and parks were observed by trained observers using an adapted and translated version of the POST audit Tool (POST) <sup>38</sup>.

### Pre-test and formative evaluation

The intervention was developed in collaboration with adolescents, teachers and behaviour change experts, who participated in a linkage group. This linkage group met twice in an official meeting and was contacted on a question-answer base by mail or phone. The adolescents and teachers were approached in several phases of the development process, to give feedback on specific intervention elements, such as the use of Google-Maps, the use and placement of images and movies and the use of an activity planner.

Materials were developed and pre-tested by members of the linkage group, adolescents and teachers. Adolescents were consulted to choose one of three intervention names and one of three logos. The web movies were shot in cooperation with adolescents, who played a role in these movies. Their input was also taken into account to shape the final script of the movies. The graphical design of the final website was developed by adolescent students of a school for graphic design (Figure 7.3). The final intervention was pre-tested by adolescents and teachers in a classroom setting. This gave us information about usability of the intervention in a classroom setting. During this pre-test some technical problems (speed problems and problems with signing in) occurred, which were solved.

We specifically focussed on pre-testing the incorporation of GoogleMaps in the tailoring software, since this was an innovative element. First, we started with observing the use of GoogleMaps in a classroom. Based on these observations some adaptations to the use of GoogleMaps were made, such as fine-tuning the radius in which facilities



Figure 7.3. Visual design of the intervention

were shown. Secondly, we pre-tested the GoogleMaps application with the adaptations made in a classroom setting (N=51 adolescents). Adolescents rated the incorporation of GoogleMaps positively. Most adolescents found that 1) the instructions were clear, 2) the map was easy to use, 3) it was fun to work with the maps and 4) the information was complete.

## **EVALUATION STUDY**

### **Interventions**

The efficacy of the regular and extended version of the computer-tailored intervention will be evaluated against an Internet delivered intervention that provides generic information about physical activity and nutrition. All three interventions have the same graphical design and lay-out and they all consisted of three lessons. The lessons will be given by teachers who are provided with a teacher manual, as a guide for using the program.

### **Aim of evaluation study**

The aim of the evaluation study is to evaluate achievement of the intervention goals that have been stated during the intervention development process. Furthermore, the aim is to identify whether changes in the outcome measures were mediated through changes in the underlying processes. Therefore, effects of the interventions on behavioural determinants, on PA behaviour and mediation of intervention effects by targeted determinants will be studied. The main outcome measures are compliance to the PA guidelines, time spent in PA and specific sub-behaviours and behavioural determinants. Additionally, the intervention will be evaluated on the process level on acceptability and implementation of the intervention.

The main research question to be answered is whether 10% more adolescents in the intervention groups, as compared to the control group, comply with the MVPA norm at six months post intervention.

### **Evaluation design**

The YouRAction intervention will be evaluated in a three-armed cluster-randomized trial, with school classes as the unit of randomization, using computer aided block-randomization with a block size of 9. In each arm, 17 classes with on average 22 respondents per class will be needed to detect a 10% difference in compliance with the MVPA norm at six months post intervention ( $\alpha=0.05$ ,  $\text{power}=0.80$ ,  $\text{ICC}=0.02$ , %compliance with norm in control group=15% (observed from baseline measurements of the ENDORSE

**Table 7.4.** Evaluation design

	<b>T0</b>	<b>T1</b>	<b>T2</b>
Timepoint	Baseline Sept-Oct 2009	1 month post intervention Oct-Dec 2009	5-6 months post intervention April-June 2010
Demographics	Gender, age, education, ethnic background		
Outcome measures	Self-reported PA Objectively measured PA Body Mass Index Waist circumference	Self-reported PA Objectively measured PA	Self-reported PA Objectively measured PA Body Mass Index Waist circumference
Determinants	All	All	All
Process evaluation	No	Yes	No

PA=physical activity

study<sup>18</sup>). Measurements will take place at baseline (T0) (September/October 2009), one month post intervention (T1) (October-December 2009) and 6 months post intervention (T2) (April-June 2010) (Table 7.4). Questionnaires will be administered at each time point. A randomly selected subsample of 10% of the participants will be asked to wear ActiGraph GT3X accelerometers, on each time point, to objectively assess PA. Height and weight (to calculate Body Mass Index) and waist circumference will be assessed among a random selection of 40% of the participants at T0 and T2. Random selection of those participating in the additional measurements will be done by using a random ranking system, in which the first ranked adolescents in each class will be picked for the additional measurements. Random selection will be separate for the accelerometer usage and anthropometric measurements.

The Medical Ethics Committee of Erasmus University Medical Center provided a declaration of “no objection” for this study.

### Measurement

Self-reported PA, will be measured by means of the AQuAA<sup>39</sup> and a sixty-minute screening measure for moderate to vigorous physical activity<sup>40</sup>. Secondary outcomes will include objectively assessed PA, by means of ActiGraph accelerometers and objectively assessed BMI and waist-circumference.

### Determinants

Of all adolescents demographic information on age, gender, education and ethnic background will be collected. Adolescents will fill in a questionnaire at T0, T1 and T2 on cognitive determinants of MVPA, sports, walking, cycling and leisure time physical activity. The cognitive determinants assessed will include those determinants targeted in the



intervention: awareness, attitudes, perceived behavioural control, subjective norm and intention, action planning and the perceived physical environment.

### **Process evaluation**

Additionally at T1, a process evaluation will be conducted, to assess the intervention on acceptability, feasibility and implementation from the teacher's and adolescent's point of view. Teachers will be stimulated to fill in a log book on how much time each lesson took them in preparation and when they gave the lesson. Furthermore they will be stimulated to fill in an online questionnaire on their experiences with using the intervention.

In some classes research staff will observe intervention implementation and make notes of their observations. Furthermore server logs will be analyzed to detect how often and when the intervention was used.

### **Participants**

Participants will be recruited in a two-step procedure. First, schools will be recruited by contacting health coordinators of schools. Second adolescents within the selected schools were recruited. School classes are eligible if they are first year classes, with the main language during teaching being Dutch. These schools should be located within the area of the Municipal Health Services Rotterdam and surroundings. All adolescents in the selected classes will be invited to participate. We will use a passive informed consent procedure, meaning that, after being fully informed about the study, its purpose and its procedures, the adolescent and/or their parents could refuse to participate.

## **DISCUSSION**

The planning process that we described in this study has resulted in an extensive, novel, PA promotion intervention for adolescents that can be implemented in a school setting. Theory and evidence based development of interventions increases the likelihood of an intervention to be effective<sup>7</sup>. The present paper contributes to providing more insight into the systematic development of interventions and a more proper and detailed description of the behaviour change methods and strategies used, as has recently been called for<sup>41</sup>.

Although this intervention is developed based on theory and evidence, its effectiveness still needs to be evaluated in an evaluation study. Moreover, there is little known about the efficacy of computer-tailored interventions among adolescents. Evidence from our

evaluation study will provide information on the efficacy of the intervention, potential mediating and moderating mechanisms and the added value of improving awareness of PA facilities in the environment. In addition, the study will provide insight in appreciation and implementation possibilities for the intervention in a school setting.

One of the novelties of this intervention is the incorporation of environmental feedback in a computer-tailored intervention. This is a novelty for adolescents, but has successfully been applied in a tailored intervention in adults by van Stralen et al.<sup>16</sup> Van Stralen et al.<sup>16</sup> sent maps on opportunities to be active on paper to respondents of her intervention. This approach was found to be effective<sup>42-43</sup>. However, the Active+ intervention did not give instant, interactive feedback on opportunities to be active using tailored online maps. In our pretest it turned out that adolescents do have skills to work with GoogleMaps. Therefore we think that the incorporation of GoogleMaps to a computer-tailored intervention in adolescents is feasible and potentially effective.

Intervention Mapping was a useful tool in developing the YouRAction interventions, however, one of the main limitations was that the protocol is not clear in how to deal with complex behaviours like physical activity, in which various sub-behaviours can be chosen to achieve one overall goal. The aim of our intervention, increasing MVPA, could be reached by improving active transport, engagement in sports and leisure time activities – or in a combination of activities. However for each activity other determinants, change objectives and methods and strategies may be important. In order to be able to do so, we decided to create separate matrices of change objectives for each sub-behaviour, which enabled us to state specific change objectives for each sub-behaviour and select the appropriate methods and strategies to meet the change objectives. The technique of computer-tailoring furthermore facilitated the development of a program consisting of such a flexible program. In fact, big parts of the interventions were tailored to the adolescents' selection of a PA sub-behaviour. However, creating programs which are too complex may need more tailoring algorithms, which may have negative impact on the speed of the program.

To conclude, the development of YouRAction based on the Intervention Mapping protocol resulted in two theory and evidence based computer-tailored interventions with innovative elements like the incorporation of GoogleMaps. An evaluation study has to provide insight into the efficacy of the basic and extended intervention and will provide evidence for the additional effect of the provision of environmental feedback for computer-tailored PA interventions. If the evaluation study proves that the interventions are effective, two well-developed interventions will become available for the promotion of PA among adolescents.

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# Chapter 8

## **Studying the effectiveness of YouRAction, a computer-tailored intervention to promote physical activity among adolescents using personal and environmental feedback: a cluster randomized trial**

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*PLoS ONE, in press*



## ABSTRACT

**Background:** In this study the one and six months effects of the computer-tailored YouRAction (targeting individual level determinants) and YouRAction+e (targeting in addition perceived environmental determinants) on compliance with the moderate-to-vigorous physical activity (MVPA) guideline and weight status are examined. In addition the use and appreciation of both interventions are studied.

**Methods:** A three-armed cluster randomized trial was conducted in 2009-2010 with measurements at baseline, one and six months post intervention. School classes were assigned to one of the study arms (YouRAction, YouRAction+e and Generic Information (GI) control group). MVPA was derived from self-reports at baseline, one and six months post intervention. Body Mass Index and waist circumference were measured at baseline and six months post intervention. Use of the interventions was measured by webserver logs and appreciation by self-reports. Multilevel regression analyses were conducted to study the effects of the intervention against the GI control group. ANOVA's and chi-squares were used to described differences in use and appreciation between study arms.

**Results:** There were no statistically significant intervention effects on compliance with the MVPA guideline, overweight or WC. Access to the full intervention was significantly lower for YouRAction (24.0%) and YouRAction+e (21.7%) compared to the GI (54.4%).

**Conclusion:** The effect of the YouRAction and YouRAction+e interventions in promoting MVPA or more favourable anthropometric outcomes among adolescents could not be demonstrated. Insufficient use and exposure to the intervention content may be an explanation for this.



## INTRODUCTION

Promoting physical activity (PA) among adolescents is a public health priority <sup>1-2</sup>, especially because most adolescents in the Netherlands – like elsewhere <sup>3-6</sup> do not meet the guideline of being moderate-to-vigorously physically active (MVPA) for at least one hour each day <sup>7</sup>. Additionally, various studies show that PA further declines during adolescence <sup>8-13</sup> and tracks to a certain extent from adolescence to adulthood <sup>14</sup>. In sum, there is an indisputable need to promote PA among adolescents.

PA levels can be promoted if interventions target important and modifiable determinants, use theory and evidence based methodologies and fit with the target group. Current evidence <sup>8;15-16</sup> and theoretical insights <sup>17</sup> suggest that motivational (e.g. intention to be active and attitude towards PA) as well as environmental level determinants should be addressed in interventions to improve PA among adolescents. It is likely that there is a large variability in PA levels, awareness of one's own PA level, attitude, self-efficacy, intention to change and opportunities to be active in the residential neighbourhood among adolescents. In promoting PA it is, therefore, important to take these individual differences into account and to adapt the educational content to the behaviour, circumstances and beliefs of each individual adolescent. Computer-tailoring is a health education technique that makes such an adaptation of information to individual characteristics possible. Various reviews show that computer-tailoring is a promising technique to promote health behaviours <sup>15; 18-20</sup> and PA among adolescents <sup>21</sup>. In addition, it has been shown that compared to information delivered through traditional or print information, computer-based information delivery suited adolescents better <sup>22</sup>. Therefore, an online computer-tailored intervention would be a promising intervention strategy to promote PA among adolescents. While socio-ecological models indicate that both individual and (physical) environmental factors are determinants of PA, to date most computer-tailored interventions solely provided tailored feedback on individual level determinants. To promote MVPA among adolescents and to gain insight in the additional effect of incorporating environmental feedback in computer-tailored interventions two versions of the computer-tailored Youth of Rotterdam in Action (YouRAction) intervention were developed <sup>23</sup>. The basic YouRAction intervention targets individual level determinants, whereas the YouRAction+e intervention targets individual and perceived environmental determinants (e.g. awareness of availability of sports facilities in the home neighbourhood). Both versions of the intervention are Internet based and developed for use in schools. The present paper describes the evaluation of the effects of the comprehensive YouRAction interventions as compared to generic feedback among Dutch adolescents.

The technique of computer-tailoring facilitates adaptation of information to individual characteristics and is, therefore, expected to be effective for all adolescents regardless of their gender, ethnic background or educational level. Recently, it has been shown that a computer-tailored intervention aimed to increase PA among Flemish adolescents was indeed equally effective across educational groups<sup>24</sup>. Nevertheless, it remains important to evaluate whether tailored interventions are equally effective in relevant subgroups.

The aims of this study are to 1) evaluate the effectiveness of the YouRAction and YouRAction+e interventions on compliance with the MVPA guideline and minutes per day spend in MVPA among adolescents in the first year of secondary education in a cluster randomized trial with a generic information (GI) control group 2) evaluate the effectiveness of the two interventions on overweight and waist circumference (WC) in a sub-sample of the study population, 3) explore differential intervention effects for boys and girls, adolescents attending higher and lower levels of education and adolescents with a Western or non-Western ethnic background, and 4) describe use and appreciation of the interventions<sup>25</sup>.

We hypothesized that after exposure to the intervention

- 1) in the YouRAction and YouRAction+e groups compliance with the MVPA guideline is 10% higher as compared to the GI control group at six months post-intervention and that average daily minutes spend in MVPA will be higher in the YouRAction and YouRAction+e groups;
- 2) the sub-sample of adolescents who are allocated to the intervention groups will be more likely to have a normal weight and WC compared to the GI group at six months post-intervention;

## METHODS

### Design

A three-armed cluster randomized controlled trial was conducted in 2009-2010 with measurements at baseline, one and six months post-intervention. School classes (clusters) were randomly assigned to one of the study arms (i.e. YouRAction, YouRAction+e, GI), in a computer determined sequence. Randomization was done in blocks of nine classes, to ensure that equal numbers of classes were assigned to each study arm.

Data on demographics, PA behaviour and determinants were collected at all time points by means of questionnaires administered during a school hour. Completion of the questionnaires was supervised by a research assistant and a teacher. Height, weight

and WC were measured by a trained research assistant at baseline and six months post-intervention in a sub-sample of the study population.

The Medical Ethics Committee of the Erasmus Medical Center gave a “declaration of no objection” for this trial. This trial is registered in the Netherlands Trial Registry (NTR1923).

### **Recruitment of participants and procedure**

Participants were adolescents aged 12-13 years, in their first year of secondary school, since this was the target group of the interventions. As a first step in recruitment, the health coordinators of 69 schools in the area of Rotterdam (the Netherlands) were contacted by phone. If they were interested in participating, a brochure with more detailed information about the intervention content and the research procedure was sent to the schools and a member of the research team visited the schools for further information exchange and planning. In each participating school between 1 and 12 classes (depending on the size of the school) were selected for participation. All adolescents in the selected classes were invited to take part in the study.

Based on a sample size calculation, 17 classes with on average 22 adolescents per class would be needed in each study arm, to detect a 10% difference in compliance with the MVPA guideline at six months post-intervention, compared to the GI group (alpha=0.05, power=0.80, ICC=0.02, %compliance with MVPA guideline in GI group=15%).

In total 54 classes, from 12 schools, in Rotterdam and surroundings were recruited. Prior to the baseline measurement, adolescents and their parents received detailed information about the trial. Based on this information, they could decide to decline participation in the trial. Of the 1240 adolescents, 27 (2.2 %) adolescents and/or their parents declined to participate in the study; 1213 students were included in the trial.

### **Measures**

*Primary outcome measures: Compliance with MVPA guideline and minutes spent in MVPA*

Compliance with the MVPA guideline and minutes spent in MVPA was calculated for all three time points (baseline, one month and six months post-intervention).

Compliance with the MVPA guideline was assessed by using one item of the PACE+ MVPA screening measure (“Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?”; scale=0-7; test-retest ICC=0.72; r: 0.37;  $p < 0.01$  for correlation with accelerometer <sup>26</sup>).

Minutes spent in MVPA was assessed with an adapted version of the Activity QuesTionnaire for Adolescents & Adults (AQUAA; test-retest ICC=0.54 for moderate-to-vigorous activities;  $r=-0.23$ ; ns for correlation with accelerometer) <sup>27</sup>. In the questionnaire used, the frequency (in days per week) and duration (in minutes per day) of walking and cycling to school, walking and cycling in leisure time and participation in sports during the past 7 days were assessed. A MET-score was attached to all activities, based on the compendium of Energy Expenditures for Youth <sup>28</sup>, assuming that activities were done at moderate effort. PA of more than 10 hours per day was considered to be unrealistic and therefore these values were re-coded to missing values. A MVPA score was created by summing the average daily minutes of activities higher than 5 MET, as recommended by the Dutch MVPA guideline <sup>29</sup>. Because data were skewed (skewness ranged from 3.51 to 3.85), the log transformed (natural logarithm) variable was used in the analyses.

#### *Secondary outcome measures: Anthropometrics*

At baseline and six months post-intervention, body weight, body height and WC were measured by trained research assistants in a random subsample (40% of total sample) of adolescents. A calibrated electronic scale (SECA 888) was used to measure body weight with an accuracy of 0.2 kg. A portable height rod (SECA 225) was used to determine body height to the nearest 0.1 cm. Adolescents were measured in their underwear, without shoes. At each measurement height was measured twice and the average value was considered to be the height of the adolescent. Body Mass Index (BMI) was calculated by using the measured height and weight ( $\text{kg}/\text{m}^2$ ). BMI cut points for adolescents, as defined from the International Obesity Task Force (IOTF), were used to categorize adolescents in “normal weight” (including underweight), “overweight” and “obese” <sup>30</sup>.

WC was measured twice to the nearest 0.1 cm, using SECA 200 circumference measuring tapes. If there was more than 1.0 cm difference between the two measurements, two additional measurements were taken. The average of the last two measures of WC was used as the measure for waist circumference.

#### *Demographics*

At baseline, questions on date of birth (to calculate age), gender, country of birth of the adolescent and both parents, and the level of education that the adolescent attended (i.e. lower vocational education (lower education) or secondary education preparing for further college or university training (higher education)) were included. Ethnicity was defined according to the procedures of Statistics Netherlands; an adolescent was considered to be of Western background if both parents were born in Europe, North America, Oceania, Indonesia or Japan. If at least one parent was born elsewhere, the adolescent

was considered to be of non-Western background<sup>31</sup>. Hence, a dichotomous measure of ethnicity was constructed: Western background (1) vs non-Western background (0).

#### *Process evaluation measures on use and appreciation*

To assess self-reported exposure to the intervention, adolescents in the YouRAction, YouRAction+e or GI groups reported in how many lessons they had used the intervention (none (0), 1 (1), 2 (2), 3 (3), more than 3 (4)). Additionally adolescents were asked if and how often they had made the YouRAction homework assignment (no (0), yes, once (1), yes, twice (2), yes, three times (3)). This latter variable was dichotomized into 'none' (0) versus "made at least one homework assignment" (1). Objective data on intervention usage were obtained from web server logs (i.e. log in frequency, modules accessed). Data were obtained for the number of times an adolescent (attempted) to log-in and for access to the first page of each lesson.

In the one month post-intervention questionnaire process measures were obtained on appreciation, personal relevance, quality, usefulness and usability of the intervention content, as well as technical problems encountered when accessing the intervention (Appendix C).

### **Interventions**

The YouRAction interventions are web-based computer-tailored PA promotion interventions developed by Intervention Mapping<sup>32</sup>, meant for use in a school-based setting, mainly as part of class room activities. Teachers were instructed by research staff on how to implement the intervention and they received a teacher manual to assist them in implementing the intervention. The YouRAction interventions consisted of three sessions that could be worked through during three lessons, and homework assignments that were provided after the second and third lesson. All adolescents in one class logged in to the website simultaneously and worked through the class assigned intervention individually. Hereafter the YouRAction interventions will be briefly described; a more thorough description is published elsewhere<sup>23</sup>.

#### *YouRAction*

All three lessons consisted of one or more self-regulatory phases (i.e. monitoring, motivational, goal setting, active goal pursuit and evaluation phases). In the first lesson the focus was on improving knowledge about MVPA and how much activity adolescents should engage in. Subsequently awareness of one's own PA level was increased (monitoring phase). In the second and third lesson the adolescents were motivated (by targeting attitudes, self-efficacy, subjective norm) to make a change in one of the PA sub-behaviours (active transport, leisure time activity or sports), depending on the

feedback on their personal PA level (motivational phase). Subsequently adolescents could state a goal and formulate an action plan for how they wanted to improve their PA level (goal setting phase). In a week in between two lessons adolescents could evaluate whether they had enacted their plans and achieved their goals (phase of active goal pursuit). They could also make plans for how to deal with difficult situations they had encountered and state a new goal (evaluation phase). Most elements in the YouRACTION intervention were theory based and translated in written feedback, cartoons, quizzes and web-movies.

#### *YouRACTION+e*

The content of the YouRACTION+e is identical to the basic YouRACTION intervention, but in addition provides feedback on the availability on PA facilities in the residential neighbourhood of the adolescent via GoogleMaps. This was done by displaying facilities to be active with icons in GoogleMaps; adolescents could click on these icons to get more extensive information about the facility (e.g. website, specific information about sports that could be done).

The YouRACTION interventions were pilot tested among 133 adolescents from 7 classes on comprehensibility and usability. During this pilot test performance problems were observed (slow website), when a whole class used the intervention. These problems were resolved by the software developers by installing a web server with higher capacity and optimization of processing of tailoring algorithms.

#### *GI*

The GI group received a non-tailored website containing general information on PA and healthy eating. This website was designed for 3 lessons and was also implemented in a class setting by teachers. The visual design of this website was identical to the design of the YouRACTION and YouRACTION+e interventions. This intervention was also called YouRACTION.

### **Statistical Analyses**

Multinomial regression analyses were used to check equality of study groups for adolescents with baseline data. In these regressions, the intervention condition was the dependent variable and gender, ethnicity, education and compliance to the MVPA guideline were the independent variables.

Logistic regression analyses were performed to study whether there was selective drop-out at first and second follow-up assessment. Drop-out (in analysis (1) /not in analysis

(0)) was regressed on demographics (i.e. gender, age, ethnicity, education), intervention group and compliance with the MVPA guideline at baseline.

The effectiveness of YouRAction and YouRAction+e was studied by means of multilevel logistic (for compliance with the MVPA guideline, % overweight) and linear (for average minutes of MVPA, WC) regression analyses, taking possible clustering of students in school classes into account. Separate analyses were performed for the one and six month post-intervention assessments. The outcome variables assessed at one and six months post-intervention (i.e. compliance with the MVPA guideline, minutes spend in MVPA, body mass index and waist circumference) were regressed on the baseline value of the outcome measure under study and two dummy variables, indicating the YouRAction and YouRAction+e interventions, with the GI as the reference group. The analyses were further adjusted for demographic factors that significantly differed between study arms at baseline.

Subsequently it was tested whether gender, ethnicity or level of education moderated the effects of YouRAction and YouRAction+e on compliance with the MVPA guideline and daily minutes spend in MVPA. This was done by adding, for both interventions simultaneously, an "intervention dummy \* demographic factor" interaction term to the regression analyses. If these interaction terms were statistically significant at  $p < 0.10$ , stratified analyses were conducted.

Complete case and intention-to-treat with last observation carried forward analyses were conducted. The data and results from the complete case analyses are presented in the tables.

ANOVA's (continuous outcomes) and chi-square tests (dichotomous outcomes) were used to describe group differences in use of the assigned intervention. For adolescents who used their assigned interventions at least once, appreciation of the intervention was also assessed with ANOVA's and chi-square tests.

Except for interaction terms, results with a p-value lower than 0.05 for a two-sided test were considered to be statistically significant. All analyses were conducted in STATA 11.0.

## RESULTS

### Participants

A total of 12 schools with a total of 54 classes and 1213 adolescents participated in the study (Figure 8.1). In one school seven classes dropped out after allocation, due to logistic problems at that school. No evidence for selective drop-out between baseline and first follow-up was found. However, adolescents in vocational classes and boys were more likely to have dropped out at the second follow-up. Table 8.1 shows background data of the participants included in the complete case analyses. The proportion of students attending lower education was significantly higher in the GI group and all analyses were therefore adjusted for level of education.

### Intervention effects

Table 8.2 shows that there were no statistically significant group differences on compliance with the MVPA guideline or minutes spend in MVPA at any of the post-intervention measurements. Table 8.2 further shows that there were no statistically significant effects of the YouRAction and YouRAction+e interventions on prevalence of overweight includ-

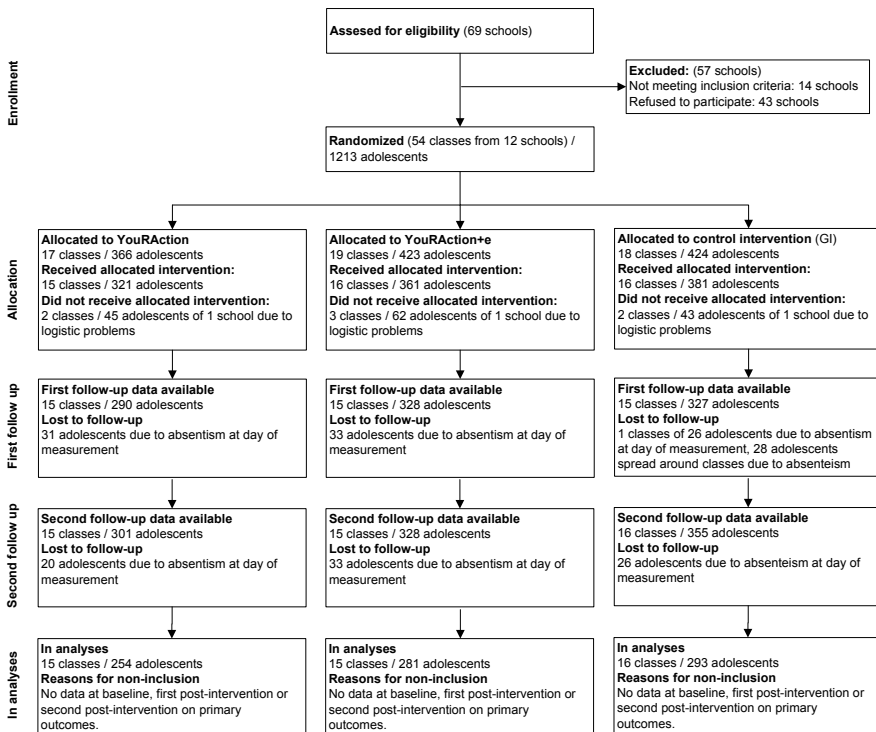


Figure 8.1. Flow diagram of the selection and enrolment of the study participants



**Table 8.1.** Baseline class and adolescent characteristics of adolescents in complete case analyses for the YouRAction, YouRAction+e, GI and total group

	<b>YouRAction</b>	<b>YouRAction+e</b>	<b>GI</b>	<b>Total group</b>
<b>Class factors</b>				
Number of classes	15	15	16	46
<b>Individual factors</b>				
Number of adolescents	254	281	293	828
Age (SD)	12.7 (0.5)	12.7 (0.5)	12.6 (0.4)	12.7 (0.5)
School level (%lower level education)	<b>56.3%</b>	<b>56.9%</b>	<b>19.8%</b>	43.6%
Ethnicity (% non-Western)	25.2%	22.1%	17.7%	21.4%
Gender (% male)	52.8%	50.9%	53.4%	52.4%
Compliance with MVPA guideline (% compliant)	17.3 %	15.3%	12.6%	15.0%
Minutes MVPA (SD)	126.1 (142.1)	117.3 (104.4)	134.9 (125.6)	126.1 (124.4)

SD=standard deviation, GI=general information; Bold values represent statistically significant differences between groups ( $p<0.05$ ), derived from multinomial regression analyses.

**Table 8.2.** Baseline and post-intervention mean scores (SD) or percentages for compliance with the MVPA guideline, minutes spend in MVPA, weight status and waist-circumference and unstandardized regression coefficients of the effects of the interventions with GI group as reference

	<b>Percentages and Means (SD)</b>			<b>Unstandardized regression coefficients (95% CI)*</b>	
	YouRAction	YouRAction+e	GI	YouRAction vs GI	YouRAction+e vs GI
<i>Primary outcomes</i>					
Number of classes	15	15	16		
Number of adolescents	254	281	293		
Compliance with MVPA guideline					
Baseline	17.3%	15.3%	12.6%		
One month post-intervention	11.8%	15.7%	14.3%	-0.30 (-0.84;0.25)	0.11 (-0.40;0.61)
Six months post-intervention	13.0%	15.7%	18.8%	-0.42 (-0.99;0.15)	-0.16 (-0.70;0.38)
Minutes in MVPA					
Baseline	126.1 (142.1)	117.3 (104.4)	134.9 (125.6)		
One month post-intervention	95.9 (79.4)	105.5 (96.8)	109.1 (90.1)	-0.03 (-0.16;0.10)	0.08 (-0.05;0.20)

Six months post-intervention	108.1 (109.5)	115.0 (90.6)	111.5 (92.6)	0.01 (-0.14;0.17)	0.07 (-0.08;0.23)
<i>Secondary outcomes</i>					
Number of classes	15	16	17		
Number of adolescents	118	136	132		
Overweight or obese					
Baseline	16.1%	20.6%	14.4%		
Six months post-intervention	16.1%	20.6%	13.6%	0.16 (-1.01;1.33)	0.28 (-0.86;1.42)
WC					
Baseline	67.1 (7.9)	68.6 (8.7)	66.2 (7.9)		
Six months post-intervention	68.3 (8.2)	70.4 (9.4)	67.5 (7.8)	-0.38 (-1.39;0.62)	0.16 (0.82;1.15)

MVPA=moderate-to-vigorous physical activity, WC=waist circumference, GI = general information; SD=standard deviations; bold figures represent statistically significant differences. <sup>a</sup> multilevel linear or logistic regression analyses with class and individual as levels, adjusted for level of education.

**Table 8.3.** Baseline and six month post intervention compliance with the MVPA guideline and unstandardized regression coefficients of the effects of YouRAction vs GI stratified for adolescents with a Western or non-Western ethnic background

	% Compliance with MVPA guideline at baseline	% Compliance with MVPA guideline at six months post-intervention	Unstandardized regression coefficients <sup>a</sup> (95% CI)
Western background			
GI (N=244)	13.9%	18.9%	
YouRAction (N=198)	18.7%	15.2%	-0.17 (-0.81;0.46)
Non-Western decent			
GI (N=52)	5.8%	17.3%	
YouRAction (N=64)	14.1%	4.7%	<b>-1.72 (-3.18;-0.25)</b>

GI=general information; CI=confidence intervals; <sup>a</sup> multilevel linear or logistic regression analyses with class and individual as levels, adjusted for level of education; bold numbers represent statistically significant values ( $p < 0.05$ ).

ing obesity, and WC at the six months post-intervention measurements. Intention-to-treat analyses resulted in similar, non-significant results.

### Interaction effects

Explorative interaction analyses showed that there were no statistically significant interactions between the dummy variables for intervention groups and gender or education. However, there was a statistically significant interaction between the dummy variable for the YouRAction program and ethnic background on compliance with MVPA guide-

line at six months post-intervention (Beta: -1.33, 90% CI: -2.59;-0.08). Stratified analyses showed that adolescents of non-Western descent in the YouRAction group had lower compliance with the MVPA guideline at the six months post-intervention measurement compared to adolescents in the GI group (Table 8.3).

### Use and appreciation of the interventions.

The self-reported number of lessons in which the intervention was used did not differ significantly between the groups. However, webserver logs showed that adolescents in the YouRAction and YouRAction+e group signed in significantly more often than adolescents in the GI. In total 91.3% of the adolescents in YouRAction accessed the second lesson as compared to 71.9% in the GI group ( $p<0.01$ ) and 78.7% in the YouRAction+e

**Table 8.4.** Self-reported and objectively measured exposure to intervention content by intervention group and differences between intervention groups

	YouRAction		YouRAction+e		GI		Significant differences
	N	Mean(SD)	N	Mean(SD)	N	Mean(SD)	
<i>Exposure in total</i>							
Self-reported number of school lessons	213	2.46 (1.29)	252	2.63 (1.32)	284	2.50 (1.22)	
Objective log in frequency	214	2.49 (1.44)	247	2.68 (1.08)	266	2.20 (1.03)	YouRAction > GI ( $p=0.02$ ) <sup>a</sup> YouRAction+e > GI ( $p<0.01$ ) <sup>a</sup>
Made at least 1 homework assignment (self-reported)	214	20.1%	252	21.0%	282	24.8%	
<i>Objectively assessed exposure to the three lessons</i>							
First lesson	224		244		263		
Second lesson (% of visited first lesson)		91.3%		78.7%		71.9%	YouRAction > YouRAction+e ( $p=0.02$ ) YouRAction > GI ( $p<0.01$ ) <sup>b</sup>
Third lesson (% of visited first lesson)		24.0%		21.7%		54.4%	YouRAction < GI ( $p<0.01$ ) <sup>b</sup> YouRAction+e < GI ( $p<0.01$ ) <sup>b</sup>

GI=general information, SD=standard deviation, <sup>a</sup> based on one-way ANOVA, <sup>b</sup> based on chi-square tests

group ( $p=0.02$ ). However, access to the third lesson was significantly lower for the YouRAction (24.0%,  $p<0.01$ ) and YouRAction+e groups (21.7%,  $p<0.01$ ) when compared to the GI group (54.4%) (Table 8.4).

With regard to measures of appreciation, content of advice and usability of the intervention content no differences between the three study arms were found (Table 8.5). The YouRAction+e intervention was perceived as more personally relevant than the GI. Technical problems were more often reported by adolescents in the YouRAction group (43.0%,  $p<0.01$ ) and YouRAction+e group (34.0%,  $p<0.01$ ) than by those in the GI group (16.4%). More specifically, a slow intervention was a technical problem that was more prevalent among adolescents who received YouRAction (39.2%,  $p<0.01$ ) and YouRAction+e (25.9%,  $p=0.02$ ) as compared to the GI intervention (13.9%) (Table 8.5).

## DISCUSSION

In contrast to our hypothesis and results reported earlier in the scientific literature<sup>15-16;21</sup> we could not demonstrate that the computer-tailored YouRAction and YouRAction+e interventions were effective in promoting MVPA or weight related outcomes among adolescents; in explorative analyses some evidence was even found that YouRAction had a negative effect on compliance with the MVPA guideline for adolescents with a non-Western ethnic background. However, the results on negative effects among non-Western adolescents should be interpreted with care, as the low absolute numbers of non-Western adolescents complying with the MVPA guideline may have caused instable results. If confirmed in other studies, future interventions should address these potential differences in intervention effects with regard to ethnicity. Our results further showed that the exposure to the full content of the tailored interventions was much lower than intended and differed significantly from the GI group, which may have limited the potential for finding intervention effects<sup>25</sup>. Because of the self-regulatory structure of the interventions, the hypothesized effect was dependent on repeated exposure to the intervention. Therefore, it is unclear what the potential effectiveness of a theory and evidence based computer-tailored intervention is under more favourable implementation conditions and what the added effect of environmental feedback can be.

The tailored interventions were developed according to the Intervention Mapping protocol<sup>32</sup>, which facilitates that the intervention is strongly rooted in behaviour change theory. The interventions included a large number of theory based change strategies and were rather extensive. Participants had to complete a substantial number of questions to receive sufficiently tailored feedback on a range of potential behavioural determinants.

**Table 8.5** Appreciation, relevance and content of advice and technical problems of YouRAction, YouRAction+e and GI reported by adolescents who at least used the intervention once and differences between intervention groups

	YouRAction		YouRAction+e		GI		Significant differences
	N	mean(SD)	N	mean(SD)	N	mean(SD)	
Overall school mark (1-10)	192	5.81 (2.19)	228	6.04 (1.91)	249	6.25 (2.01)	
Liked the intervention (5 point scale)	194	2.52 (1.16)	224	2.57 (1.11)	249	2.80 (1.23)	Regular < GI (p=0.04) <sup>a</sup>
Program was interesting (5 point scale)	193	2.61 (1.15)	224	2.62 (1.21)	248	2.82 (1.21)	
<i>Personal relevance</i>							
Intervention was personally relevant	194	2.65 (1.05)	228	2.77 (1.06)	250	2.47 (1.06)	YouRAction+e > GI (p=0.01) <sup>a</sup>
Advice suited well	194	2.88 (1.11)	228	2.90 (1.08)	249	2.78 (1.05)	
<i>Content of advice</i>							
I learned a lot from the program	192	2.88 (1.14)	227	2.88 (1.10)	249	2.94 (1.21)	
Advice was useful	194	3.08 (1.08)	228	3.07 (1.07)	249	2.99 (1.13)	
I could adhere to advice	194	3.12 (1.08)	228	3.16 (1.16)	248	3.20 (1.12)	
<i>Usability</i>							
Intervention was easy to use	194	3.29 (1.14)	228	3.48 (1.19)	251	3.43 (1.26)	
Intervention was easy to understand	194	3.74 (0.97)	227	3.72 (1.10)	249	3.86 (1.05)	
Faced technical problems during intervention usage (% yes)	193	43.0%	227	34.0%	250	16.4%	YouRAction > GI (p<0.01) <sup>b</sup> YouRAction+e > GI (p<0.01) <sup>b</sup>
<i>Type of technical problems</i>							
Could not log in	194	8.8%	228	12.3%	249	5.2%	
Program was slow	194	39.2%	228	25.9%	251	13.9%	YouRAction > GI (p<0.01) <sup>b</sup> YouRAction > YouRAction+e (p=0.02) <sup>b</sup> YouRAction+e > GI (p=0.02) <sup>b</sup>
Got stuck in the program	193	14.0%	227	9.7%	250	4.8%	

GI=general information, SD=standard deviation, <sup>a</sup> based on one-way ANOVA, <sup>b</sup> based on chi-square tests

As a result considerable amounts of data needed to be loaded when adolescents logged in to the website. When many adolescents worked simultaneously on the YouRAction interventions, this caused severe load on the server, resulting in a slow intervention program and log-in problems. Perceived slowness was significantly more prevalent in both YouRAction interventions. The YouRAction interventions were tested extensively before broader implementation, but the problems with regard to higher number of participants evidently only appeared when the intervention was used on a larger scale. It is, therefore, recommended that stress-testing of a program to assess performance of a web-based intervention when multiple people log-in simultaneously are performed in addition to pre-tests in the setting in which the intervention takes place.

Besides sub-optimal implementation, factors in the intervention and study design may have further caused limited potential for our interventions. First, the evidence for most of the methods used to modify determinants is derived from studies among adults and there is only limited evidence as to how effective these specific strategies are for an adolescent target group. Most of these methods were based on theory<sup>32-33</sup>, but no empirical evidence is available for their effectiveness when incorporated in a computer-tailored intervention developed for adolescents. Future studies need to examine which methodologies are effective in computer-tailored intervention for adolescents. Secondly, in the design of our evaluation study, the use of a control group that received an intervention is likely to have impacted our findings. It has been shown that effect sizes tend to be lower for computer-tailored interventions that were tested against a generic information control group as compared to a no-intervention control group<sup>20</sup>. However, this design allows drawing conclusions about the effects of tailoring and not only about the effects of an intervention as such.

Despite the fact that we could not demonstrate the effectiveness of the YouRAction and YouRAction+e interventions, we recommend to pursue research on tailoring and more specifically tailoring with environmental feedback to promote PA among adolescents. The effectiveness of such interventions have not been evaluated a lot, and their effectiveness is relatively unknown but the technique has always been indicated as promising also in other studies<sup>21</sup>. The incorporation of feedback on opportunities in the neighbourhood environment to be active was a unique feature of YouRAction+e, a strategy that has shown to be promising among an older adult sample<sup>34-36</sup>. However, this strategy has not been applied before in an Internet program for adolescents. Interestingly, the YouRAction+e intervention was perceived as more personally relevant and showed higher point estimates than the YouRAction intervention. Future studies aimed at promoting PA among adolescents should thus consider the incorporation of environmental feedback in tailoring.

Strengths of the present study include the cluster randomized controlled trial design and the use of measured anthropometrics in a subsample of the study population. Also the use of objective measures on exposure to the interventions is a strength of this study, where previous studies called upon<sup>16</sup>. The use of a self-reported measure of PA is a limitation, as this may be prone to information and social desirability bias. It may be that adolescents who received one of the YouRAction interventions were more likely to report their PA more realistically (and thus lower<sup>37</sup>) at the follow-up measures than the GI students, because they received tailored feedback about their levels of PA.

In conclusion, we could not demonstrate an effect of the theory and evidence based YouRAction and YouRAction+e interventions in promoting PA or more favourable anthropometric outcomes among adolescents. One of the explanations for a lack of effect may be insufficient use and exposure to the intervention content, due to technical problems. Since the use of environmental feedback in computer-tailored PA interventions seems promising, further research is needed to evaluate the potential effect of such a component. Furthermore, future studies should use more objective measures of PA to evaluate the effectiveness of the interventions.

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# Chapter 9

## General Discussion



Engaging in sufficient physical activity (PA) during adolescence has numerous health benefits in adolescence<sup>1-2</sup> and in later life<sup>3</sup>. According to the Dutch guidelines, adolescents should engage in moderate to vigorous physical activity (MVPA) at least one hour each day<sup>4</sup>. However, levels of PA among Dutch adolescents are low, with approximately only one in four adolescents meeting the MVPA guideline<sup>5</sup>. Clearly, there is a need for promotion of PA among Dutch adolescents. This requires sufficient understanding of the underlying determinants of PA that can be targeted in interventions. Socio-ecological models propose that both individual (e.g. attitude, intention) and environmental level factors (e.g. availability of facilities to be active) are of importance in influencing PA. However, the evidence with respect to the influence of environmental factors on PA and the proposed interplay between environmental and individual level factors is limited. Research is needed to better understand the factors that potentially determine MVPA among adolescents.

Insights in these determining factors may be applied in promising intervention techniques to promote MVPA among adolescents, such as computer-tailoring. Computer-tailoring has been identified as a promising health education technique to encourage and promote health behaviours, including MVPA<sup>6-9</sup>. However, despite the fact that current behavioural theories suggest joint individual and environmental level influences on PA, computer-tailored interventions to date typically target individual level factors in promoting PA among adolescents, thereby omitting potentially important determinants. Targeting environmental factors in a computer-tailored intervention may therefore further enhance its efficacy. To promote PA among adolescents, a computer-tailored intervention (YouRAction+e) that targets both individual and environmental level factors was developed and evaluated.

This thesis aimed to answer two research questions:

1. How is the physical environment associated with PA behaviour among adolescents?  
(Part 1)
2. What are the effects of a computer-tailored intervention that targets individual level factors and of a computer-tailored intervention that targets individual and environmental level factors on compliance with the MVPA norm among Dutch adolescents?  
(Part 2)

In this final chapter, results of the studies will be summarized and integrated; methodological issues will be discussed and implications for research and practice will be given.

## 1. MAIN FINDINGS

In the first part of this thesis, one study explored whether cognitive factors and perceived environmental factors (i.e. perceived availability of sports facilities, perceived neighbourhood attractiveness and perceived neighbourhood safety) could explain socio-demographic (i.e. gender, ethnicity, education) differences in self-reported disengagement from sports during adolescence. Disengagement from sports was operationalized in two outcome variables: 1) ceased compliance with the fit norm (i.e. engaging at least three times a week in sports) and 2) stopping to participate at least once per week in sports. Despite the fact that most adolescents engaged in sports at baseline, strong declines over a two year period were found. This study showed that girls, adolescents attending lower educational levels and adolescents from non-Western descent were more likely to disengage from sports than boys, adolescents attending higher levels of education, and adolescents from 'Western' background. Less positive intentions to engage in sports and lower perceptions of neighbourhood safety among these groups, could partly explain the difference between groups in their likelihood to stop sports participation (**Chapter 2**).

In **Chapter 3** differences between the objectively measured (derived from Geographic Information Systems; GIS) physical environment and perceptions (derived from questionnaires) of the physical environment as correlates of self-reported leisure time walking and cycling and sports participation were explored. More specifically, objectively measured and perceived availability of parks, sports facilities, sidewalks and bicycle lanes were considered as correlates of PA. It was found that perceptions of the environment clearly differed from objective measures: based on objective measures, the opportunities in the physical environment for physical activity (e.g. parks, sports facilities) were much more prevalent than perceived. Thus, adolescents generally under-reported the opportunities in their neighbourhood to be active. Perceptions of the physical environmental opportunities to be active were associated with specific self-reported PA behaviours, but the objectively measured physical environmental opportunities were not.

**Chapter 4**, examined whether cognitive determinants (i.e. attitudes, self-efficacy and perceived availability of recreational facilities) of MVPA mediated the relation between objectively measured availability of sports facilities and parks in the adolescent's residential neighbourhoods and objectively measured MVPA. The relations were studied for availability of parks and sports facilities captured at 400, 800 and 2000 meter buffer sizes (i.e. the radius around the home in which the number of facilities were counted). In neither buffer size, the objectively-measured availability of sports facilities and parks

was associated with objective assessments of MVPA. It was found that attitude and self-efficacy were consistently associated with objectively measured MVPA. No evidence for mediation by cognitions was found in any of the buffer sizes.

Subsequently, in **chapter 5** it was explored whether the objectively measured availability of sports facilities within a 1600 meter buffer moderated the association between intentions to be physically active at baseline and changes in self-reported sports participation over a two year period. Results from this study revealed a strong decline in sports participation throughout adolescence. In the first year of secondary education 74% of adolescents engaged in sports, two years later only 48% of the adolescents. It was found that the objectively measured availability of sports facilities was not associated with changes in self-reported sports participation. This study further showed that cognitions measured at baseline (i.e. attitude and subjective norms regarding physical activity, but *not* intention) were directly associated with changes in sports participation over a two year period. The availability of sports facilities moderated the association between intention and sports participation in such a way that the intention-sports participation association was stronger when more sports facilities were available.

The associations of the social environment (neighbourhood social capital; NSC) and objectively measured availability of sports facilities and parks with leisure time sports participation were explored in **chapter 6**. More specifically, it describes the direct associations and interaction of these associations with self-reported leisure time sports participation. In this study NSC was aggregated on a zip-code level and the availability of parks and sports facilities were measured in the zip-code area and within a 1600 meter crow-fly buffer. It was found that NSC was strongly correlated with self-reported leisure time sports participation among adolescents. No significant association between the objectively measured physical environmental opportunities (i.e. presence of parks and sports facilities in the zip-code area as well as within 1600 m buffers) and sports participation was found. There was a significant NSC\*availability of parks interaction effect. Decomposition of the interaction term indicated that high levels of NSC were especially important when the availability of parks within the zipcode area was also high.

To summarize, in the first part of this thesis it was found that perceptions of the physical environment clearly differ from objectively measured physical environmental opportunities (**Chapter 3**). No evidence was found for a direct association of the objectively measured availability of sports facilities or parks with physical activity among adolescents (**Chapters 3, 4, 5, 6**). One of the hypothesized mechanisms through which the physical environment may have an influence on PA behaviour is through mediation of cognitive factors. In the one study in this thesis exploring these mechanisms, no



evidence for mediation by cognitions was found (**Chapter 4**). However, some evidence that the objectively measured physical environment interacts with other factors (e.g. intentions or NSC) in shaping sports participation was found (**Chapter 5 and 6**).

In part 2 of this thesis, the planned development of the online, computer-tailored YouRAction and YouRAction+e interventions was described in **Chapter 7**. Both interventions aimed to promote MVPA among adolescents in the first year of secondary education and used the technique of computer-tailoring to provide feedback on individual and environmental level determinants. The YouRAction intervention targets individual cognitions (e.g. awareness, attitude, intention) and YouRAction+e additionally targets awareness of opportunities in the neighbourhood to be active (e.g. making respondents aware of the availability of parks and other facilities/opportunities for PA in the neighbourhood). Incorporation of environmental feedback in computer-tailored interventions is novel and was found to be feasible. Both interventions were evaluated for their effectiveness in improving compliance with the MVPA guideline, minutes spend in MVPA, and weight in a cluster-randomized trial (**Chapter 8**). The results of this trial provided no evidence that these interventions were effective in promoting MVPA. It was further found that only a minority of the participants used the interventions as intended and appreciation of the interventions was not high. Hence, implementation of and exposure to the intervention was not optimal, which may explain the absence of a detectable intervention effect.

## 2. METHODOLOGICAL CONSIDERATIONS

The studies presented in this thesis have some shared methodological issues that need to be discussed. In this section, first issues with regard to the design of the studies presented in the first part of the thesis will be discussed, subsequently the measures used and finally the development, implementation and evaluation of the YouRAction interventions will be addressed.

### 2.1 Design of studies in the first part of this thesis

In this thesis various research designs were applied to answer research questions on the association between physical environmental factors and PA. Chapters 3, 4 and 6 were cross-sectional studies whereas in chapters 2 and 5 longitudinal analyses were conducted. A limitation of observational studies is that it is not possible to draw causal inferences, and this is strongly so for cross-sectional studies<sup>10</sup>. However, a cross-sectional design is efficient for exploration and generating stronger hypotheses for further research. Studies with more robust designs are needed to corroborate the findings from cross-sectional studies, to be able to draw firmer conclusions. Cross-sectional designs

can only provide information about associations between, in this case, environmental features and physical activity; longitudinal designs can be used to test prediction. This latter design was used in chapters 2 and 5.

### *2.1.1 Sampling and subjects: Place*

A number of the studies presented in the first part of the thesis used data from the ENvironmental Determinants of Overweight in Rotterdam SchoolchildrEn (ENDORSE) study<sup>11</sup>. The ENDORSE study was embedded in the academic collaborative Centre for Effective Public Health Promotion In the larger Rotterdam area (CEPHIR) and as a consequence this study (Chapters 2, 3 and 5) took place in the larger Rotterdam area. The data collection took place in close cooperation with the Municipal Health Service of the Rotterdam area and was part of the Youth Monitor Rotterdam, their ongoing health surveillance system. In interpreting the outcomes of the presented studies, it is important to know that Rotterdam is a city in the Netherlands with a very diverse ethnic makeup, with a relatively high number of inhabitants from non-Western origin, especially among children and adolescents. This demographic makeup is most probably a result of the industrial and harbour activities in the larger Rotterdam area. Many adolescents are second generation immigrants from Turkey, Morocco and the Netherlands Antilles, which are ethnic minority groups also represented in other large cities in the Netherlands. However, Rotterdam also has some specific groups of immigrants not represented in most other cities, for example Cape-Verdean immigrants<sup>12</sup>. Therefore, the results of the studies presented in this thesis may not be generalizable to other Dutch cities.

The study presented in chapter 4 was based on data from the Children Living in Active Neighbourhoods (CLAN) study, which was carried out in Melbourne, Australia. The city of Melbourne is different from that of Rotterdam in terms of population make-up, urban sprawl and other cultural factors. This should be taken into account in interpreting the results of this study, because the results may not be generalizable to other cities or other countries.

### *2.1.2 Sampling and subjects: People*

In the ENDORSE study, adolescents were recruited from classes, which were selected from schools that participated in the Youth Monitor Rotterdam. Of the 54 schools that participated in the Youth Monitor Rotterdam, 24 were interested in taking part in the study. These schools are likely to be those that were most motivated to promote healthy lifestyles among their pupils. Of the 24 interested schools, a random sample of 17 school locations was drawn, after stratification of the schools according to four city areas. Approximately five classes per school participated in the study. All adolescents in one class participated in the study, unless they or their parents indicated that they were not

willing to participate (passive consent procedure). Because no data were obtained from adolescents who refused to participate in the study, it is not possible to draw conclusions about selection bias.

## 2.2 Measures

### 2.2.1 Measures of physical activity

The ENDORSE study and the evaluation of YouRAction used the Activity Questionnaire for Adults and Adolescent (AQuAA) to assess MVPA. This questionnaire, that includes questions about frequency and duration of a range of physical activities, has shown to be fairly to moderately reliable<sup>13</sup> and has -similar to other available self-report measures- rather low validity as compared to accelerometer measures of PA. The validity of the AQuAA was, however, not tested for specific physical activity behaviours, but only for total levels of light PA, moderate PA, MVPA and vigorous PA<sup>13</sup>. In most studies presented in this thesis a specific category of PA, namely sports participation, was the outcome of interest. It may be argued that it is very likely that such a specific means of PA will be better recalled than more general daily activities as active transport or active play, but evidence to support this is lacking. Self reported measures are prone to various biases, such as recall bias and social desirability bias. Furthermore, interventions may not only influence PA levels but also the biases in self reported PA. For instance, interventions that provide feedback on PA levels may cause adolescents to better recall (i.e. recall bias) and estimate (i.e. information bias) PA. Given the fact that without awareness raising interventions, adolescents generally over-report their PA levels<sup>13-14</sup>, post-intervention assessments of PA may be lower, suggesting a negative intervention effect, due to more realistic self-reports after exposure to the intervention. This may be one explanation of the results found in the evaluation of the YouRAction intervention. However, interventions that promote PA may also increase social desirability bias, leading to higher self-reports after exposure to the intervention.

Because of the relatively low validity of self-reports, the use of objective measures for PA is strongly advocated. An objective method to measure PA is the use of accelerometers, which can classify minutes spend in categories of intensity of activity (e.g sedentary, light, moderate or vigorous)<sup>15</sup>. A major advantage of accelerometers is that the data is objectively derived and therefore it is not prone to information or recall bias. However, accelerometers also have some limitations. For instance, due to recommended research protocols<sup>16-17</sup> data is likely to be available for 66%<sup>18</sup> to 80%<sup>18-20</sup> of participants. In repeating measurements, like in the evaluation of interventions this data loss may be higher. For example, in the YouRAction evaluation study accelerometer data was collected in a 10% subsample (118 adolescents) but in the final post-intervention measurement in

which data could be matched for 15 (13% of the sub sample) adolescents. Because the number of adolescents with complete data was too low, these data could not be used for intervention evaluation. Given the advantages of accelerometers over self-reported data in establishing the effectiveness of interventions, future studies consider the use of accelerometers. These studies should be sufficiently powered and take into account the loss of data in determining the required sample size.

Another limitation is that, in contrast to questionnaires, accelerometers cannot assess the type of activity that is undertaken. Especially for research into physical environmental correlates and predictors of PA, this is of importance, because the environment is likely to have behaviour-specific influences<sup>21</sup>. For example, the presence of a sports court in ones neighbourhood is likely to be of influence on sports participation, but not on walking to school. Therefore, most of the studies on environmental influences in this thesis (except for chapter 4) used self-reported data on specific behaviours. However, recent advances in accelerometer data processing show that it seems possible to extract (a limited number of) activity types from the accelerometer data<sup>22-24</sup>. This is done for example by using artificial neural network models in which accelerometer signal characteristics (for example absolute deviations, coefficients of variability and percentiles of the data) are inputted.

Questionnaires and accelerometers both have advantages and disadvantages and may assess different PA constructs (i.e. intensity of activity for accelerometers and type in questionnaires), which are important when the use of outcome measures is considered. Therefore it is recommended to collect both objective (i.e. accelerometers) and self-reported measures of PA<sup>25</sup>.

### *2.2.2 Measurement of the Physical Environment*

Assessment of availability of physical activity facilities in the physical environment can be done through questionnaires (i.e. perceived environment), and through observations or GIS (i.e. objective environment). In the studies described in this thesis, both questionnaires and GIS were used. For both types of assessment, the development of the best way to do these assessments and how the data should be used is still ongoing<sup>26</sup>.

Generally, there are two ways to measure the area in which the facilities to be active are counted when GIS are used: network buffers or crow-fly buffers. Network buffers are considered to be the preferred method. In this case the area (buffer) is defined by drawing a buffer around the respondents' home, using the street network – for example, a 600 meter buffer would capture all facilities that can be accessed by travelling 600 meters *via the road*. In order to do so, vector data on road networks is needed. Unfortu-

nately no data on street networks was available for the studies presented in this thesis. Therefore assessment of the availability of the parks and sports facilities took place using crow-fly, or Euclidean, buffers (i.e. the number of facilities within a *circular buffer* of some size from the respondent's house is counted). Compared to network buffers, a disadvantage of crow-fly buffers is that they do not account for barriers, such as rivers, highways etcetera. For example, if a respondent would live at the border of the river Maas in Rotterdam, a 600 meter buffer would easily capture facilities at the other side of the Maas. Because bridges or tunnels to cross the river are only few, the respondent is likely to need to travel further than 600 meters to reach a facility across the river and therefore that facility may not be of practical relevance to the respondent. Therefore it may be that in the studies presented in this thesis for some adolescents some facilities are captured that are not easily reachable by the adolescent, which may have partly prevented us from finding associations between the environment and PA. However, given the relatively high connectivity of the Dutch road network, for most adolescents the buffers used will be suitable.

Another challenge in studying the association of the objectively measured environment with PA is the size of the relevant buffer size, or spatial scale, in which facilities are captured. This factor varies greatly between various studies and typically ranges from 400 meters to 3200 meters <sup>26</sup>. Moreover, there is no consensus on what buffer size would be most appropriate <sup>26-27</sup>. To gain insight in the most relevant buffer size, Brownson et al. recommend studying associations between environmental factors and behaviours in various buffers, to get head-to-head comparisons <sup>26</sup>. In chapter 4 various spatial scales were used, as suggested by Brownson et al., which were based on the previously mentioned study and another study by Timperio et al. This study suggests that children are allowed by their parents on average to travel 1600 meters roundtrip (i.e. 800 meter each way) <sup>28</sup>. Another way to define "the right spatial scale" is to use theory and evidence, which was done in most of the studies in this thesis. A 1500-1600 meter buffer was chosen in most of the studies in this thesis (Chapter 3, 5 and 6), inferred by a study in which an average travel time of 15 minutes was found to be acceptable <sup>29</sup>. Given that cycling is a common mode of transport in the Netherlands, this distance can be easily reached within 15 minutes – even when waiting for traffic lights.

Although the choice of the buffer size was informed by evidence on the potentially relevant buffer size for physical activity among adolescents, the definition of the neighbourhood may still not be optimal. It may be that adolescents are active in other places than the neighbourhood in which they live. It is very well possible that the environment around their school, or environments where their friends live, is more important for some adolescents. Such differences in what the most appropriate environment for

assessment of PA opportunities is, may have contributed to lack of associations found. Future research should consider using advances in GPS technology in determining the environment where adolescents are active and to determine associations between the physical environments and PA. Some preliminary research indicates that using these advances in GPS technology is feasible and promising <sup>30-33</sup>.

The definition of a neighbourhood may be highly individual <sup>34</sup>; neighbours or even family members may have a completely different definition of what their “neighbourhood” constitutes. This is likely to be dependent on the available transport options <sup>35</sup>. Availability of a bicycle, for example, will enlarge the area that can easily be covered as compared to walking as mode of transportation and may enlarge ones perception of what ones neighbourhood is. Acknowledging such differences is of importance with regard to studies that aim to measure perceptions of the neighbourhood. Because of this individual variability it is important to measure perceptions of the environment with an explicit definition of the “neighbourhood”. This can be done for example by asking “Are there parks *within 10 minutes walking distance from your home*” instead of “Are there parks *within your neighbourhood*”.

### **2.3 Development and implementation of the YouRAction and YouRAction+e intervention**

The YouRAction and YouRAction+e interventions were developed informed by behavioural theories and earlier evidence, by using the Intervention Mapping protocol. It has been shown that development of an intervention based on theories and earlier evidence increases its likelihood to be effective <sup>36-38</sup>, if implemented and used as intended <sup>39</sup>. Both, the use of theory and evidence and a good implementation of an intervention will protect against a type III error (i.e. evaluating a program that has not been adequately implemented) <sup>40-41</sup>.

Despite the planned development of the YouRAction interventions, several decisions that were made in the development process of YouRAction may have had an impact on the potential effectiveness of the interventions. First, most of the evidence on effectiveness of behaviour change strategies comes from studies among adults and there is only limited evidence on the effectiveness of specific strategies (such as feedback on behaviour or action planning) are for adolescents in particular. Most behaviour change methods applied in the interventions were ‘only’ based on theory <sup>37; 42</sup>, but not tested in formative research and thus it could be that the intervention contained behaviour change strategies that are not effective for adolescents.

Secondly, the comprehensiveness of the interventions may have caused lower appreciation and usage of the intervention. In a qualitative study about the use of the internet for health promotion among adolescents, Crutzen et al. found that a computer-tailored program would be appreciated<sup>43</sup>. However, the adolescents indicated that the questionnaire used to generate the advice should not take long to complete and that the advice should be “to the point” and concise<sup>43</sup>. The Intervention Mapping procedure used to develop the YouRAction interventions resulted in a comprehensive intervention with a large number of components (e.g. YouRBehaviour, targeting awareness of one’s PA level, based on a PA questionnaire; YouROpinion, targeting attitudes; YouRSkills; targeting barriers to be active), in which adolescents repeatedly had to complete questions to receive feedback messages. Even though in the YouRAction interventions short questionnaires were used followed by short feedback messages, the adolescents may have experienced the program as too long. Interventions that are more concise may suit adolescents better. Moreover, the comprehensiveness of the intervention and its online delivery required a lot of server capacity. This slowed down the program and caused unforeseen technical problems, particularly when many participants tried to log in simultaneously. Such group-wise use of the intervention was to be expected in a class setting, but that this caused technical problems was not anticipated by the company that provided and managed the server for the intervention. Due to the technical problems not all adolescents could get access to the follow-up modules in the program and they were thus not fully exposed to the intervention content. Additionally, the technical problems and slowness may have annoyed the adolescents<sup>44</sup>, resulting in lower appreciation of the intervention and a negative atmosphere in the classroom. This may have been a reason for the teachers who implemented the program to decide not to spend more lessons using the program. A more comprehensive test of the final intervention in a real-life full class setting should have been conducted, which may have avoided these problems.

Finally, solely using a computer-tailored program, even if it targets individual and perceived environmental factors, may not be sufficient to promote PA among adolescents. Recent reviews indicate that school-based interventions are most likely to be effective if health education is combined with changes in the school environment.<sup>45-46</sup> Furthermore, among adults it has been shown that neighbourhood environments may moderate the effect of PA promotion interventions<sup>47</sup>. Unfortunately in the YouRAction evaluation study the neighbourhood environmental factors as a moderator of the intervention effect were not studied. In the study described in chapter 5 of this thesis it was also found that objectively measured physical environmental factors may interact with cognitive factors. YouRAction+e was a health education intervention that did include feedback and advice on *perceptions* of the neighbourhood environment, but no actual environmental changes were induced or promoted. Simultaneously promoting inten-

tions and creating opportunities to be active in the neighbourhood may be needed to effectively improve sports participation.

### *2.3.2 Implementation of YouRAction*

With regard to implementation of the intervention, three dimensions are of concern: fidelity (the degree to which the methods and strategies are intact), completeness (the proportion of the program delivered) and dose (amount of the program the participants receive)<sup>37;48</sup>.

In a computer-tailored program all necessary elements for inducing the behaviour change process are stored in the program and the program guides the participants through all the important steps. Thus, when adolescents log in to the program and use the program as intended, fidelity is more or less guaranteed, since implementation of the program and delivery of important components is not dependent on an implementing agent or intermediary. The YouRAction interventions were designed to be implemented by teachers. The most important role of the teachers was that they had to facilitate adolescents to work through the program during three lessons in three consecutive weeks (Chapter 7). In order to anticipate on implementation, a linkage-group was formed in which teachers had an advisory role, but they were not structurally engaged with the intervention development. The efforts to implement the interventions well, focused mostly on “human” factors and the methods used for implementation (i.e., instruction and teacher manual) worked well; in all schools the program started. However, due to unforeseen problems, such as long-term sick leave of the teacher, in one school several classes could not use the program. Furthermore, technical aspects form an important factor that facilitates or hinders successful implementation and exposure to the intervention and its components. In the YouRAction evaluation study, the aforementioned technical problems posed a barrier for successful implementation and exposure in such a way that most adolescents were not exposed to the full content of the intervention (Chapter 8). Thus, in the evaluation study a type III error may have occurred.

## **2.4. Evaluation of YouRAction**

### *2.4.1 Design of the YouRAction study*

In the second part of this thesis, the YouRAction interventions were evaluated. YouRAction was designed as a classroom-based intervention and evaluated in a cluster-randomized trial (CRT) with classes as level of randomization. Even though this design has its limitations, it is one of the strongest for evaluating intervention effects and the most feasible in class-room settings. A limitation of a cluster randomized design is that there is a risk that the randomization does not result in equivalent study groups due



to the limited number of school classes randomly allocated to each study condition. This was indeed the case in the YouRAction study. More adolescents in lower secondary education were allocated to the YouRAction and YouRAction+e groups compared to the control group. In other studies (chapter 2), we showed that adolescents attending lower levels of education are more likely to disengage from sports participation (chapter 2). To take the inequality of study groups into account, the analyses were adjusted for level of education.

#### *2.4.2 Sampling and subjects*

In the recruitment of schools and classes, the YouRAction research team collaborated with the Municipal Health Services Rotterdam, because this study was embedded in the academic collaborative center CEPHIR. Via this research-practice collaborative network of Erasmus University Medical Center, the Rotterdam area Municipal Health Service and associated partners, the research team could efficiently reach the right persons, such as the health coordinators of schools to recruit schools and classes in the study. In total 54 classes were selected from 12 schools and all adolescents in one class were invited to participate to fit with the class-based system and minimize selection bias. In this study a passive (i.e. opt out) consent procedure was used, which is likely to have resulted in higher participation rates and thus better generalisability of the results to the region in which the intervention was implemented<sup>49-50</sup>.

### **3. INTEGRATION AND REFLECTION ON THE STUDY FINDINGS**

Despite the aforementioned methodological issues some overall conclusions can be drawn from the studies presented in this thesis, and this is done for each of the two main research questions of this thesis.

#### **3.1 Part 1: How is the physical environment associated with PA behaviour among adolescents?**

In the first part of this thesis it was explored how the physical environment is associated with PA behaviour among adolescents. This was done by taking a socio-ecological perspective, using the EnRG-framework<sup>51</sup>. According to socio-ecological models, there is a shared influence of environmental and individual factors in shaping PA behaviour. The EnRG framework suggests that factors in the physical environment have a direct influence on behaviour, but may also have an indirect influence mediated by individual cognitions such as attitude and intention. While the EnRG framework does not explicitly conceptualize interactions between environmental factors and cognitions, other theories such as the extended Theory of Planned Behaviour (TPB) suggest that

environmental factors are likely to moderate the cognition-behaviour relationship<sup>52-53</sup>. Furthermore, not all ecological models explicitly describe interaction between various types (i.e. physical, social, political, economic) of environment, even though it is very likely that interactions between such different types of environment do occur<sup>54</sup>. The studies in this thesis have explored these issues.

### *3.1.1 Direct associations of the physical environment on PA behaviour*

The studies in this thesis consistently show that the objectively measured availability of facilities in ones neighbourhood was not directly associated with PA among adolescents (Chapters 3-6). These results add to the inconsistent evidence regarding the importance of the physical environment for adolescent PA<sup>55-57</sup>. It needs to be mentioned, however, that (except for the review by Davison<sup>56</sup>) these reviews did not discriminate between perceived and objectively measured environmental factors. Earlier research<sup>58-59</sup>, as well as the study described in Chapter 3 of this thesis, show that the perceived and the objectively measured environment are different constructs in the sense that they are only partly correlated and have different associations with physical activity behaviours. Interestingly, the review by Davison was the only review that concluded that there was a positive association between both the objectively measured and perceived availability of facilities and PA<sup>56</sup>. Moreover, also the results from chapter 3 show that there are differences between the objectively measured and perceived environment. Therefore, the interpretation of results of the studies discussed in this final chapter will be presented for perceived and objectively measured environment separately.

Apart from the methodological issues mentioned before (i.e. conceptualization of the environment and specificity of measures) a potential explanation for the absence of a direct effect of availability of facilities on PA may be that there is lack of variability in availability of facilities. In the Rotterdam area there is a lot of choice and availability of facilities to be active and everybody has access to PA facilities. Motivational aspects and social environmental factors may in this “physical activity friendly” context be stronger correlates of behaviour as was shown in this thesis (Chapter 5 and 6).

Mixed results were found for the association between perceived environmental factors and PA. Perceived availability of sports facilities was found to be associated with self-reported sports and perceived availability of parks with leisure time walking or cycling (Chapter 3), but not with a decline in sports participation during adolescence (Chapter 2) or objectively measured MVPA (Chapter 4). These results add to the mixed findings from previous studies on this topic. A review from studies published until 2006 concluded that there is a significant association between perceived availability of recreational facilities and PA among adolescents<sup>56</sup>. More recent studies show that there is indeed evidence

that perceived availability of walking and cycling facilities<sup>60-61</sup>, higher perceived street connectivity<sup>61</sup> and perceived availability<sup>62</sup> and access to facilities<sup>63</sup> were associated with PA among adolescents. However, other studies have found that perceived availability of recreational facilities<sup>63-64</sup> and perceived access to facilities<sup>65</sup> were not associated with PA.

To conclude, the results of the studies presented in this thesis suggest that the objectively measured availability of facilities in ones neighbourhood is not directly associated with PA among adolescents, when the currently available measurement instruments are used. New technology that allows for more refined measurement of the environment where an individual is active (i.e. by means of GPS data) and the processing of accelerometer data (i.e. signal analyses, which may discriminate between activities) may provide better insight in physical environmental factors associated with PA. With regard to perceived environmental factors such as availability of PA facilities, results are mixed and more research is needed to be able to draw firmer conclusions about the associations between perceived environmental factors and PA among adolescents.

### 3.1.2 Mediation mechanisms

One study in this thesis examined whether the association between objectively measured availability of PA facilities and PA was mediated through individual cognitions (attitude, self-efficacy, intention). The hypothesized mediation effects were not found (Chapter 5), largely because there was no effect to be mediated (i.e. the perceived physical environment was not associated with objectively assessed MVPA). The findings of this study are in line with previous studies that did not find mediation effects. Maddison et al.<sup>65</sup>, did not find evidence that individual cognitions (TPB constructs) mediated the association between accessibility of facilities and objectively measured PA. Dowda et al.<sup>66</sup>, found no evidence that self-efficacy mediated the commercial PA facilities – self-reported PA association. So, the few studies conducted on this topic to date did not provide evidence for cognitive factors as mediators of the environmental factor – PA relationship.

For mediation analyses it is important that 1) the independent variable (X) is significantly associated with the mediator (M) and that 2) the mediator is significantly associated with the dependent variable (Y) after adjustment for the independent variable. Similar to environmental constructs<sup>21</sup>, one of the criteria for accurate prediction of behaviour by the Theory of Planned Behaviour is that the measured constructs need to be compatible or correspond with the behaviour<sup>67</sup>. For instance, if the behaviour of interest is “engaging at least once per week in sports”, intention should be measured towards “engaging at least once per week in sports” and not merely intention towards “engaging in sports”. Likewise, it is likely that better correlations between the physical environment and cog-

nitions will be found if the context in which the behaviour takes place is considered (for example intention towards “engaging at least once per week in sports in a park”). This should also be applied to the measurement of the behaviour. To draw firmer conclusions about mediation mechanisms, further exploration by taking into account the specific measurement of constructs is needed.

### 3.1.3 Moderation mechanisms

Two studies in this thesis provided evidence for interaction between availability of PA facilities and 1) intention in the association with changes in sport participation and 2) NSC in the association with LT sports participation. The first study (chapter 5) showed that when adolescents had a positive intention toward sports participation and when there were more opportunities to be active, they were most likely to increase their sports participation. Although interaction analyses are relatively scarce<sup>68</sup>, our results are in line with previous research by Rhodes et al., who found that the *perceived* availability of neighbourhood recreation facilities moderated the relation between intentions for walking and walking among adults<sup>69</sup>. The results of the study presented in this thesis are furthermore in line with the suggestion of Giles-Corti that for PA promotion, the individual and social environmental factors are the more important factors in determining PA behaviour, but that the physical environment is a necessary facilitating factor<sup>70</sup>.

The second study showed that NSC is a potentially important moderator of the relation between the availability of sports facilities and sports participation. The findings of the study presented in chapter 6 indicate that high availability of sports facilities in one’s neighbourhood may only be related to sports participation when NSC is high. This study was one of the first to study interaction between two types of environmental factors in their association with adolescent PA, but the results seem promising and may shed a new light on the relation between physical environmental factors and PA. Findings from previous, qualitative, studies are in line with the results from chapter 6 and suggest that it is not only the presence of facilities to be active that is important in determining PA behaviour, but that also social environmental factors are of importance<sup>71-72</sup>. When the findings of this study are replicated and form a consistent pattern, it may implicate that intervening on neighbourhood level not only requires a focus on improving availability of facilities, but also improving levels of NSC. Therefore, future studies should focus on replication of our study findings and extend on it by examining whether interaction occurs on other constructs, to get better insight in the role of the objectively measured physical environment in adolescent PA.

### 3.1.4 Explaining socio-demographic differences in PA: the role of individual and environmental factors

In the study presented in chapter 4 it was already shown that there is a strong decline in sports participation during adolescence. Even though decline in sports participation during adolescence is increasingly receiving research attention <sup>73-77</sup>, there is very little research on socio-demographic differences in decline in sports participation. In chapter 2 it was found that the decline is stronger for girls, adolescents of non-Western descent and adolescents that attend lower education and that perceived neighbourhood safety and intention could partly explain these disparities. The differences in decline in sports participation were striking and this means that research in socio-demographic differences is highly important, especially because this may eventually lead to disparities in health <sup>78</sup>. Futures studies could focus on other factors than cognitions that explain these differences, such as biological maturation <sup>79</sup> for gender differences or cultural or political aspects (e.g. family rules to engage in sports) for ethnic differences. The results further imply that, as a majority of adolescents engage in sports at the first year of secondary education, interventions should also be aimed at *maintaining* sports participation and not only at *promoting* sports participation. This may require other intervention methodologies <sup>80</sup>.

## 3.2. Part 2: What are the effects of a computer-tailored intervention that targets individual level factors and of a computer-tailored intervention that targets individual and environmental level factors on compliance with the MVPA guideline among Dutch adolescents?

### 3.2.1 Development of the YouRAction and YouRAction+e interventions

The planned development of the YouRAction interventions resulted in a comprehensive program that targeted a large number of determinants (e.g. awareness, attitudes, perceived behavioural control) and a variety of theory informed strategies to modify these determinants (e.g. quizzes, movies and cartoons) to make the program varied and attractive for adolescents. A novelty of the YouRAction+e intervention was that it additionally aimed to increase awareness of the availability of facilities in the neighbourhood, by providing feedback on availability of PA facilities in the residential neighbourhood (chapter 3). Interactive web based maps (i.e. Google maps) were used to provide this feedback. The approach may have potential, since the component was well appreciated in the pre-test of the program. Furthermore, a study among older adults, in which environmental feedback was incorporated in a print tailored intervention to promote PA showed that the addition of environmental information increased the effectiveness of the intervention <sup>81-82</sup>. Providing feedback on availability of facilities in one's neighbourhood through a Google Maps application requires that information on location and

quality of facilities such as parks and sport facilities is available. Collection of all this information through site visits and observations (only in the case of parks) is labour intensive. Nevertheless it was feasible to collect all the information required in a couple of days, mainly because many cities in the Netherlands already have a basic registration of availability of facilities.

The planned development process resulted in a theory and evidence based PA promotion program which included novel elements, which is a prerequisite for, but no guarantee for intervention effectiveness.

### *3.2.2 The effectiveness of the YouRAction interventions*

Reviews of the literature showed that computer-tailored interventions can be effective in promoting PA among adolescents<sup>83</sup>. The effectiveness of both interventions was evaluated compared to a generic information control group, in a cluster randomized trial. Despite the promising outlooks, the effectiveness of the YouRAction interventions could not be demonstrated among Dutch adolescents (Chapter 8). The adolescents using YouRAction and YouRAction+e were insufficiently exposed to the intervention and this sub-optimal implementation of the interventions prevented us from drawing definitive conclusions on the effectiveness of the interventions. Therefore, it was also not possible to gain full insight in the potential effects of the environmental feedback component. The most likely reason for the much lower than intended exposure are the technical difficulties which slowed down the program, causing problems with browsing and logging in. Hence, adolescents were not exposed to all content.

To conclude, the results of the effect evaluation of YouRAction and YouRAction+e showed that, under insufficient exposure, neither of the interventions was more effective in promoting PA behaviour than the control group. Because of the limited implementation no final conclusions about the potential effectiveness of the interventions can be drawn. The techniques used (e.g. computer-tailoring and incorporation of environmental feedback) may still be promising, but the interventions need to be improved to increase use and appreciation of the interventions. One of the first steps is to improve the program in such a way that the high server load, causing a slow intervention, does not occur anymore. A next step would be to test the intervention with adolescents to assess appreciation and interpretation of content, using for instance a thinking-aloud methodology. If necessary, the intervention content should be fine-tuned and subsequently pre-tested in a classroom setting. Finally, this intervention needs to be evaluated to show whether it is effective in promoting PA behaviour.

## 4. IMPLICATIONS AND RECOMMENDATIONS FOR PRACTICE

### **Promoting PA among adolescent: Educating and facilitating**

The studies in this thesis showed that the objectively measured physical environmental factors were not associated with PA among adolescents. Cognitive factors, such as attitude, self-efficacy and subjective norm were the stronger predictors of sports participation. However factors in the environment may be important in combination with other factors such as intention. Therefore, notwithstanding the increased attention for the environment in promotion of PA, it is still important to focus on modifying individual level factors in interventions to promote PA among adolescents. Ideally, both individual and environmental level factors should be targeted in interventions to promote PA among adolescents.

### **No evidence for effectiveness of YouRAction and YouRAction+e, so at the moment they should not be implemented on a larger scale**

The YouRAction interventions received a certificate for being “theoretically well described and underpinned” from the Dutch recognition system for health promotion interventions<sup>84</sup>. However, since the YouRAction and YouRAction+e interventions were not effective in promoting PA among adolescents, implementation in its current form cannot be recommended.

### **Use of Google Maps in computer-tailored interventions is feasible**

The use of Google Maps as a means to provide feedback on availability of facilities in the home neighbourhood was feasible and adolescents liked the incorporation of this environmental feedback, by making use of GoogleMaps. Therefore, Google Maps applications may be a potentially useful and innovative tool for use in PA promotion interventions, even though the effect of using this tool on promoting PA still has to be established.

### **Aiming at promoting and maintaining sports participation among younger adolescents**

Sports participation declines rapidly during adolescence, thus it is important to also focus on maintenance instead of initiating sports participation. These declines were stronger for girls, adolescents of non-Western descent and lower educated adolescents as compared to boys, adolescents of Western descent and higher educated adolescents. Therefore, special attention should be paid to these specific groups of adolescents in the promotion and maintenance of sports participation.

## 5. IMPLICATIONS OF STUDY FINDINGS FOR SCIENCE

### Replication of the findings in this thesis

The studies in this thesis contributed to the evidence with regard to potential mediating and moderating pathways through which the physical environment may influence PA among adolescents. Further research is still required to generate a larger body of evidence and to draw more final conclusions on the influence of physical environmental factors on PA. The findings in this thesis, especially with regard to the mediation and moderation analyses, need to be replicated and extended (e.g. study moderation of factors in the physical environment with other cognitive or environmental factors) to draw firmer conclusions. In conducting further research, it is important to make a clear distinction between objective and subjective (i.e. perceived) assessments of the physical environment. As these two different constructs measure different aspects of “the environment”, researchers should be clear in which measure is used in reporting results.

### Use specific measures of the environment, cognitions and behaviour

To be able to appropriately link factors in the physical environment with behaviour, future studies should focus on studying associations between very specific elements in the environment that match with specific behaviour (e.g. “the influence of availability of running tracks on leisure time running is mediated by attitudes towards leisure time running on running tracks”).

New technologies may facilitate finding a better match between specific factors in the physical environment and PA. For instance, by using technologies that can discriminate between types of activity based on accelerometry measurement. On the environmental side, the tracking of GPS signals seems promising. If advanced processing of accelerometer data and GPS systems are combined, much better insight in the influence of environmental factors on PA behaviour can be obtained.

### Continue research on social environmental influences on PA

NSC has found to be a potentially important correlate of sports participation. This was especially the case when there were also plenty of parks within that neighbourhood. However this study had a cross-sectional design and stronger designs, such as longitudinal studies and intervention studies are required to draw firmer conclusions about the association of NSC with PA.



### **Provide more evidence on methods which make computer-tailored interventions among adolescents more effective**

One of the potential reasons for the low appreciation and use of YouRAction may be the comprehensiveness of the intervention. It should be tested what methodologies are needed in a computer-tailored intervention to be effective among adolescents. Moreover, given the promise of incorporating environmental feedback in computer-tailored interventions, this should continue to be studied.

## **6. GENERAL CONCLUSION**

The studies presented in this thesis showed no evidence for a direct association between objectively measured availability of facilities to be active and adolescent PA. Compared to objectively measured availability of facilities, perceived availability was stronger correlated with PA behaviour among adolescents. Cognitive and social environmental factors were also stronger correlates of adolescent PA than objective availability of facilities to be active.

However, even though no direct association between physical environmental factors and PA were found, environmental factors may play a role in combination with other factors such as intention or NSC on promoting sports participation among adolescents. It was found that when either a high intention or high levels of social capital were present in combination with high objectively measured facilities, adolescent were most likely to participate in sports. Individual level factors remain, therefore, important targets in interventions to promote PA.

The comprehensive theory and evidence based YouRAction and YouRAction+e interventions were not effective in promoting MVPA among adolescents in the first year of secondary education. An important explanation for the lack of effects is insufficient implementation and exposure to the intervention content, due to technical problems.

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# Appendices

## APPENDIX A. ESTIMATING NEIGHBOURHOOD SOCIAL CAPITAL

The model estimating Neighbourhood Social Capital (NSC) is as follows:

$$Y_{ijk} = \gamma_{000} + \sum_{m=1}^1 \alpha_m D_{mijk} + \sum_{q=1}^6 \delta_q X_{qjk} + v_{00k} + u_{0jk} + e_{ijk}$$

where,  $Y_{ijk}$  is the response to item  $i$  of adolescent  $j$  in neighbourhood  $k$ ,  $\gamma_{000}$  is the grand mean of NSC,  $m$  is the number of social capital variables (two in total, one serves as reference),  $D$  are item dummies,  $q$  is the number of individual level adjusters (6 in total),  $X$  are the adjuster variables,  $v$  is the neighbourhood variance,  $u$  is the individual variance, and  $e$  is the item variance.

The most important parameters are the neighbourhood level residuals,  $v$ , which indicate the degree to which social capital of neighbourhood  $k$  differs from the grand mean,  $\gamma_{000}$ . These residuals constitute the NSC measure. Positive values indicate higher than average levels of NSC.

The reliability of NSC is estimated by

$$\lambda_k = \frac{\sigma^2}{\sigma^2 + \frac{\tau^2}{J_k} + \frac{\omega^2}{nJ_k}}$$

, where  $\sigma^2$  is the variance on neighbourhood level,  $\tau^2$  is the variance between individuals per neighbourhood, and  $\omega^2$  is the variance between the items.  $J_k$  is the number of individuals in neighbourhood  $k$ . Finally,  $n$  is the number of items to measure NSC.

The average reliability of our econometric-based NSC measurement is 0.57. The correlation—performed at the neighbourhood level—between an aggregated social capital measure and the econometrics-based social capital measure is 0.80.

## APPENDIX B. URLS TO DEMO MOVIES YOURACTION



### **Demo movie of an interactive map to explore the home neighbourhood**

**Description:** This movie shows strategies incorporated in the YouRAction intervention to actively explore possibilities to be physically active in the home neighbourhood.

**URL:** <http://www.biomedcentral.com/content/supplementary/1471-2458-10-474-S1.SWF>



### **Demo movie of an interactive map showing availability of parks**

**Description:** This movie shows strategies incorporated in the YouRAction intervention to change perceptions of availability of parks in the neighbourhood by giving adolescents an overview of what is available.

**URL:** <http://www.biomedcentral.com/content/supplementary/1471-2458-10-474-S2.SWF>



## APPENDIX C. DESCRIPTION OF PROCESS EVALUATION MEASURES

Category	Item	Scale
Appreciation	YouRAction was fun to use	totally disagree (1) – totally agree(5)
	YouRAction was interesting	totally disagree (1) – totally agree(5)
	How would you rate YouRAction on a scale from 1 (worst) to 10 (best)?	1-10
Personal relevance	Advices and questions in YouRAction were specially meant for me	totally disagree (1) – totally agree(5)
	The advices that the YA program gave me suited me well	totally disagree (1) – totally agree(5)
Content of advice	I learned a lot from YouRAction	totally disagree (1) – totally agree(5)
	The advice provided by YouRAction was useful	totally disagree (1) – totally agree(5)
	I could adhere to the advice	totally disagree (1) – totally agree(5)
Usability	YouRAction was easy to use	totally disagree (1) – totally agree(5)
	YouRAction was easy to understand	totally disagree (1) – totally agree(5)
Technical problems	Did you experience technical problems during working with YouRAction. If so, which problems?	“No, I had no problems”, “The program was difficult to use”, “I could not log in”, “The program was too slow”, “I got stuck in the program”



# Summary/Samenvatting



## SUMMARY

Not engaging in sufficient levels of physical activity (PA) during adolescence is correlated with a number of diseases and negative health outcomes. Moreover, adolescents who are insufficiently active have higher chances of being insufficiently active as an adult. Based on the Dutch PA guidelines (adolescents should engage in moderate-to-vigorously physically active (MVPA) for at least one hour each day), approximately one quarter of the Dutch adolescents are sufficiently physically active. Therefore PA levels of Dutch adolescents should be increased.

In order to promote PA levels, it is important to focus on important and modifiable determining factors, which can be targeted in interventions. Various models and empirical evidence suggest that individual level factors may partly determine PA. Examples of these factors include attitude, subjective norm, perceived behavioural control, intention and awareness of PA levels. According to socio-ecological models also environmental factors, such as availability of facilities to be active, may be of importance to PA. Moreover, these environmental factors are hypothesized to act together with individual level factors as determinants of PA. One way in which environmental factors may interplay with individual level factors is through mediation; it is hypothesized that the association between environmental factors and PA is mediated (i.e. explained) by cognitions. A second way they may interplay is through moderation; associations between, for example, intention and PA may become stronger or weaker based on the availability of facilities to be active. However, the evidence with respect to the influence of environmental factors on PA and the proposed interplay between environmental and individual level factors is limited. Research is needed to better understand how these factors potentially determine MVPA among adolescents. That is what the first part of this thesis aimed for.

Insights in the aforementioned influences of the physical environment together with individual level factors may aid intervention development to promote PA among adolescents. This should be done by using theory and evidence based techniques to promote PA. Computer-tailoring is a promising technique to promote PA among adults and adolescents. However, traditionally only cognitive factors are targeted in such computer-tailored interventions. Since theory suggests that environmental factors can also be potent determinants of PA, these factors should be targeted in tailored interventions as well. Tailoring on environmental factors may enhance the efficacy of such interventions. Therefore, the second part of this thesis was focused on the development and evaluation of a computer-tailored intervention that aimed to promote MVPA among adolescents by targeting individual cognitions and awareness of opportunities to be active in one's neighbourhood.

This thesis aimed to answer two research questions:

1. How is the physical environment associated with PA behaviour among adolescents? (Part 1)
2. What are the effects of a computer-tailored intervention that targets individual level factors and of a computer-tailored intervention that targets individual and environmental level factors on compliance with the MVPA guideline among Dutch adolescents? (Part 2)

In the first part of this thesis it was explored how the physical environment is associated with PA among adolescents.

In **chapter 2** it was explored whether a decline in sports participation during adolescence differed for various socio-demographic groups (i.e. gender, ethnic background and education). Moreover it was explored which factors (i.e. attitude, subjective norm, perceived behavioural control, intention, perceived safety, perceived attractiveness and perceived availability of sports facilities) could explain these differences. The results of the study presented in this chapter showed that there were large decreases in sports participation between the first and third year of secondary education. The magnitude of the decrease differed for various demographic groups. Girls, were more likely than boys to disengage from sports and girls, lower educated adolescents and adolescents of non-western descent were more likely to cease compliance with the fitnorm. Differences between non-Western and Western adolescents and differences between lower and higher educated adolescents in ceased compliance with the fitnorm could partly be explained by differences in intention to be active. Gender differences in disengagement from sports could partly be explained by perceived safety.

Socio-ecological models propose that environmental factors can have a direct or an indirect influence, through individual cognitions, on PA. Chapters 3 to 6 explicitly focus on the way the physical environment is associated with PA among adolescents.

**Chapter 3** explored whether there is a direct association of the objectively measured availability of parks, sports facilities, sidewalks and bicycle lanes with compliance with the fitnorm (i.e. engaging at least three times per week in sports) and leisure time (LT) active transport. In addition it was explored whether the perceived and objectively measured physical environmental factors differed from each other. This study showed that perceived availability of sports facilities was associated with compliance with the fitnorm and perceived availability of parks was associated with LT walking and cycling. This study further shows that there was no association between objectively measured environmental factors and PA behaviours, but that perceived environmental factors

were associated with PA. Moreover, it was found that there are differences between the objectively measured environment and the perceived environment; the perceived environment is a stronger correlate of PA behaviours and the influences of the perceived environment may be behaviour specific.

Besides a direct effect on PA behaviour, factors in the physical environment may also interplay with other environmental factors or cognitive factors through mediation or moderation. This was explored in chapters 4 (mediation), 5 (interaction with intentions) and 6 (interaction with neighbourhood social capital).

The study described in **chapter 4** studied whether cognitive factors mediated the relation between the objectively measured availability of recreational facilities with objectively measured MVPA. This was done by using data of the Children Living in Active Neighbourhoods study, which took place in Melbourne, Australia. The relations were studied for availability of parks and sports facilities captured at 400, 800 and 2000 meter buffer sizes (i.e. the radius around the home in which the number of facilities were counted). There was no association between the availability of sports facilities and parks in any of the buffer sizes with MVPA. Attitude and self-efficacy were associated with MVPA, but not with the availability of parks and sports facilities. No mediation of cognitive factors on the association between the physical environment and MVPA was found.

In **chapter 5** it was explored whether the objectively measured availability of sports facilities moderates the intention-sports participation relation. It was found that the availability of sports facilities moderated the intention-behaviour association in such a way that when more facilities were available, the association between intention and behaviour was stronger. Hence, when more facilities were available adolescents could better translate their intentions into action than when fewer facilities were available.

The aim of the study presented in **chapter 6** was to study direct influences of neighbourhood social capital (NSC) and objectively measured physical environmental factors on LT sports participation among Dutch adolescents. Moreover it was studied how neighbourhood social capital interacted with objectively measured availability of sports facilities in explaining leisure time sports participation. The results from this study show no evidence for an association between objectively measured physical environmental factors and LT sports participation; NSC was however associated with LT sports participation. The results from this study further show that NSC moderated the relation between availability of parks in the zipcode area and sports participation. Decomposition of the interaction terms revealed that, when neighbourhood social capital was high and the density of parks in that neighbourhood was high, adolescents were most likely to

engage in LT sports. NSC did not moderate the relation between availability of sports facilities and sports participation.

In sum, the studies in the first part of this thesis provided no evidence for a direct, or mediated, effect of the physical environment on PA among adolescents. However, together with a positive intention or high levels of NSC, availability of sports facilities was positively associated with sports participation among adolescents.

The studies presented above (chapters 2-6) provided input for the development and evaluation of two computer-tailored interventions: YouRAction and YouRAction+e.

The development of the YouRAction and YouRAction+e interventions is described in **chapter 7**. These computer-tailored interventions were developed for use in a classroom and targeted adolescents in the first year of secondary education. YouRAction and YouRAction+e were developed by following the Intervention Mapping protocol, which ensures that the intervention is grounded in theory and evidence. The aim of the YouRAction interventions was to promote compliance with the MVPA guideline by 10%. Two versions of the YouRAction intervention were developed: YouRAction, which targets individual level determinants (e.g. awareness of PA levels, attitudes towards PA, perceived behavioural control, goal setting and action planning) and YouRAction+e which additionally targets environmental level determinants (i.e. awareness of opportunities to be physically active in the neighbourhood). Environmental feedback was used as a method to improve awareness of available facilities to be physically active. This feedback was provided by displaying opportunities to be active in the neighbourhood of the adolescent. This application was an interactive web based map (i.e. GoogleMaps) and was found to be feasible to incorporate in the computer-tailored program. Moreover, the provision of information on the opportunities to be active by using GoogleMaps was appreciated by the adolescents who participated in the pre-test.

The results of the evaluation study are described in **chapter 8**. The results of this study showed that the interventions were not effective in promoting compliance with the MVPA guideline among adolescents, which might be due to the sub-optimal implementation of the interventions.

In the final chapter (**Chapter 9**) study findings are integrated and recommendations for practice and future research are given. It was concluded that there is no evidence for a direct association between the objectively measured physical environment and PA among urban adolescents. However, even though there was no direct association between the physical environment and PA among adolescents, the physical environ-

ment was found to be an important factor in combination with social environmental or cognitive factors. When adolescents had a high intention or high level of NSC in combination with high availability of facilities, they were more likely to participate in sports or increase their sports participation. It was also concluded that the YouRAction and YouRAction+e interventions were not effective in increasing compliance to the MVPA guideline, which might be due to sub-optimal implementation of the intervention.



## SAMENVATTING

Onvoldoende bewegen tijdens de adolescentie is gecorreleerd met een aantal ziekten en aandoeningen. Daarnaast hebben jongeren die onvoldoende bewegen een grotere kans om ook een volwassene te worden die te weinig beweegt. De Nederlandse Norm Gezond Bewegen stelt dat jongeren iedere dag minimaal 60 minuten matig intensief moeten bewegen. In Nederland voldoet slechts een kwart van de jongeren aan deze norm. Het is daarom van belang dat Nederlandse jongeren meer gaan bewegen.

Om beweeggedrag te bevorderen is het belangrijk om inzicht te krijgen in belangrijke en veranderbare determinanten. Verschillende modellen en empirisch bewijs laten zien dat individuele factoren, zoals attitude, waargenomen gedragscontrole, intentie en bewustzijn van beweeggedrag, belangrijke determinanten van beweeggedrag zijn. Sociaalecologische modellen veronderstellen dat naast individuele factoren ook omgevingsfactoren, zoals de beschikbaarheid van faciliteiten om te bewegen, mogelijk een invloed hebben op beweeggedrag. De invloed van deze omgevingsfactoren zou volgens deze theorieën in samenspel met individuele factoren van invloed zijn op beweeggedrag, bijvoorbeeld door mediatie of moderatie. Bij mediatie wordt verondersteld dat de invloed van de omgeving op beweeggedrag (deels) verklaard kan worden door individuele factoren. In het geval van moderatie wordt de associatie tussen bijvoorbeeld intentie om te bewegen en beweeggedrag sterker of zwakker naarmate er meer of minder mogelijkheden om te bewegen in de buurt zijn. Het bewijs voor de invloed van omgevingsfactoren op beweeggedrag van jongeren en het samenspel met andere factoren is echter beperkt. Daarom is verder onderzoek nodig om te begrijpen hoe deze omgevingsfactoren gerelateerd zijn met beweeggedrag bij jongeren. Hier richt het eerste deel van dit proefschrift zich op.

De inzichten verkregen uit het eerste deel van dit proefschrift kunnen helpen om een interventie te ontwikkelen die beweeggedrag bij jongeren bevordert. Bij deze interventieontwikkeling moet gebruik gemaakt worden van op theorie en bewijs gestoelde technieken om het beweeggedrag van jongeren te bevorderen. In dit kader is advies-op-maat een veelbelovende techniek. De advies-op-maat interventies die tot dusver ontwikkeld zijn, richten zich voornamelijk op individuele determinanten van gedrag. Gezien de mogelijke invloed van de omgeving op beweeggedrag, zou het meenemen van deze factoren in advies-op-maat, de effectiviteit van deze interventies mogelijk-erwijs vergroten. Het tweede deel van dit proefschrift richt zich daarom op het ontwikkelen en evalueren van een advies-op-maat interventie om matig intensief beweeggedrag bij jongeren te bevorderen. Deze interventie richt zich zowel op individuele als op omgevingsfactoren.

Het doel van dit proefschrift is om de volgende twee onderzoeksvragen te beantwoorden:

1. Hoe is de fysieke omgeving geassocieerd met beweeggedrag bij jongeren?
2. Wat is het effect van een advies-op-maat interventie die ingaat op zowel individuele als op omgevingsdeterminanten van beweeggedrag op het voldoen aan de bewegnorm bij Nederlandse jongeren?

In het eerste deel van dit proefschrift werd geëxploreerd hoe de fysieke omgeving geassocieerd was met beweeggedrag bij jongeren.

In **hoofdstuk 2** werd bestudeerd of de afname in sportparticipatie gedurende de adolescentie verschilde naar demografische groepen (geslacht, etnische achtergrond en opleiding). Verder werd geëxploreerd welke factoren (attitude, subjectieve norm, waargenomen gedragscontrole, intentie, waargenomen veiligheid, waargenomen aantrekkelijkheid van de buurt en waargenomen aanwezigheid van sportfaciliteiten) deze verschillen konden verklaren. De resultaten van deze studie laten zien dat er een grote afname was in sportparticipatie tussen de eerste en derde klas van het voortgezet onderwijs (VO). De mate van afname verschilde voor de verschillende demografische groepen. Meisjes, lager opgeleide jongeren en jongeren van niet-Westerse afkomst hadden een grotere kans om te stoppen met voldoen aan de fitnorm (drie keer per week sporten). Daarnaast hadden meisjes een grotere kans om helemaal te stoppen met sporten dan jongens. Verschillen tussen jongeren van niet-Westerse en Westerse afkomst en tussen laag- en hoogopgeleide jongeren konden gedeeltelijk verklaard worden door de intentie om te bewegen en sporten. Verschillen naar geslacht konden gedeeltelijk verklaard worden door waargenomen veiligheid in de buurt.

Sociaalecologische modellen geven aan dat factoren in de omgeving een directe of een indirecte invloed (via cognities) kunnen hebben op beweeggedrag. De hoofdstukken 3 tot en met 6 van dit proefschrift richten zich op de manier waarop de fysieke omgeving geassocieerd is met beweeggedrag bij jongeren.

In **hoofdstuk 3** werd geëxploreerd of er een directe associatie is tussen de objectief gemeten fysieke omgeving (aanwezigheid van parken, sportfaciliteiten, voetpaden en fietspaden) en voldoen aan de fitnorm en actief transport in de vrije tijd. Daarnaast werd onderzocht of de objectief gemeten en waargenomen fysieke omgeving van elkaar verschilden. De resultaten van deze studie lieten zien dat de waargenomen aanwezigheid van sportfaciliteiten geassocieerd was met het voldoen aan de fitnorm en dat de waargenomen aanwezigheid van parken geassocieerd was met actief transport in de vrije tijd. De objectief gemeten aanwezigheid van faciliteiten om te bewegen was niet

geassocieerd met voldoen aan de fitnorm of actief transport in de vrije tijd. De waargenomen omgeving lijkt een sterkere samenhang te hebben met beweeggedrag dan de objectief gemeten omgeving. Verder bleek dat jongeren gemiddeld minder faciliteiten om actief te zijn waarnemen dan er objectief gezien zijn.

Naast een directe associatie met beweeggedrag, kunnen factoren in de fysieke omgeving ook in samenspel met andere omgevingsfactoren of cognitieve factoren een invloed hebben op beweeggedrag; door mediatie of moderatie/interactie. Dit werd geëxploreerd in hoofdstuk 4 (mediatie), 5 (interactie met intentie) en 6 (interactie met buurt sociaal kapitaal).

In de studie beschreven in **hoofdstuk 4** werd bestudeerd of cognitieve factoren (attitude, eigen-effectiviteit en de gepercipieerde fysieke omgeving) de associatie tussen de objectief gemeten aanwezigheid van faciliteiten om te bewegen (fysieke omgeving) en objectief gemeten matig intensief beweeggedrag mediëren. De analyses van deze studie zijn gedaan op de gegevens van de Children Living in Active Neighbourhoods study (CLAN), welke plaatsvond in Melbourne, Australië. In deze studie zijn de associaties tussen de fysieke omgeving en beweeggedrag bestudeerd voor de aanwezigheid van parken en sportfaciliteiten binnen een straal van 400, 800 en 2000 meter van het huis van de jongeren. Er werd geen associatie gevonden tussen objectief gemeten matig intensief beweeggedrag en de aanwezigheid van faciliteiten in deze stralen. Attitude en eigen-effectiviteit waren wel geassocieerd met objectief gemeten matig intensief beweeggedrag. Er is geen bewijs gevonden voor mediatie van cognitieve factoren in de associatie tussen de fysieke omgeving en matig intensief beweeggedrag.

Moderatie van de objectief gemeten aanwezigheid van sportfaciliteiten op de relatie tussen intentie en sportparticipatie werd geëxploreerd in **hoofdstuk 5**. In dit hoofdstuk werd gevonden dat de aanwezigheid van sportfaciliteiten de relatie tussen intentie en sportparticipatie modereerde. Een nadere beschouwing van de resultaten liet zien dat wanneer er meer sportfaciliteiten aanwezig waren, de relatie tussen intentie en sportparticipatie sterker werd. Dus, als er meer sportfaciliteiten waren was het voor jongeren makkelijker om hun intentie te vertalen in daadwerkelijke actie dan wanneer er minder sportfaciliteiten aanwezig waren.

In **hoofdstuk 6** werd de directe invloed van buurt sociaal kapitaal en de objectief gemeten aanwezigheid van sportfaciliteiten en parken op sportparticipatie in de vrije tijd bestudeerd. Daarnaast werd onderzocht of er interactie was tussen buurt sociaal kapitaal en de fysieke omgevingsfactoren in hun associatie met sportparticipatie in de vrije tijd. De resultaten van deze studie laten zien dat de fysieke omgevingsfactoren

niet geassocieerd waren met sportparticipatie; buurt sociaal kapitaal was echter wel geassocieerd met sportparticipatie. Daarnaast is er een significante interactie gevonden tussen buurt sociaal kapitaal en de dichtheid van parken in het postcodegebied waarin de jongeren woonden in hun associatie met sportparticipatie. Nadere beschouwing van de interactieterm liet zien dat wanneer zowel buurt sociaal kapitaal als de dichtheid van parken hoog was, jongeren de grootste kans hadden om aan sportparticipatie in de vrije tijd te doen.

Samenvattend laten de studies uit het eerste deel van dit proefschrift zien dat er geen bewijs is gevonden voor een directe, of gemedieerde, associatie tussen de aanwezigheid van objectief gemeten fysieke omgevingskenmerken en beweeggedrag bij jongeren. Echter, samen met een positieve intentie of een grote hoeveelheid buurt sociaal kapitaal is de objectief gemeten aanwezigheid van sportfaciliteiten positief geassocieerd met sportparticipatie bij jongeren.

De studies uit het eerste deel van dit proefschrift gaven inzichten voor de ontwikkeling en de evaluatie van twee advies-op-maat interventies: YouRACTION en YouRACTION+e.

De ontwikkeling van beide advies-op-maat interventies staat beschreven in **hoofdstuk 7**. Deze advies-op-maat interventies werden ontwikkeld voor gebruik in de eerste klas van het VO. Doordat de YouRACTION interventies ontwikkeld zijn op basis van het Intervention Mapping protocol, zijn ze goed theoretisch onderbouwd. Het doel van de YouRACTION interventies was om het aantal jongeren dat, 6 maanden na interventiegebruik, voldoet aan de Nederlandse Norm Gezond Bewegen met 10% te verhogen. Beide versies van de interventie richtten zich op individuele determinanten, zoals bewustzijn van beweeggedrag, attitude ten aanzien van bewegen, waargenomen gedragscontrole en actie planning. De uitgebreidere YouRACTION+e interventie richtte zich daarnaast ook op het bewustzijn van mogelijkheden om in de buurt te bewegen. Om jongeren bewust te maken van mogelijkheden om in de buurt te bewegen, werd omgevingsfeedback gegeven door gebruik te maken van GoogleMaps. In deze kaarten werden bijvoorbeeld sporthallen en parken afgebeeld samen met extra informatie over deze faciliteiten en websites. Uit testen van de interventie bleek dat het technisch goed mogelijk was om deze vorm van feedback te gebruiken. Daarnaast waardeerden de jongeren de gegeven informatie over de mogelijkheden om te bewegen in hun omgeving.

In **hoofdstuk 8**, is de effectevaluatie van beide interventies beschreven. De resultaten van deze studie lieten zien dat de interventies geen effect hadden op het bevorderen van het aantal jongeren dat voldoet aan de Nederlandse Norm Gezond Bewegen; dit had mogelijk te maken met suboptimale implementatie van de interventies.

## Praktische aanbevelingen

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### **Richt interventies op zowel bevordering als op behoud van sport participatie**

Sportparticipatie daalt snel gedurende de adolescentie; veel jongeren doen in de eerste klas van het voortgezet onderwijs echter wél aan sport. Interventies zouden zich daarom niet alleen op het bevorderen van sportparticipatie moeten richten, maar ook op behoud van sportparticipatie.

### **Bevorderen van beweeggedrag bij jongeren: educatie en facilitatie**

De studies in dit proefschrift laten zien dat de aanwezigheid van faciliteiten om actief te zijn in combinatie met buurt social kapitaal en/of een positieve intentie om te bewegen, sportgedrag bevorderen. Daarmee richten interventies zich idealiter op zowel individuele factoren als op omgevingsfactoren.

### **Geen bewijs voor de effectiviteit van de YouRAction interventies**

Hoewel de YouRAction interventies volgens het Centrum Gezond Leven theoretisch goed onderbouwd zijn, is er geen bewijs gevonden voor hun effectiviteit op beweeggedrag bij jongeren. Het is daarom niet aan te bevelen om de interventies te implementeren in hun huidige vorm.

### **Het gebruik van GoogleMaps in advies-op-maat is haalbaar**

Het gebruik van GoogleMaps in advies-op-maat is technisch haalbaar en werd geapprecieerd door jongeren. Hoewel het effect op gedrag nog onderzocht moet worden, lijkt het gebruik van GoogleMaps veelbelovend.

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In het laatste hoofdstuk (**hoofdstuk 9**) werden de bevindingen van de studies beschreven in dit proefschrift geïntegreerd en werden aanbevelingen voor praktijk (zie kader) en toekomstig onderzoek gegeven. Er werd geconcludeerd dat er geen bewijs is voor een directe associatie tussen de objectief gemeten fysieke omgeving en beweeggedrag bij jongeren. De objectief gemeten fysieke omgeving is echter wel een belangrijke factor in combinatie met andere factoren; op omgevingsniveau of op individueel niveau. Wanneer jongeren een positieve intentie hadden om te bewegen of in een buurt woonden met veel buurt sociaal kapitaal in combinatie met veel faciliteiten om te bewegen, was de kans dat jongeren sportten het grootst. Er werd in dit laatste hoofdstuk ook geconcludeerd dat de YouRAction en YouRAction+e interventies niet effectief waren in het bevorderen van het voldoen aan de Nederlandse Norm Gezond Bewegen. Dit had mogelijk te maken met de suboptimale implementatie van de interventies.

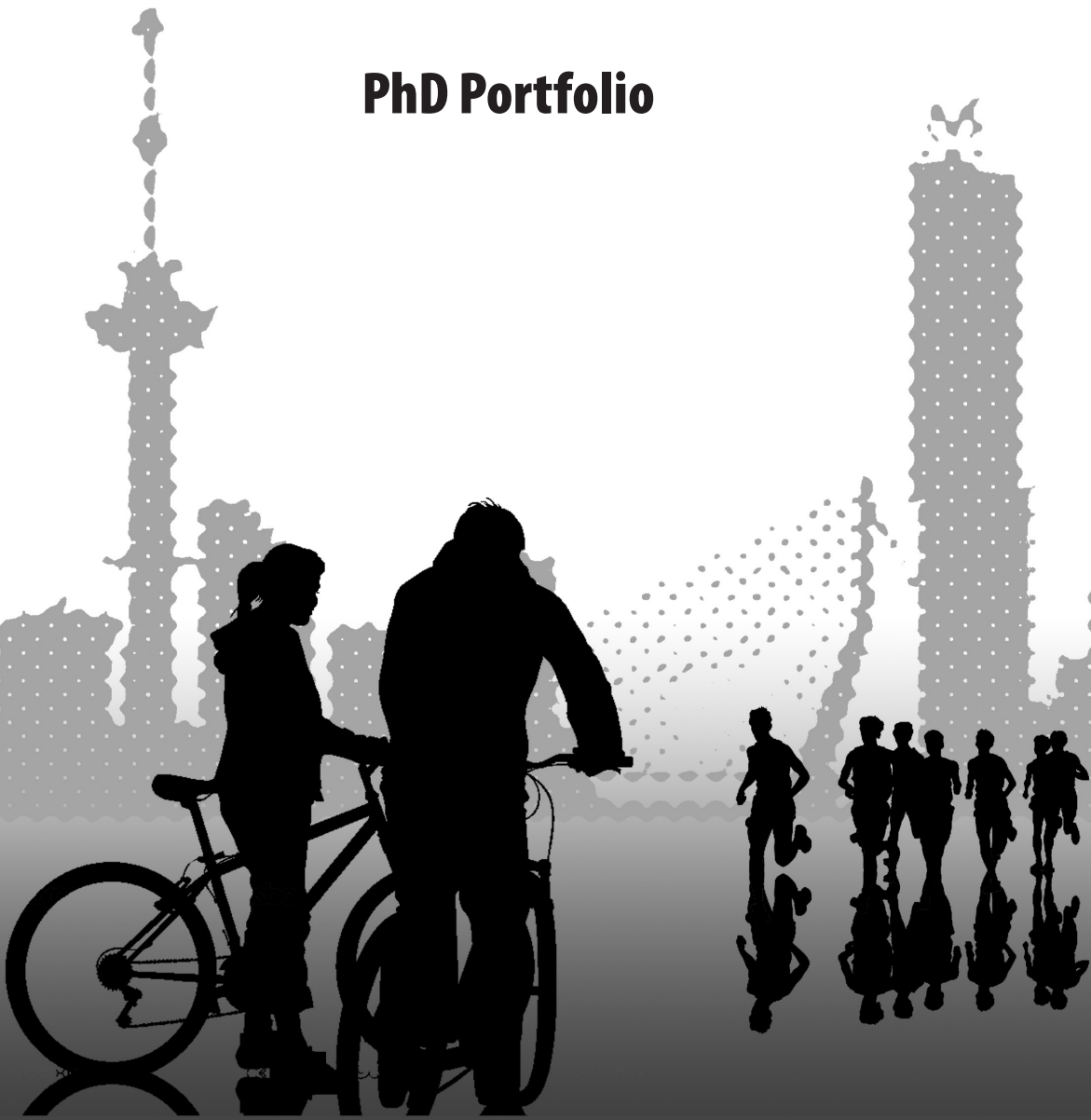


**Dankwoord**

**Curriculum Vitae**

**List of publications**

**PhD Portfolio**







## DANKWOORD

Promoveren is goed te vergelijken met het lopen van een hardloopwedstrijd; je hebt uithoudingsvermogen nodig, maar zonder de juiste mensen om je heen gaat het een stuk lastiger. Promoveren is, net als hardlopen, een prestatie die vaak wordt toegeschreven aan één individu, terwijl anderen een groot aandeel in de prestatie hebben gehad. De mensen die in mijn promotietraject belangrijk voor me zijn geweest, wil ik in dit laatste hoofdstuk bedanken.

De eerste persoon die ik wil bedanken is Anke Oenema, mijn co-promotor en om in hardlooptermen te blijven, mijn trainer. Anke, jij schiep de juiste voorwaarden zodat ik "mijn ding" kon doen. Je hebt me beter leren schrijven, de nodige theoretische basis bijgebracht en geleerd hoe een groot onderzoek op te zetten. Maar naast al dat werk was je ook geïnteresseerd in het leven na(ast) het werk. Dank voor vijf jaren prettig samenwerken.

Tijdens mijn promotietraject heb ik het geluk gehad om met twee promotoren, mijn hoofdcoaches, te werken: Hans Brug en Johan Mackenbach. Hans, we hebben maar heel even samen op MGZ gewerkt. Ik ben erg blij dat je ook vanuit Amsterdam een promotor bent gebleven die me motiveerde. Je was bijvoorbeeld van groot belang toen er opeens wat horden op het traject gezet werden. Daarnaast kon ik fijn met je sparren en discussiëren; uiteindelijk zaten we vaak op één lijn, maar er is één klein dingetje waar we altijd discussie over zullen houden: wat is nou de mooiste club van Nederland?

Met mijn andere promotor, Johan, had ik een kleinere fysieke afstand. En hoewel de fysieke afstand klein was, ligt onze onderzoeksexpertise best wel (relatief) ver uit elkaar. Johan, ik vind het knap hoe je elke keer weer feilloos weet aan te wijzen waar de zwaktes in een manuscript of het project zitten; zelfs als het niet helemaal in jouw expertisegebied ligt.

Alle leden van de promotiecommissie ("de jury") wil ik bedanken voor het lezen van mijn proefschrift en alle tijd die ze daarin hebben gestoken.

Zonder deelnemers geen data en dus, in mijn geval, geen onderzoek. Ik wil daarom alle scholen, docenten en leerlingen bedanken voor hun inbreng. Mariëlle en Linda, jullie hebben enorm bijgedragen aan het ontwikkelen van de YouRAction interventie en het binnenhalen van alle data. Jullie waren voor mij supergoede hazen, die zelfs plannen hebben om zelf de wedstrijd uit te lopen! Ik wil ook Amika, Leen, Stef, Pepijn en Ingrid bedanken voor hun adviezen bij de interventie ontwikkeling. Youri, Ellen, Amely, Cla-

rissa, Laura, Thomas, Fleur, Wilmar, Vanya en Lotte zonder jullie was het niet gelukt om al die vragenlijsten af te nemen, accelerometers op te halen en de metingen te doen.

Als alle data binnen is, moet dit verwerkt worden in goede manuscripten. Ik heb het genoeg gehad om met verschillende mensen - noem het mijn paramedisch team - samen te werken. Een aantal van hen wil ik in het bijzonder bedanken. Allereerst Pepijn; jouw enthousiasme en af en toe verrassende invalshoeken werkten aanstekelijk. Mariëlle - daar sta je weer - dank ook voor het meeschrijven op twee papers en meedenken op vele andere papers (ik herinner me in dat kader nog een slapeloze nacht in Portugal, nadat we in de hotellobby mooie interactiegrafieken hadden gemaakt). Ik ben Klazine dankbaar voor haar werk in het opzetten en uitvoeren van de ENDORSE studie en de discussies die we hebben gevoerd over percepties van de omgeving. Frank, hopelijk kunnen we nog lang discussiëren over sociaal epidemiologische methoden en allerlei voorspellers van gedrag/gezondheid. Ik kijk erg uit naar de komende jaren van verdere samenwerking. Carlijn, dank voor je scherpe opmerkingen bij het schrijven van hoofdstuk 2 van dit proefschrift. Bedankt Saskia, voor de vliegende start die je me gaf en voor de multilevel analyses waar je me bij hebt geholpen. Sigrid, zonder jouw inzet had het hoofdstuk over sociaal kapitaal er heel anders uitgezien – of misschien was het er dan wel helemaal niet geweest. Danke schön!

David, thank you for inviting me to join your group for a couple of weeks at Deakin University. I am very happy that this resulted in an interesting paper which is part of this thesis. Kylie, Jo and Anna thanks for all advices and support you gave me on my work I did on the CLAN study. LUKAR, you definitely added one unforgettable experience to my life; kicking a footy is not as easy as it seems (and punching it – probably with a bad technique - over 10 times hurts).

Trainen voor een hardloopwedstrijd doe je niet alleen. Daarom wil ik mijn “medelopers en trainingsmaatjes” bedanken voor besprekingen, etentjes, koffie, et cetera. Mariëlle (alweer), Ilke, Lenneke, “de Mirjams”, Nicolien, Lidy, Noortje, Jan, Marieke en Ilse, hoeveel uur hebben we doorgebracht met een bak koffie bij het DE-cafe? – ik denk minimaal 3 papers. Vicki, Lenneke en Britt, wij zijn met z’n viertjes als enige oud-DGGers over op MGZ – dat scheidt een mooie band en ik ben dan ook blij dat we onze expertise actief blijven delen in onze eigen bijeenkomsten. Jitske, je begon bij mij als stagestudent en hebt inmiddels al voor verschillende projecten als onderzoeksmedewerker gewerkt; ik kijk uit naar onze toekomstige samenwerking. Bij Nicole heb ik het trucje af kunnen kijken; jij liep steeds net wat op mij voor en kon daardoor veel van mijn vragen beantwoorden. Wendy, ook op jouw kamer heb ik aardig wat koppen koffie gedronken. Helaas is je kamer nu wat te ver...

Suzan, we zitten vandaag volgens mij op de kop af vijf jaar bij elkaar op een kamer. In die vijf jaar hebben we veel zin maar ook onzin met elkaar gedeeld. Op naar nog een paar jaren zin en onzin en BBQ's!? Van enveloppen vouwen in de Soos tot Sambuca's in Cluj-Napoca en van IM irritaties tot de eerste publicaties, met jou, Lenneke, liep ik gelijk op. Fijn dat we het laatste stukje ook samen doen en bijna hand-in-hand over de finish komen! Jullie hebben beiden elke punt en komma van mijn proefschrift meegemaakt (inclusief alle "major breakthrough" bevindingen die ik later altijd feilloos wegcorrigeerde) en ik ben blij dat jullie mij over de finish willen brengen.

Elke hardloper weet dat supporters je nét dat beetje extra geven, wat van essentieel belang is om de wedstrijd lekker uit te lopen. Sanne en Carolien, als oprichtsters van Victory Camp, maar ook daar buiten, zijn jullie een grote inspirator voor mij geweest. @berlotti BIM, bam, bom (dat heb ik altijd al willen zeggen)! Dank voor de leuke on- en offline gesprekken. Gerjan en Marleen, we wonen helaas niet meer bij elkaar om de hoek, maar onze bezoeken zijn altijd erg lekker en ontspannend. Hopelijk kunnen we snel onze, door allerlei "blessures" uitgestelde, mountainbiketocht maken. Af en toe een weekendje bier drinken, wat cultuur opsnuiven en terugkomen met goede onderzoeksideo's – dat is wat de Resolution "bedrijfsuitjes" in een notendop zijn. Dank Egbert en Michiel, waar gaan we dit jaar heen? Ilse en Bert, dank voor alle lekkere door-de-weekse Houtense bakkies en fijne gesprekken.

Mijn trouwste supporters zijn toch wel mijn schoonfamilie en familie. Paul, Hanny, Dick, Marieke en Rick, Peter en Willemijn en natuurlijk ook Dox, Mees, Kee, Puck en Tijn – ik heb de afgelopen jaren genoten van de etentjes, familieweekenden, de Kennedymars, mountainbiken en tafeltennissen op zolder (en ingemaakt worden door Dox en Mees). Jullie zijn een "skon familietje". Opa en Oma Prins, bedankt voor alle mooie dingen die we hebben gedaan; met als hoogtepunt ons borrelende uitje naar Arnhem. Myrthe – lieve zus – jouw luisterend oor is erg fijn. Dank voor de meestal erg grappige en relativerende virtuele gesprekken die we voerden wanneer ik in het buitenland was. Mark – bro – af en toe wilde ik wel eens dat ik jouw nuchtere kijk op dingen had... en met Kim heb je voor mij een uitstekende schoonzus gevonden! Papa en mama, bedankt voor de prettige en veilige omgeving waarin ik opgroeide en het geloof in mij – ook als het even niet ging zoals gepland. Maar ook alle ondersteuning in de afgelopen vijf jaar waren erg fijn en belangrijk; van het afstraten van onze tuin toen ik in Australië was tot leuke ontspannende uitjes, etentjes, borrels (veel anders kun je onze vrijdag/zaterdagavond niet noemen) en aanmoedigingen tijdens mijn triatlon.

En tot slot, lieve Marijn....



## CURRICULUM VITAE

Richard Geuchien Prins was born on 29<sup>th</sup> October 1982 in Zwolle and was raised in Balkbrug. In 2001 he graduated from secondary school (van der Capellen Scholengemeenschap, Zwolle). Subsequently, he started studying Human Movement Sciences at the VU University in Amsterdam. He obtained his Master of Science degree in 2005 with a major in "human movement at the workplace". While finishing his Master thesis, he started working as product developer at Lifeguard in Utrecht. In 2006 he started with the PhD project which resulted in this thesis on environmental influences on physical activity among adolescents at the Department of Public Health of the Erasmus MC in Rotterdam. Meanwhile he completed the Master of Science programma of the Netherlands Institute for Health Sciences (Nihes), with a specialization in public health in 2009. He is currently working as a researcher at the Department of Public Health, Erasmus MC, Rotterdam on environmental influences on walking among older adults.

Richard Geuchien Prins is geboren op 29 oktober 1982 in Zwolle; hij groeide op in Balkbrug. In 2001 behaalde hij zijn VWO diploma aan de van der Capellen Scholengemeenschap te Zwolle. Daarna ging hij Bewegingswetenschappen studeren aan de Vrije Universiteit in Amsterdam. Daar studeerde hij in 2005 af met een specialisatie in "bewegen in de context van arbeid". Tijdens het schrijven van zijn afstudeerscriptie, startte hij als productontwikkelaar bij Lifeguard in Utrecht. In 2006 startte hij met zijn promotieproject naar omgevingsinvloeden op beweeggedrag bij jongeren, aan de afdeling Maatschappelijke Gezondheidszorg van het Erasmus MC in Rotterdam. In deze periode volgde hij de opleiding Public Health bij de Netherlands Institute for Health Sciences (Nihes), die hij in 2009 met een Master of Science afrondde. Momenteel werkt hij als onderzoeker op de afdeling Maatschappelijke Gezondheidszorg van het Erasmus MC en doet hij onderzoek naar de invloed van de omgeving op beweeggedrag bij ouderen.



## LIST OF PUBLICATIONS

### 2011

Prins RG, Ball K, Timperio A., Salmon J., Oenema A., Brug J., Crawford D. Associations between availability of facilities within three different neighbourhood buffer sizes and objectively assessed physical activity in adolescents. *Health and Place*, 2011;17(6):1228–34

Bere E., Oenema A., Prins RG., Seiler S., Brug J. Longitudinal associations between cycling to school and weight status. *Int J Pediatr Obes*. 2011;6(3-4):182-7

### 2010

Prins RG, Van Empelen P, Beenackers M, Brug J, Oenema A. Systematic Development of the YouRAction program, a computer-tailored Physical Activity promotion intervention for Dutch adolescents, targeting personal motivations and environmental opportunities. *BMC Public Health* 2010;10:474

Prins RG, van Empelen P, te Velde SJ, Timperio A, van Lenthe FJ, Tak NI, Crawford D, Brug J, Oenema A. Availability of sports facilities as moderator of the intention-sports participation relationship among adolescents. *Health Ed. Res* 2010;25(3):489-97

### 2009

Prins RG, Oenema A, van der Horst K, Brug J. Objective and perceived availability of physical activity opportunities: differences in associations with physical activity behavior among urban adolescents *Int J Behav Nutr Phys Act* 2009;6:70

### 2008

Bere E, van der Horst K, Oenema A, Prins R, Brug J. Socio-demographic factors as correlates of active commuting to school in Rotterdam, the Netherlands. *Prev Med*. 2008 47(4):412-6.

### Submitted

Prins RG, Kamphuis CBM, van Empelen P, Beenackers M, Mackenbach J., Brug J, Oenema A. Explaining sociodemographic differences in disengagement from sports in adolescence

Prins RG, Mohnen SM, van Lenthe F, Brug J, Oenema A. Are Neighbourhood Social Capital and availability of sports facilities related to sports participation among Dutch adolescents?

**In press**

Prins RG, van Empelen P, Brug J, Oenema A. Studying the effectiveness of YouRAction, a computer-tailored intervention to promote physical activity among adolescents using personal and environmental feedback: a cluster randomized trial. PLoS ONE, in press



# PhD Portfolio

## SUMMARY OF PHD TRAINING AND TEACHING ACTIVITIES

Name PhD student: R.G. Prins	PhD period: 2006-2012
Erasmus MC Department: Public Health	Promotor(s): J. Brug, PhD; J.P. Mackenbach, PhD
Research School: NIHES	Supervisor: A. Oenema, PhD

### 1. PhD training

	Year	Workload (Hours/ECTS)
<b>General academic skills</b>		
- Master of Public Health, Netherlands Institute for Health Sciences (NIHES), Erasmus MC, Rotterdam, the Netherlands	2006-2009	70 ECTS
<b>Specific courses</b>		
- Planning Health Promotion Programs: an Intervention Mapping approach, Maastricht University	2007	16 hours
- Mplus Short Courses: Multilevel Modelling With Latent Variables, Frei Universität Berlin	2009	20 hours

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**Presentations**

- Fysieke omgeving en lichamelijke activiteit: GIS in advies op maat (CEPHIR seminar)	2007	12 hours
- Associations of perceived and objective environmental factors with physical activity in adolescents (poster presentation at ISBNPA, Oslo, Norway)	2007	12 hours
- Development of a novel computer-tailored intervention that incorporates environmental information (poster presentation at ICPAPH, Amsterdam, the Netherlands)	2008	12 hours
- An exploration of 'perceived' and 'objective' environmental factors as correlates of adolescent physical activity (ISBNPA, Banff, Canada)	2008	12 hours
- Future directions: the YouRAction program (Department of Public Health)	2008	12 hours
- Motivating adolescents to be physically active. An application of computer-tailoring (Centre for Physical Activity and Nutrition Research, Deakin University, Burwood, Australia)	2009	12 hours
- The YouRAction program. A computer-tailored physical activity promotion intervention for adolescents targeting individual motivations and environmental opportunities (ISBNPA, Cascais, Portugal)	2009	12 hours
- Flitspresentatie interventies jeugd & overgewicht (CEPHIR seminar)	2010	12 hours
- Availability of sports facilities as a moderator of the intention – sports participation association in adolescents (EHPS, Cluj-Napoca, Romania)	2010	12 hours
- YouRAction: een advies-op-maat interventie gericht op cognitieve en omgevingsdeterminanten (MUSC meeting, Erasmus MC)	2010	12 hours
- Evaluatie van YouRAction: een advies-op-maatinterventie met individuele en omgevingsfeedback ter bevordering van beweeggedrag bij jongeren (NCVGZ)	2011	12 hours
- Can demographic differences in quitting compliance with the "fit norm" in adolescence be explained by cognitive constructs? (Poster presentation ISBNPA, Melbourne, Australia)	2011	12 hours
- Evaluation of YouRAction: "a computer-tailored intervention providing individual and environmental feedback to promote physical activity among adolescents" (ISBNPA, Melbourne, Australia)	2011	12 hours

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**(Inter)national conferences**

- 6 <sup>th</sup> Conference of the International Society of Behavioral Nutrition and Physical Activity (ISBNPA), Oslo, Norway	2007	24 hours
- 7 <sup>th</sup> Conference of the International Society of Behavioral Nutrition and Physical Activity (ISBNPA), Banff, Canada	2008	24 hours
- International Congress on Physical Activity and Public Health (ICPAH), Amsterdam, the Netherlands	2008	24 hours
- 8 <sup>th</sup> Conference of the International Society of Behavioral Nutrition and Physical Activity (ISBNPA), Cascais, Portugal	2009	24 hours
- 24 <sup>th</sup> European Health Psychology Conference (EHPS), Cluj-Napoca, Romania	2010	24 hours
- Nederlands Congres Volksgezondheid (NCVGZ), Rotterdam, the Netherlands	2010	16 hours
- 10 <sup>th</sup> Conference of the International Society of Behavioral Nutrition and Physical Activity (ISBNPA), Melbourne, Australia	2011	24 hours
- Nederlands Congres Volksgezondheid (NCVGZ), Amsterdam, the Netherlands	2011	8 hours

**Seminars and workshops**

- Department of Public Health seminars	2006-2011	100 hours
- Pre-conference workshop ISBNPA "Qualitative research methodology", Oslo, Norway	2007	8 hours
- Pre-conference workshop ISBNPA "Physical activity measurement", Banff, Canada	2008	8 hours
- Pre-conference workshop EHPS "Mechanisms of Health Behaviour Change", Cluj-Napoca, Romania	2010	8 hours
- Pre-conference workshop ISBNPA "Technology based diet and physical activity assessment", Melbourne, Australia	2011	4 hours
- Pre-conference workshop ISBNPA "Healthy Parks Healthy People", Melbourne, Australia	2011	4 hours

**2. Teaching activities**

	<b>Year</b>	<b>Workload (Hours/ECTS)</b>
<b>Lecturing</b>		
- Curriculum Medical Students, 1 <sup>st</sup> and 2 <sup>nd</sup> year, Erasmus MC, Rotterdam: lectures as part of themes 1.S/2.2: 'Disorders in nutrition, metabolism and hormonal regulation'.	2009-2010	20 hours
<b>Supervising Master's theses</b>		
- J.M. de Graaf. Thesis title: 'Immediate effects of a Google maps application and a web movie on self-efficacy for perceived availability of physical activity facilities and perception of the environment among adolescents regarding physical activity: a randomized controlled trial'	2010	45 hours
- S. Seldenthuis. Thesis title: 'The renewed YouRAction program: redevelopment, implementation and evaluation of a computer-tailored intervention to promote physical activity among adolescents'	2011	45 hours
<b>3. Other activities</b>		
- Treasurer of Promeras (Association for PhD-students at Erasmus MC)	2007-2008	20 hours