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Department of Movement and Sports Sciences**

The effectiveness of an intervention promoting physical activity in elementary school children

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Summary

Regular physical activity (PA) is an important component of a healthfully lifestyle in children and adolescents. While children are more active than adults, a substantial proportion of young people have lower activity levels than those desirable for good health. Furthermore, it is well documented that PA levels decline from childhood to adulthood and tracking studies have revealed that low levels of PA remain stable from adolescence into adulthood. Therefore, the promotion of lifelong PA among youth should be emphasized at an early age. The school environment is an ideal setting for the promotion of PA, since all children can be reached. Schools can provide opportunities to engage in PA during physical education (PE) classes, during recess periods and after school hours. Additionally, schools can teach the children behavioral skills necessary to develop and maintain an active lifestyle. The main purpose of this thesis was to evaluate the effectiveness of a comprehensive PA promotion intervention in elementary school children. Furthermore, the effectiveness of some of the intervention components was evaluated. Sixteen elementary schools participated in the intervention study. They were randomly assigned to the intervention ($n = 8$) and control condition ($n = 8$). The intervention included a health-related PE program, classroom-based health-education lessons and an extracurricular PA promotion program. However, before evaluating the intervention, the validity of a questionnaire measuring children's usual PA was evaluated in a preliminary study. The results indicated that the questionnaire, completed with parental assistance, is useful to measure children's usual PA levels. The evaluations of the intervention study revealed that the comprehensive PA promotion intervention was effective in promoting PA in elementary school children. The intervention was successful in preventing the age-related decline in children's total PA participation. Moreover, the intervention was successful in promoting PA both at school and in leisure time. Children in the intervention condition reported more moderate intensity activity in leisure time than the controls. Moreover, the health-related PE program was found to be promising in promoting PA during PE classes. Furthermore, providing game equipment during recess periods was effective in increasing children's activity levels during those periods. However, no intervention effects were found on children's physical fitness and psychosocial correlates of PA. A strong point of the intervention was the integration of several school environmental factors to promote lifelong PA, including PE classes, health-education classes, recess periods and extracurricular activities. Furthermore, the intervention was not expensive and most components could be implemented within the existing school programs by the schools themselves. Therefore, implementation of the intervention in elementary schools needs to be encouraged.

Samenvatting

Voldoende bewegen is ook voor kinderen en adolescenten een belangrijke component voor een gezonde levensstijl. De meeste jongeren doen veel aan sport en beweging maar toch blijkt een deel van de jongeren een lagere activiteitsgraad te hebben dan aanbevolen om gezondheidsvoordelen te ervaren. Het is ook aangetoond dat de activiteitsgraad daalt tijdens de kinderjaren en adolescentie, en kinderen die niet actief zijn, hebben een grotere kans om fysiek inactieve volwassenen te worden. De promotie van sport en beweging is bijgevolg al nodig op jonge leeftijd. De school is een ideale setting voor de promotie van sport en beweging gezien bijna alle jongeren kunnen bereikt worden. Via het schoolsysteem kunnen sport en beweging zowel op school (tijdens de les lichamelijke opvoeding, de middagpauze, speeltijden en naschools) als buiten school gepromoot worden (leerlingen aanleren hoe ze een actieve levensstijl kunnen ontwikkelen en behouden). Het hoofddoel van deze thesis was om de effectiviteit van een tweejarige interventie ter promotie van sport en beweging na te gaan bij kinderen van de lagere school. Zestien basisscholen in Oost-Vlaanderen namen deel aan het onderzoek (interventiegroep: 8 scholen, controlegroep: 8 scholen). De interventie bestond uit drie componenten: een component waarbij gezondheidsgerelateerde lichamelijke opvoeding werd gepromoot, een component waarbij extra-curriculaire bewegingsactiviteiten werden aangeboden (georganiseerde bewegingsactiviteiten tijdens de middagpauze en speelkoffers met spel materiaal om een actieve speelplaats te promoten) en een component waarbij zelf-management lesjes werden gegeven in de klas. In een pilotstudie werd eerst de validiteit van een vragenlijst nagegaan. De resultaten toonden aan dat de vragenlijst betrouwbaar was om de sport- en bewegingsactiviteiten te meten van de kinderen wanneer deze samen met 1 van de ouders werd ingevuld. De evaluatie van de tweejarige interventie toonde aan dat de interventie een positief effect had op de activiteitsgraad van de leerlingen. De totale hoeveelheid dagelijkse beweging van de leerlingen in de interventiegroep daalde minder dan deze in de controlegroep. Vervolgens bleek dat promotie van sport en beweging via het schoolsysteem kan leiden tot een hogere activiteitsgraad van de leerlingen op school en buiten school. Gezondheidsgerelateerde lichamelijke opvoeding resulteerde in een duidelijke toename van de hoeveelheid beweging tijdens de les lichamelijke opvoeding en het aanbieden van spel materiaal tijdens de speeltijd en de middagpauze deed de activiteitsgraad van de leerlingen toenemen tijdens deze momenten. Tot slot werd aangetoond dat de promotie van sport en beweging via het schoolsysteem resulteerde in een toename van de tijd gespendeerd aan matig intense bewegingsactiviteiten tijdens de vrije tijd. Er werd geen effect gevonden op de fysieke fitheid van de leerlingen en hun psychosociale determinanten. Gezien de promotie van sport en beweging reeds op jonge leeftijd nodig is, moeten dergelijke programma's worden aangemoedigd.

Chapter 1

General introduction

Definitions of physical activity, fitness and health in children

Although the terms “physical activity”, “exercise”, “sports”, “physical fitness” and “health” are commonly used in the spoken language, a clear definition of those terms seems necessary.

“Health” was defined at the 1988 Consensus Conference as ‘a human condition with physical, social, and psychological dimensions, each characterized on a continuum with positive and negative poles. Positive health is associated with the capacity to enjoy life and to withstand challenges. It is not only the absence of a disease. Negative health is associated with morbidity and in the extreme, with premature mortality’ (Bouchard & Shephard, 1994).

“Physical activity” can be defined as ‘any body movement produced by the skeletal muscles, resulting in energy expenditure’. Physical activity is a complex behavior and can be subdivided into different categories such as leisure time activities and occupational activities. Leisure time physical activity can be further subdivided into categories such as sports, exercises, household tasks and other activities. Thus, “sports and exercise” are subcategories of physical activity. “Exercise” is ‘physical activity that is planned, structured, repetitive and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective’. As many sports are performed to improve and maintain components of physical fitness, they can be considered exercise. “Habitual physical activity” refers to the overall level of regular physical activity engagement (Bouchard & Shephard, 1994; Caspersen, Powel, & Christenson, 1985).

“Physical fitness” is generally considered to be ‘a set of attributes or components that people have or achieve and that relates to the ability to perform physical activity’. The set of components are related to performance as well as to health. “Health-related fitness” has been defined as ‘the ability to perform daily activities with vigor and the capacity associated with a low risk of premature development of hypokinetic diseases’. It refers to those components of physical fitness that are affected favorably or unfavorably by habitual physical activity and that are related to health status. The most accepted components of health-related physical fitness include cardiorespiratory fitness, muscular strength and endurance, body composition and flexibility. “Performance-related fitness” refers to those components of physical fitness that are necessary for optimal work or sport performance. It is defined in terms of the individual’s ability in athletic competition, a performance test or occupational work.

However, a clear separation between “performance-related” and “health-related fitness” is not possible (Bouchard & Shephard, 1994; Caspersen et al., 1985)

Studies investigating the relationship between physical activity and health-related physical fitness in children (using a variety of indicators within each domain) indicate a significant small to moderate relationship (Katzmarzyk, Malina, Song, & Bouchard, 1998; Malina, 2001). Sallis, McKenzie, and Alcaraz (1993) showed that active children appear to engage in a sufficient variety of activities to enhance multiple components of health-related fitness, implying that increasing children’s overall activity levels is recommended to improve children’s health-related physical fitness. However, it is difficult to investigate the relationship between physical activity and physical fitness in children since factors other than physical activity also exert an influence on the health-related physical fitness in children (e.g., health status, diet, growth and maturation, heredity) (Bouchard & Shephard, 1994).

In this thesis a distinction between children and adolescents was made. Children were defined as 6- to 12-year-olds (= elementary school children). Adolescents were defined as 13- to 18-year-olds (= secondary school students).

Measurements of physical activity and fitness in children

The accurate measurement of children’s physical activity patterns, which are typically spontaneous and intermittent, is extremely difficult. Moreover, physical activity is a complex behavior with different dimensions (frequency, intensity, time and type). Different techniques for the assessment of physical activity measure different dimensions of physical activity (Welk, Corbin, & Dale, 2000). To date, a wide range of methods have been used to quantify children’s physical activity behavior. These methods include doubly labeled water, direct observation, motion sensors (pedometers, accelerometers), heart rate monitoring and self-reports (recall questionnaires, interviews, diaries, proxy-reports). However, a gold standard for assessing physical activity levels in children is missing, which implies that any criterion physical activity measure will contain random measurement errors (Kohl, Fulton, & Caspersen, 2000; Sirard & Pate, 2001; Welk et al., 2000). Doubly labeled water is an expensive but accurate measure of energy expenditure, but it provides no data on children’s physical activity patterns. Although self-reports are commonly used in large field studies

because of their low cost, self-reports in children are associated with problems like recall limitations and inaccurate reporting of the duration and the intensity of physical activities. Therefore, the use of self-reports in children aged less than 10 years is discouraged (Kohl et al., 2000; Sallis, 1991). Objective measurements are an alternative to self-reports in children. While accelerometers and heart rate monitors objectively measure the frequency, intensity and duration of children's physical activity; direct observation can provide additional information concerning the type of activities performed, the environmental setting and the related social interactions. However, all have their specific limitations in measuring children's physical activity. Heart rate monitoring is not appropriate to measure periods of relative inactivity, implying that heart rate monitoring can potentially mask children's intermittent activity patterns. Pedometers only provide information about the relative volume of activity performed. Accelerometers are insensitive to several forms of children's physical activity (cycling, stair climbing, swimming, etc.) and it is difficult to convert their output (counts) to units of energy expenditure in children. Nevertheless, accelerometry is a very popular technique in physical activity research in children (Sirard & Pate, 2001; Trost, 2001; Welk et al., 2000). However, the method of choice will largely depend on the study design. Before selecting a method, the strengths and weaknesses of the different techniques should be carefully considered. Ideally, a combination of different techniques should be used (Kohl et al., 2000; Trost, 2001).

The different components of physical fitness can be measured by laboratory and field tests. Differences between laboratory and field tests were generally related to cost, sophistication and precision of control over extraneous factors which might affect the results. Specially designed equipment to measure, analyze, monitor and record information is generally used only in the laboratory (e.g., cycle ergometers). Field tests are usually done with equipment already available in communities and with methods accessible and familiar to populations with an average level of education (Skinner & Pekka, 1994). Field tests were commonly used to test a large number of children. Several field test batteries have been developed to measure the different components of physical fitness in children (Freedson, Cureton, & Heath, 2000). Whereas most of these test batteries have been used in the United States (Freedson et al., 2000), the Eurofit test battery is one example of a field test battery commonly used in European children (Adam, Klissouras, Ravazzolo, Renson, & Tuxworth, 1988).

Health benefits of physical activity in children

While the health benefits of physical activity are well documented in adults, evidence of the relationship between physical activity and health outcomes for young people is much weaker. A possible explanation may be that most chronic diseases associated with physical inactivity do not appear until adulthood. Therefore, studies in children must rely on risk factors as markers of potential future diseases. Such risk factors may only account for 50% of eventual future diseases and they may be an incomplete set of markers. Additionally, difficulties in measuring health and physical activity in children and a lack of large-scale longitudinal studies may also explain the weak relationship (Boreham & Riddoch, 2001; Riddoch, 1998).

In adults, physical activity is inversely related to all-cause mortality and in particular to cardiovascular diseases mortality. However, the relationship is complex as the type and the amount of physical activity play a part. The health risks of being physically inactive in adulthood include obesity, cardiovascular diseases, hypertension, insulin-dependent diabetes mellitus, depression, osteoporosis and some cancers (Penedo & Dahn, 2005).

In children, regular physical activity is associated with improvements in children's current and future health. Regular physical activity can enhance children's psychological well-being and reduce symptoms of depression and anxiety. Moreover, physical activity has a small but beneficial effect on chronic disease risk factors such as serum lipid and lipoprotein concentrations and blood pressure. In addition, increased physical activity has a beneficial effect on reducing body fat, which is important in the prevention and treatment of overweight and obesity. Positive effects of physical activity were also found on children's aerobic fitness and skeletal health (Biddle, Gorely, & Stensel, 2004; Boreham & Riddoch, 2001; Strong et al., 2005).

The long term effects of regular physical activity engagement during childhood are largely dependent on the maintenance of an active lifestyle until adulthood, emphasizing the importance of establishing regular physical activity habits during childhood that will persist throughout life. Longitudinal studies investigated the tracking or stability of physical activity over time. The review study of Malina (1996) revealed that physical activity tracks low to moderate across childhood and adolescence into adulthood. The "Leuven Longitudinal Study on Lifestyle, Fitness and Health" also found that physical activity tracks low to moderate in

Flemish males from 18 to 40 year (Lefevre et al., 2000). Similar results were found in the “Amsterdam Growth and Health Study”, revealing that daily physical activity tracks low to moderate over a period of 15 year covering adolescence and young adulthood (13 - 27 year) (Twisk, Kemper, & van Mechelen, 2000). However, these tracking results need to be interpreted with caution since the majority of these studies are based on self-reports.

Current levels of physical activity and fitness in children and youth

Several public health organizations have developed physical activity guidelines among youth recommended for good health. Fulton, Garg, Galuska, Rattay, and Caspersen (2004) reviewed the literature from 1980 to 2004 to identify the existing public health recommendations for physical activity in youth. The first recommendations were developed for adolescents (aged 11 to 18 years) in the beginning of the 1990s by the “International Consensus Conference on Physical Activity Guidelines for Adolescents”. A first recommendation was that all adolescents should be physically active daily or nearly every day as part of their lifestyle. Secondly, adolescents should engage in three or more sessions per week of activities that last 20 minutes or more and that require moderate to vigorous levels of exertion. Moderate to vigorous activities are defined as those that require at least as much effort as brisk or fast walking (Armstrong & van Mechelen, 1998). Examples of moderate to vigorous physical activities may include walking, cycling, swimming, dancing, and most sports. However, a shortcoming of the first guideline was that a desired duration of daily activity levels was not indicated. Moreover, the second guideline did not account for children’s activity patterns, which are typically intermittent. Therefore, in 1996, participation in at least 30 minutes of moderate intensity activities on most days of the week was recommended for children and adolescents by the “National Institutes of Health Consensus Development Panel on Physical Activity and Cardiovascular Health”. However, although available studies indicated that the majority of children were engaged in 30 minutes of moderate intensity activity on most days of the week, the prevalence of overweight and obesity in children was still increasing. Therefore, in 1998, the “Health Education Authority symposium Young and Active” in the UK recommended that all children and adolescents should participate in physical activity of at least moderate intensity for 60 minutes per day (Biddle, Sallis, & Cavill, 1998). The activities may be performed intermittently accumulated throughout the day or in a continuous fashion. The activities should be enjoyable and developmentally appropriate and may be carried out as

part of transportation, games, sports, physical education, recreation or structured exercises (Pate, Trost, & Williams, 1998). More recently developed recommendations advocated that all children should participate in physical activity of moderate to vigorous intensity for at least 60 minutes per day (Fulton et al., 2004). This guideline is consistent with the guideline of the UK Expert Consensus group (Cavill, Biddle, & Sallis, 2001) and the recommendations of the Health Enhancing Physical Activity group of Belgium (Beunen, De Bourdeaudhuij, Vanden Auweele, & Borms, 2002). Till now, this recommendation is generally accepted.

To date, many studies have investigated children's physical activity levels. However, it is problematic to compare the results across the different studies due to differences in measurement of physical activity, methodology and criteria applied to classify children as "active" or "inactive". However, despite the variation in methods, the available data are generally consistent in that boys appear to be more physically active than girls of the same age (Armstrong & van Mechelen, 1998; Biddle et al., 2004; Riddoch et al., 2004). This gender difference was also found in a sample of 1124 10- and 11-year-old children in Flanders (Belgium) (Cardon et al., 2005). Furthermore, it is well documented in the literature that physical activity levels decline from childhood to adolescence and adulthood (Pate et al., 2002; Riddoch et al., 2004; Roberts, Tynjala, & Komkov, 2004; Trost et al., 2002; van Mechelen, Twisk, Post, Snel, & Kemper, 2000). The largest age-related decline seems to occur during the adolescence period (Sallis, 2000). The age-related decline during adolescence was also found in Flanders (Belgium). Philippaerts et al. (2003) investigated the physical activity levels of 6117 12- to 18-year-old adolescents and reported that the activity levels declined with age.

Studies investigating the percentage of children meeting the recommendation of at least 60 minutes of moderate to vigorous physical activity engagement per day revealed that a substantial proportion of young people have lower activity levels than recommended for good health (Biddle et al., 2004). The "Health Behavior in School-aged Children" survey, executed in approximately 1500 11-year-olds in each of the 35 participating countries and regions in Europe and United States, revealed that only 38% of all children reported physical activity levels that met the guideline of "1 hour or more of at least moderate intensity activity on five or more days a week" (Roberts et al., 2004). Moreover, more boys (44%) than girls (33%) met the guideline. However, there was a wide variation between the countries and regions with proportions of children that met the guideline ranging from 25 to 61% in boys and from

11 to 51% in girls. The results for Belgium (Flanders) revealed that 28% of all boys and 19% of all girls reported physical activity levels that met the guideline. However, these results need to be interpreted with caution because they are based on self-reports. Probably the children only took sports participation into account in answering this question. Ridloch et al. (2004) investigated the physical activity levels of 2185 9- and 15-year-old children from Denmark, Portugal, Estonia and Norway, using MTI accelerometers. The results indicated that almost all 9-year-old children achieved the activity recommendation of “being active for at least 60 minutes of moderate activity on most days of the week”. However, the proportions of 15-year-olds meeting the recommendation were markedly lower, especially in girls. Cardon et al. (2005) investigated the physical activity levels of 1124 10- and 11-year-old Flemish children, using the Flemish Physical Activity Questionnaire. The results indicated that children participated in physical activity both at school (physical education excluded) and in leisure time for an average of 6 hours per week. The recommended 60 minutes of moderate to vigorous physical activity engagement was achieved by 80% of the boys and 70% of the girls.

Studies investigating children’s health-related physical fitness focused most frequently on the aerobic component of physical fitness. Since there is no consensus about the optimal levels of aerobic fitness in children, it is difficult to answer the question if children are fit or unfit. Studies focused more on changes in children’s fitness levels over the past years. Again, methodological differences and different tests used to measure children’s aerobic fitness make it difficult to compare the result of the different studies. The review of Armstrong and van Mechelen (1998) included studies investigating children’s aerobic fitness levels in Europe, Australia and North America. The results indicated that there is no evidence suggesting that young people’s aerobic fitness has declined over the last 50 years. However, more recent studies indicated a decrease in aerobic fitness over time and an emerging polarization with the differences between fit and unfit young people increasing over time (Tomkinson, Léger, Olds, & Cazorla, 2003; Wedderkopp, Froberg, Hansen, & Andersen, 2004). In Flanders (Belgium), the physical fitness levels of 12- to 18-year-old students were compared between 1997 and 2005 (Lefevre, Philippaerts, & Duquet, 2005). Physical fitness was measured using the Eurofit test battery. In general, the results indicated that the scores of several fitness tests significantly decreased between 1997 and 2005, in both boys and girls (flexibility, explosive and static strength).

In summary, although many young children seem to be active, a substantial proportion of young people have lower activity levels than those recommended for good health.

Furthermore, it is well documented that physical activity levels decline with age, with a marked decline during the adolescence years. Moreover, some studies indicated that children's fitness levels have declined over the past years. Therefore, interventions designed to promote regular physical activity participation, leading to lifelong physical activity should be implemented at an early age.

Correlates of physical activity in children

A better understanding of the different variables influencing children's activity behavior is necessary, because they can be targeted as mediating variables in intervention programs. Studies investigating physical activity determinants in children have used a variety of theories to explain and predict children's physical activity participation (e.g., Theory of Planned Behavior, Social Cognitive Theory). Based on the review of Sallis, Prochaska, and Taylor (2000), the most important correlates of children's physical activity will be discussed.

Several psychological variables have been shown to be important for children's physical activity participation. More physical activity was found to be related to enjoyment or fun and the intention to be physically active. Less physical activity was found to be associated with more perceived barriers. Furthermore, some studies found that more physical activity was related to an increase in children's self-efficacy, perceived competence and positive attitudes towards physical activity, while other studies did not.

Behavioral variables that were found to be associated with more physical activity in children were previous physical activity and healthy diet. No consistent correlations were found between physical activity and sedentary behavior (e.g., television viewing) in children. This can be explained by the fact that physical activity and sedentary behavior are not two sides of the same coin and that correlates of physical activity are likely to differ from correlates of sedentary behavior (Biddle et al., 2004; Marshall, Biddle, Sallis, McKenzie, & Conway, 2002). Marshall et al. (2002) demonstrated that sedentary behavior (e.g., reading, video games, homework, etc.) can sometimes compete with and sometimes coexist with physical activity. It is possible that some children watch substantial amounts of television and still obtain adequate levels of physical activity at other times of the day.

No social variables were clearly associated with children's activity levels. Only 38% of 29 studies indicated that parental physical activity was related to more physical activity in children. Moreover, 5 of 10 studies revealed that children were more active when a parent was physically active together with the child. The weak findings for social variables were in contrast with previous studies who concluded that parental influences (such as modeling, support and encouragement) on children's activity levels were very strong (Sallis et al., 1992; Stucky-Ropp & DiLorenzo, 1993; Wold & Hendry, 1998).

Finally, several environmental variables were found to be related to children's physical activity. Access to facilities and programs was related to more physical activity in children. Moreover, the time spent outdoor was associated with more physical activity in young children.

In summary, research on children's correlates of physical activity provides useful information for intervention programs. Interventions promoting physical activity in children should focus on providing enjoyable, developmentally-appropriate physical activity and on reducing perceived barriers. Moreover, additional attention is necessary for the promotion of physical activity in girls. Furthermore, interventions should also increase children's access to activity programs and facilities. Although not supported by Sallis et al. (2000), the involvement of parents in the intervention seems to be promising.

Interventions promoting physical activity in children

Although most elementary school children seem to reach adequate levels of physical activity, interventions promoting physical activity are still needed to reach the least active children and to prevent the decline in physical activity. Interventions should focus on the development of physically active lifestyles, leading to lifelong physical activity. To achieve a substantial behavioral change, interventions need to take children's correlates of physical activity into account.

The school environment is an ideal setting for the promotion of physical activity, because virtually all children can be reached. Schools have the potential and the personnel to promote physical activity during the school day (physical education classes, recess periods, extracurricular activities) as well as to promote generalization of physical activity outside of

school. Moreover, parents can be involved through meetings and educational material can be sent to the family's home (e.g., information or practical guidelines to increase children's activity levels). Furthermore, the promotion of active commuting to school and informing children and parents about the possibilities to be active in the community can also contribute to the development of an active and healthy lifestyle.

Several intervention studies in elementary schools have attempted to increase children's activity levels at school by focusing on physical education (Kahn et al., 2002). It has been recommended by "Healthy People 2010" that all children should be engaged in moderate to vigorous physical activity for at least 50% of the physical education class time (United States Department of Health and Human Services, 2000). Secondly, it is recommended that schools should provide daily physical education lessons for children of all ages. However, evidence suggests that children do not meet the recommended 50% moderate to vigorous physical activity engagement during the majority of physical education classes (Barnett, van Beurden, Zask, Brooks, & Dietrich, 2002; Cardon, Verstraete, De Clercq, & De Bourdeaudhuij, 2004; Friedman et al., 2003). Furthermore, increasing the frequency or duration of physical education classes is difficult because the time allocated to physical education is mostly limited within existing school programs. Therefore, it is important to use the scheduled time for physical education optimally and efficiently to promote high activity levels. According to the literature, health-related physical education programs were evaluated as effective in enhancing children's moderate to vigorous physical activity levels during physical education classes (Kahn et al., 2002). Health-related physical education curricula strive to keep all children as active as possible during physical education classes and to develop children's knowledge and movement skills promoting engagement in an active lifestyle.

While school time allocated to physical education is often limited, recess periods provide daily opportunities for physical activity participation. Only a few studies have investigated children's physical activity levels during recess periods, revealing that children spent less than 50% of recess time engaged in moderate to vigorous physical activity (Jaho & Baranowski, 2004; Wechsler, Devereaux, Davis, & Collins, 2000). Moreover, boys were more active during recess periods than girls (Ridgers & Stratton, 2005; Sarkin, McKenzie, & Sallis, 1997). Intervention studies focusing on recess periods revealed that social prompts (encouragement) for physical activity and playground markings were effective in increasing children's activity levels during recess (McKenzie et al., 1997; Stratton, 2000). Moreover, providing structured

fitness training breaks may provide high activity levels for both boys and girls (Scruggs, Beveridge, & Watson, 2003).

Besides physical education and recess periods, providing extracurricular school activities may also be an important opportunity to promote physical activity among children. However, no studies in elementary schools could be located providing data on the proportion of children who participate in extracurricular activities or evaluating the amount and types of physical activities in which they engage during extracurricular activities (Jaho & Baranowski, 2004; Wechsler et al., 2000).

To meet public health benefits and to promote lifelong physical activity, school-based interventions should also focus on the promotion of regular physical activity outside the school because children spend a lot of their time in non-school environments (Biddle et al., 2004). In the literature, only a few comprehensive studies in elementary schools could be located targeting both children's physical activity at school and out-of-school (Kahn et al., 2002; Stone, McKenzie, Welk, & Booth, 1998). In the United States, the SPARK program (Sports, Play and Active Recreation for Kids) was designed to increase children's activity levels during physical education classes and out-of-school by implementing a health-related physical education program and a self-management program (Sallis et al., 1997). During the self-management lessons, children learned cognitive-behavioral skills, necessary to develop and maintain an active lifestyle. In the same line, the physical activity component of the "CATCH" (Child and Adolescent Trial for Cardiovascular Health) and "Go For Health" programs was designed to increase children's moderate to vigorous physical activity engagement during physical education classes and to promote generalization of physical activity (McKenzie et al., 1996; Simons-Morton, Parcel, Baranowski, Forthofer, & O'Hara, 1991). The physical activity component in both studies included a physical education intervention and classroom-based health curricula including behavior change skills. Although the three studies were effective in increasing children's physical activity levels during physical education classes, only the CATCH study found a significant increase in children's vigorous activity out-of-school. School-based interventions including parental involvement revealed that the specific effect of parental involvement was limited, largely due to low participation rates (Nader et al., 1996; Sallis, 1998). Furthermore, active commuting to school has been suggested as a potential to increase children's activity levels (Jaho & Baranowski, 2004). Cooper, Page, Foster, and Qahwaji (2003) found that walking to and from school

contributed 8 to 14 minutes per day of moderate to vigorous physical activity in 10-year-old children. Sirard, Riner, Mciver, and Pate (2005) indicated that regular walking to and from school (= at least five times per week) was associated with approximately 24 additional minutes of moderate to vigorous physical activity per day in fifth-grade students. These findings suggest that schools should promote active commuting to school. Because active commuting to school may require safe sidewalks and cycle paths, the school will need to include local governments in the promotion of active commuting to school.

Problem analysis

In Belgium (Flanders), the promotion of a healthy lifestyle within the school context has received more attention during the last decade. The development of a healthy and safe lifestyle is recognized as an important mission of physical education, next to the development of motor and social skills and competences. However, the study of Cardon and De Bourdeaudhuij (2002) revealed that many physical education teachers are not sufficiently aware of the health-promoting role of physical education. Moreover, although elementary school children in Flanders receive a weekly average of 70 minutes of physical education, and 85% of the physical education classes are led by physical education specialists; observational data showed that children's moderate to vigorous physical activity levels during physical education classes in elementary schools in Flanders were lower than the recommended 50% moderate to vigorous physical activity engagement (Cardon et al., 2004). This indicates that it is useful to implement a health-related physical education program in Belgium. Furthermore, physical activity should also be promoted during recess periods and extracurricular activities. During recess periods, all children can be active on a daily basis. Most elementary schools in Belgium organize several recess periods per day, including a morning recess, a lunch break and an afternoon recess, making it an important school factor for the promotion of physical activity. Moreover, children are typically engaged in unstructured physical activity during recess, preparing them for adult activity, which is also typically unstructured. Since the development of a healthy, active lifestyle also implies behavioral change, children need to be taught specific techniques to attain this such as goal-setting, problem solving, self-monitoring, etc. Therefore, the implementation of classroom-based health-education lessons promoting lifelong physical activity seems useful. However, classroom-based lessons promoting lifelong physical activity are a new concept in Belgium. Till now, existing health curricula in

elementary schools mostly include health topics such as nutrition, dental hygiene and drugs prevention, but no physical activity promotion.

Till now, the effectiveness of a comprehensive physical activity promotion program has not yet been evaluated in Belgium. Because a substantial proportion of young people have lower physical activity levels than recommended for good health and the age-related physical activity decline is also present in Belgium (Flanders), an intervention promoting physical activity in children was implemented in Belgium (Flanders). This intervention study was part of a broader research project entitled “Sport, Physical activity and Health” (Sport, Beweging en Gezondheid), carried out by the Policy Research Centre, a consortium of researchers from KULeuven, Ghent University and VUBrussel, and funded by the Flemish Government. This Policy Research Centre was set up by the Flemish Government together with 12 other Policy Research Centers. The main purpose of the Policy Research Centre “Sport, Physical activity and Health” was to provide scientific support to the Flemish Government regarding sports participation, physical activity, fitness and health. Besides gaining more insight into the current status of and the relationship between sports participation, physical activity, fitness and health in the Flemish population; an important aim of this Policy Research Centre was to evaluate the effects of intervention programs promoting physical activity and sports participation in different populations. As part of this last aim, the current intervention study was executed, investigating the effects of a comprehensive physical activity promotion intervention in elementary school children.

Aims of the thesis

The main purpose of this thesis was to evaluate the effectiveness of a multi-component physical activity promotion intervention in elementary school children.

To evaluate the effectiveness of physical activity promotion programs, valid measurements of physical activity are necessary. Therefore, the validity of a questionnaire measuring children’s usual physical activity was evaluated in a preliminary study. Because self-reports in children are associated with recall limitations, a possible solution to improve physical activity self-reports in children may be that parents assist their children. Parents can improve the activity report and additionally, they can enhance children’s full understanding of the questions and

their motivation to finish the questionnaire. Therefore, the reliability and validity of the questionnaire completed with and without parental assistance were compared.

Subsequently, the effectiveness of a comprehensive physical activity promotion intervention was evaluated. The intervention included a health-related physical education program, an extracurricular physical activity promotion program (providing organized physical activities during lunch break and providing game equipment during recess periods) and classroom-based health-education lessons (see p. 18). The effects of the comprehensive physical activity promotion intervention on children's physical activity levels, physical fitness and psychosocial correlates were evaluated. Besides evaluating the effects of the total intervention, the effects of some of the intervention components were evaluated separately because they could be studied within a more isolated context. Despite the fact that these components were embedded within the larger intervention, we wanted to receive more information concerning whether these components of the intervention were successful. Therefore, we evaluated the effect of the health-related physical education program on children's activity levels during physical education classes and the effect of providing game equipment during recess periods on children's activity levels during those periods. Finally, the perceptions of the classroom-based health-education lessons were evaluated because classroom-based health-education lesson promoting physical activity were a completely new concept. The perceptions of the lessons and the perceptions of their impact on children's physical activity awareness and activity levels were evaluated.

Aim 1: to compare the validity and reliability of a questionnaire to measure usual physical activity in 9- to 11-year-old children completed with and without parental assistance.

Aim 2: to evaluate the effects of the comprehensive physical activity promotion intervention on children's total physical activity levels, physical activity levels in leisure time, physical fitness and psychosocial correlates of physical activity.

Aim 3: to evaluate the effects of the health-related physical education program on children's activity levels during physical education classes.

Aim 4: to evaluate the effect of providing game equipment on children's activity levels during recess and lunch break.

Aim 5: to investigate the perceptions of the classroom-based health-education lessons and the perceptions of their impact on children's physical activity awareness and children's activity levels in children, classroom teachers and parents.

Participants

The validity of the questionnaire measuring children's usual physical activity was evaluated in a preliminary study (aim 1). Two elementary schools were selected to participate in the study by simple randomization. The study sample included 100 fourth- and fifth-grade children (9 class groups, mean age: 10.4 ± 0.7).

For the intervention study, out of all elementary schools in East-Flanders, 16 elementary schools were selected to participate in the physical activity promotion intervention study by simple randomization, taking the actual distribution over catholic and community schools into account. Participating schools were randomly assigned to the intervention condition ($n = 8$) and the control condition ($n = 8$). The intervention was implemented over two school years. During the first intervention year, the study sample included 810 fourth- and fifth-grade children (40 class groups, mean age: 9.7 ± 0.7). During the second intervention year, the study sample included 764 fifth- and sixth-grade children (38 class groups, mean age: 11.7 ± 0.7). The 46 drop outs were caused by children who changed schools or who were not present at the days of data collection. Due to reorganizations of the class groups between the two school years, 40 class groups were remodeled into 38 class groups.

The effects of the physical activity promotion intervention on children's physical activity levels, physical fitness and psychosocial correlates of physical activity (aim 2) and the effects of the health-related physical education program on children's activity levels during physical education classes (aim 3) were evaluated in the total sample (= 16 schools). The effect of providing game equipment on children's activity levels during recess and lunch break (aim 4) was evaluated in seven elementary schools. The seven schools were selected out of the 16 participation schools by simple randomization (intervention condition: four schools; control

condition: three schools). The classroom-based health-education lessons (aim 5) were evaluated in all the intervention schools (= eight schools).

Intervention

The intervention evaluated in the present thesis was developed to promote physical activity and was mainly based on the SPARK program (Sports, Play, and Active Recreation for Kids) of San Diego State University (Sallis et al., 1997). SPARK was designed to increase children's physical activity levels during physical education classes and out-of-school by implementing a health-related physical education intervention and a self-management program. For the intervention in the present study, the original SPARK program was adjusted to the educational system and the culture of Belgium (Flanders). The adjustments we made are described in detail in the following chapters. In addition to the SPARK program, physical activity was also promoted during recess periods and lunch break, since elementary schools in Belgium organize several recess periods per day and have longer lunch breaks compared with the elementary schools in the United States, making it important school environmental factors for the promotion of physical activity.

The intervention in the present thesis was largely based on the Social Cognitive Theory (Bandura, 2004) and the ASE model (Kok et al., 1991). The Social Cognitive Theory is a model of behavior change in which personal, behavior and environmental factors interact reciprocally to predict behavior. In this model, self-efficacy, or persons' judgment of their ability to perform a particular behavior, is thought to be the primary mediator of behavior change. Other key determinants of behavior change include outcome expectations, or the expectations about the consequences of a given behavior, personal goals, or the standard individuals want to attain, and the perceived facilitators and impediments to the changes they seek (Bandura, 2004). The ASE model, an extension of the theory of Planned Behavior (Kok et al., 1991), includes concepts of both the Theory of Planned Behavior and the Social Cognitive Theory. The ASE model is based on the assumption that the intention to be physically active is an immediate determinant of behavior and that the intention can be explained by three main variables: attitude, social influences and self-efficacy. Attitude towards physical activity can be expressed as the balance between perceived benefits and perceived barriers. Social influences mostly include modeling, identification with others who

are active and social support. Self-efficacy is defined as one's belief in one's ability to be physically active in potentially difficult situations. In the present intervention, the applied cognitive-behavioral intervention strategies to target children's activity behavior were based on those two models of behavior change and included creating a positive attitude towards physical activity, increasing knowledge, enhancing self-efficacy, stimulating social support and teaching skills. These strategies were applied in the different intervention components. Additionally, the intervention also included environmental changes to target children's activity levels. During the past decade, ecological approaches to influence physical activity behavior received more attention. Ecological models emphasize the role of the environment in influencing behavior (Green 1996). Based on the study of Sallis et al (2003), targeted environmental changes in the present study included the availability of game equipment during recess periods and providing organized, supervised physical activities during lunch break.

The intervention in this thesis included: (1) a health-related physical education program, (2) classroom-based health-education lessons and (3) an extracurricular physical activity promotion program.

The **health-related physical education program** was implemented over the two school years. Like in the SPARK physical education program, the main goal of the present health-related physical education program was to promote high levels of physical activity for all children during physical education classes. Additionally, the intervention was intended to make teachers aware of the health-promoting role of physical education. In the original SPARK physical education program, structured health-related physical education curricula were provided and implemented because a substantial amount of the physical education teachers were classroom teachers. In the present study, the physical education teachers were not asked to follow the entire SPARK physical education curriculum because all the physical education teachers were physical education specialists and because public schools in Flanders have a mandatory physical education curriculum. The present physical education intervention focused on providing the teachers with didactical guidelines based on SPARK to teach health-related physical education and to increase children's activity levels during physical education lessons. The teachers received a manual, containing didactical guidelines and some SPARK lessons as sample lessons. The teachers were asked to

implement the didactical guidelines in all the physical education classes. Additionally, the teachers were asked to give at least six of the 49 elaborated sample lessons. A research staff member (a physical education specialist who was trained to teach the SPARK principles) visited each physical education teacher four times (4 x 2 hr). During those contacts, teachers were familiarized with the manual and encouraged to implement the didactical guidelines in all the lessons. Additionally, an 2 hr training was provided for all the physical education teachers of the intervention schools, including a repetition of the didactical guidelines promoting health-related physical education and illustrations of strategies to increase students' activity levels during physical education lessons, recess periods and outside of school.

The **classroom-based health-education lessons** were implemented during the first intervention year. The health-education lessons, based on the self-management program of SPARK, consisted of six lessons and three repetition lessons and were implemented by a research staff member within the existing health promotion curriculum. The lessons were designed to promote lifelong physical activity. Like in the SPARK self-management program, the purpose of the health-education lessons was to increase knowledge and to develop and maintain an active and healthy lifestyle by teaching the children behavior change skills including goal-setting, time planning, problem solving and self-talk. Children also received homework to promote physical activity out-of-school and to stimulate parental support for physical activity.

The **extracurricular physical activity promotion program** was implemented over the two school years and focused on recess periods to promote physical activity. During the first and second intervention year, organized physical activities were provided once a week during lunch break. The organized physical activities were lead by an external physical education teacher. Participation was on voluntary base. The extracurricular activities promoted a positive attitude towards physical activity and encouraged the children to be active in leisure time by providing activities and games that can be easily transferred towards leisure time (e.g., rope skipping, Frisbee, ball games, etc.). During the second intervention year, game equipment was provided during recess periods to increase children's activity levels. Each class group of the intervention schools received a set of game equipment. Children were allowed to play outdoors with the game equipment during recesses and lunch break. Before providing

the game equipment, the different play toys were presented to the children of each class group by a research staff member. The organization was assigned to the classroom teachers. The teachers were asked to stimulate the children to play with the game equipment. The teachers agreed on rules with the children about the use and the loss or damage of the game equipment to assure its endurance. The teachers were also advised to divide the game equipment into different sets and to exchange those sets regularly to prevent children losing interest in the equipment. Additionally, during the first and second intervention year, children were informed through a brochure about the sports clubs in the neighborhood (competitive and recreational) to stimulate sports participation in leisure time. During the second intervention year, the principals of the intervention schools were asked to promote active commuting to school.

Measurements and evaluation

The multi-component intervention was implemented over two school years, starting in November 2002 and ending in April 2004. Pretest measurements were performed from September to October 2002, posttest measurements from April to June 2004.

In the total sample, children's activity levels in leisure time and psychosocial correlates of physical activity were evaluated using a physical activity questionnaire (pretest: $n = 810$; posttest: $n = 764$). The Eurofit test battery was used to evaluate children's physical fitness (pretest: $n = 810$; posttest: $n = 764$). Children's total physical activity levels were evaluated in a representative sub sample using accelerometers (pretest: $n = 123$, posttest: $n = 111$). The sub sample included children of eight schools (four control schools, four intervention schools), randomly selected from the 16 participating schools. The parents of all children ($n = 312$) were contacted by telephone to ask for participation of their child in the evaluation. The parents of 123 children (39%) gave approval for participation and returned the signed informed consent form. All 123 children participated in pretest measurements. At posttest, 12 children were excluded from the analyses, four children were excluded due to accelerometer malfunctions and eight children were excluded due to being sick on a day of measurement. (Chapter 3)

In the total sample, the effect of the health-related physical education program on children's activity levels during physical education lessons was evaluated using accelerometers and direct observation. The children of one class group did not participate in the pretest measurements because they were not at school on the day of measurement. To evaluate children's activity levels during physical education lessons using accelerometers, ten children from each class group were randomly selected to wear an accelerometer during the physical education lesson (pretest: $n = 390$, posttest: $n = 380$). To evaluate children's activity levels using direct observation, six children were randomly selected from each class group (pretest: $n = 234$, posttest: $n = 228$). (Chapter 4)

In addition to the pretest and posttest measurements, some extra evaluations were performed. In June 2003, the perceptions of the health-education lessons were evaluated in children, classroom teachers and parents. In September and December 2003, children's activity levels were measured during recess periods.

The effect of providing game equipment on children's activity levels during recess periods was evaluated using accelerometers. Out of the 16 participating schools, seven schools were selected to participate in this measurement by simple randomization (four intervention schools, three control schools). Because game equipment during recess periods was only provided during the second intervention year, extra measurements were performed at the beginning of the second intervention year (September 2003, $n = 249$) and 3 months after providing the game equipment (December 2003, $n = 235$). During data gathering, three children were excluded from analyses due to accelerometer malfunctions and 11 children were excluded due to sickness on the day of measurement. (Chapter 5)

The perceptions of the health-education lessons were evaluated using a questionnaire and interviews. As the health-education lessons were implemented during the first intervention year, the perceptions were evaluated at the end of the first intervention year (June 2003) in all children of the intervention schools ($n = 412$), in all classroom teachers of the intervention schools ($n = 20$) and in 50 parents, randomly selected from three of the eight intervention schools. (Chapter 6)

Outline of the thesis

Chapter 2 describes the validity and reliability of a questionnaire to measure usual physical activity in 9- to 11-year-old children, completed with and without parental assistance. The validity of the physical activity questionnaire was evaluated, using MTI accelerometers.

In chapter 3, the effects of the comprehensive physical activity promotion intervention on children's activity levels, physical fitness and psychosocial correlates of physical activity were evaluated. Children's activity levels in leisure time and the psychosocial correlates of physical activity were measured using a questionnaire. Children's total activity levels were evaluated, using MTI accelerometers. The Eurofit test battery was used to evaluate children's physical fitness.

Chapter 4 describes the effect of the health-related physical education program on children's activity levels during physical education classes, using direct observation and MTI accelerometers.

In chapter 5, the effects of providing game equipment on children's activity levels during recess and lunch break were evaluated, using MTI accelerometers.

Chapter 6 describes the perceptions of the classroom-based health-education lessons and the perceptions of their impact on children's physical activity awareness and children's activity levels, evaluated in children, classroom teachers and parents. The perceptions in children were evaluated using a questionnaire. The classroom teachers were interviewed at school and the parents were interviewed by telephone.

Finally, in a last chapter, general conclusions, limitations, directions for further research and practical implications are formulated (chapter 7).

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Chapter 2

Reliability and validity of a questionnaire to measure usual physical activity in children with and without parental assistance

Abstract

Because of the increasing prevalence of obesity among children and the decline in physical activity levels with age, the measurement of usual physical activity becomes an important health issue. Physical activity questionnaires in young children show poor validity and reliability. Parental assistance in completing the questionnaire may be a possible solution to improve self-reports in children. This study evaluated the reliability and validity of a questionnaire to measure usual physical activity in 9- to 11-year-old children ($N = 100$), completed with parental assistance ($n = 51$, parent condition) and without parental assistance ($n = 49$, non-parent condition). The MTI accelerometer was used as validity criterion. The reliability coefficients were higher in the parent condition compared with the non-parent condition. In the parent condition, comparison to accelerometers supported the validity of vigorous intensity activities, moderate to vigorous intensity activities and total levels of physical activity. In the non-parent condition only vigorous intensity activities showed significant correlations with the accelerometer data. The results of the present study indicate that parental assistance can improve self-reports to an acceptable level in 9- to 11-year-old children. The physical activity questionnaire, completed with parental assistance, is useful to measure children's usual physical activity levels.

Key words: self-report, measurement, exercise and childhood

Introduction

Regular physical activity during childhood and adolescence is associated with improvements in numerous physiological and psychological variables, and is being promoted as an objective for disease prevention (Cavill, Biddle, & Sallis, 2001; Harsha, 1995; Sothorn, Loftin, Suskind, Udall, & Blecker, 1999). Moreover, it is believed that children's physical inactivity habits track into adulthood (Janz, Dawson, & Mahoney, 2000; Malina, 1996). Although it is frequently assumed that physical activity is an integral part of growing up, numerous studies have shown that physical activity levels decline from childhood to adolescence and adulthood (Armstrong, 1998; Caspersen, Pereira, & Curran, 2000; Telama & Yang, 2000; van Mechelen, Twisk, Post, Snel, & Kemper, 2000). Therefore the promotion of lifelong physical activity should be emphasized at an early age.

To evaluate the effectiveness of programs promoting physical activity, valid measures of physical activity are necessary. To date, a wide range of methods has been used to quantify physical activity behavior in children. Although objective measures like heart rate monitors and direct observation provide valid assessments in youth of all ages, they are not often used in large field studies because of the expense or time constraints (Pate, 1993; Welk, Corbin, & Dale, 2000). Self-reports are commonly used in large surveys. However, self-reports include problems associated with recall limitations, social desirability and over-reporting (Kohl, Fulton, & Caspersen, 2000; Sallis & Saelens, 2000). Moreover, the use of self-reports in children has additional problems including limited ability to recall their activity, inaccurate reporting of duration and intensity and lack of motivation to persist with the task (Sirard & Pate, 2001). Although the measurement of children's usual physical activity may be more useful to get an overall picture of children's relative amount of physical activity, some investigators have tried to improve children's activity recall by restricting the time period (e.g., 1-day or 3-day recall) (Janz, Witt, & Mahony, 1995; Sallis et al., 1996; Trost, Ward, McGraw, & Pate, 1999). However, even when children were asked to recall their activity over a specific time period in the recent past, validity coefficients were discouraging in young children (Kohl et al., 2000; Sallis & Saelens, 2000; Treuth et al., 2004). In general, studies with children aged less than 10 years reported no significant validation coefficients, whereas the validity and reliability of self-report techniques in children improved with increased age. These findings have led to the recommendation that physical activity recalls should not be used in children aged less than 10 years (Kohl et al., 2000; Sallis, 1991).

A possible alternative for self-reports in children who are too young to report their own activity behavior are proxy reports (Harro, 1997; Kohl et al., 2000; Sallis, 1991). However, the utility of proxy reports in children was also found to be limited because adults are not well informed about all the physical activities of the children. Neither parents nor teachers are able to observe children the whole day (Kohl et al., 2000; Sallis, 1991; Sallis & Owen, 1998). Therefore another possible solution to improve physical activity self-reports in children may be that parents assist their children. Parents can improve the activity report and additionally they can enhance children's full understanding of the questions and their motivation to finish the questionnaire. To our knowledge, no evaluations of questionnaires in which parents and children work together to report children's usual physical activity could be located in the literature.

The main goal of the present study was to evaluate the convergent validity and test-retest reliability of a questionnaire measuring children's usual physical activity, completed with and without parental assistance. The hypothesis was that parental assistance in completing the questionnaire may result in higher reliability and validity coefficients than compared with the questionnaire completed without parental assistance.

Methods

Participants

The present study was performed in Flanders (Belgium). Two elementary schools were selected to participate in the study by simple randomization. All fourth and fifth grade children of both schools ($n = 177$) were verbally informed about the study. They received an information leaflet and an informed consent letter. The parents of 110 children (62%) gave approval for participation and returned the signed informed consent form. During data gathering, 10 children were excluded from the analyses, five due to accelerometer malfunctions and five due to fewer than 6 days of complete monitoring data. Finally, a sample of 100 children was used. Children from one elementary school (21 girls, 30 boys; M age = 10.6 years, $SD = 0.5$) were assigned to complete the physical activity questionnaire with parental assistance (parent condition). Children from the other school (39 girls, 10 boys; M age = 10.2 years, $SD = 0.9$) were assigned to complete the physical activity questionnaire without parental assistance (non-parent condition). The study protocol was approved by the Ethical Committee of the Ghent University Hospital.

Procedure

All children participated in the study for 1 week. At day 1, all children completed the same physical activity questionnaire. Children in the parent condition were asked to complete the questionnaire the same day at home together with one of their parents. A letter for the parents was added to the questionnaire, clearly instructing that one of the parents had to assist the child in completing the entire questionnaire and that the parent had to explain the questions if necessary. Children in the non-parent condition completed the physical activity questionnaire in the classroom at school. A trained research staff member remained in the classroom during questionnaire administration, gave instructions on how to complete the questionnaire and made sure that the children understood the questions. On the 1st day, all children of both conditions were also familiarized with the accelerometer. They were requested to wear the accelerometer during waking hours, removing the monitor only for water based activities and sleeping. The children were also asked to record each activity performed without wearing the accelerometer on a recording form (e.g., swimming, showering, contact sports), including the duration and the intensity. An accelerometer instruction form for the parents was included to ensure correct accelerometer use. After 1 week, on day 7, accelerometers and recording forms were collected at school and all children completed an identical retest questionnaire. Children in the parent condition were instructed to complete the physical activity questionnaire the same day at home, together with one of their parents. Those questionnaires were collected at school the next day. Children in the non-parent condition completed the identical retest questionnaire in the classroom, under supervision of a trained research staff member.

Instruments

Questionnaire. The questionnaire evaluated in the present study is the paper and pencil version of the Flemish Physical Activity Questionnaire (FFAQ). The FFAQ was validated in 12- to 18-year-old boys and girls and was found to be reliable and valid in measuring adolescents' usual physical activity (Philippaerts et al., 2005). The questionnaire in the present study measured children's usual physical activity. The questionnaire covered physical activity at school (physical education included), leisure time physical activity, active transportation, and sedentary activities (see Appendix A).

To evaluate the quantity of physical activity at school, children were asked if they participated in sports or physical activities during playtime, lunch break and after school hours and how much time they spend on these activities (see Appendix A, items 5-6).

Furthermore participants reported how much time was provided weekly for physical education (see Appendix A, item 2). A *physical activity at school index of moderate to vigorous intensity (physical education included)* was computed expressed in minutes per week, summing the time they spend in sports or physical activities at school and during physical education.

Leisure time physical activity (LTPA) was assessed by asking for children's main sports practiced in leisure time (with a maximum of three sports). For each sport, they reported the frequency and the usual time they spend on that activity (see Appendix A, item 10). For coding the physical activities of the questionnaire by intensity, the compendium of Ainsworth et al. (2000) was used. Activities of 3.0 to 5.9 METs were defined as moderate activities and activities of more than 6.0 METs were defined as vigorous activities. A *LTPA index of moderate intensity* and a *LTPA index of vigorous intensity* were calculated expressed in minutes per week, summing up the three main sports. A *LTPA index of moderate to vigorous intensity* was composed by summing the two indexes above.

Active transportation was questioned by asking how much time they spend on walking and cycling to school and back home (see Appendix A, item 1) and in leisure time (see Appendix A, items 7-8). Two transportation indexes were composed: *walking and cycling to school and back home* and *walking and cycling in leisure time, expressed in minutes per week*. A *total physical activity index, including active transportation*, was calculated by summing the physical activity at school index of moderate to vigorous intensity, the LTPA index of moderate to vigorous intensity and walking and cycling to school and back home. A *total physical activity index without active transportation* was also computed by summing the physical activity at school index of moderate to vigorous intensity and the LTPA index of moderate to vigorous intensity.

Sedentary activities were determined by asking how many hours per day they spend watching television or video, playing computer games, etc. during a week day and during a weekend day (see Appendix A, item 9). A *sedentary index* was computed expressed in minutes per week.

Accelerometry. The accelerometer has been shown to be a valid, reliable, and objective method for monitoring physical activity in children in field settings, when 4 or more days of monitoring are taken into account (Janz, 1994; Trost, Mciver, & Pate, 2005). In the present study, the MTI Actigraph model 7164 (Manufacturing Technologies Inc., Shalimar, FL) was used as an objective reference method for the physical activity reported in the

questionnaire. Technical specifications of the MTI accelerometer have been described elsewhere (Freedson, Melanson, & Sirard, 1998). Monitors were worn just above the right hipbone underneath clothes and were held in place by an elastic belt. For the present study, a 1-min sampling interval was used, based on the studies of Janz et al. (1995), Trost et al. (1999), and Mota et al. (2002). The 1-min movement counts were stored in memory for 6 days, downloaded into a personal computer and converted into an Excel file for subsequent analyses. To convert the total weekly activity counts into moderate (3.0 – 5.9 METs) and vigorous intensity activity (> 6.0 METs), two different sets of accelerometer cutoffs were used, namely the adult count cutoffs of Freedson et al. (1998) and the child count cutoffs used by Trost et al. (2002) (see Table 1). In the study by Nilsson, Ekelund, Yngve, and Sjöström (2002), the adult count cutoffs were used to determine participation in moderate and vigorous activities in children. However, recently Trost et al. (2002) used age-specific count cutoffs to determine the time spent in activities of moderate and vigorous intensity. The equations used to derive the age-specific accelerometer cutoffs were validated for treadmill running and walking in 80 children and adolescents aged 6 to 18 years (Trost et al., 2002). Because there is no clear consensus regarding the most appropriate count cutoffs to use in field studies involving children, both sets of cutoffs were used in the present study. All physical activity measures were expressed in minutes per week.

Table 1. MTI accelerometer count cutoffs corresponding to MET levels.

	Low intensity activities (< 3.0 METs)	Moderate intensity activities (3.0 – 5.9 METs)	Vigorous intensity activities (> 6.0 METs)
Trost et al. (2002) 9 year	< 913	913 – 3521	> 3521
Trost et al. (2002) 10 year	< 1017	1017 – 3696	> 3696
Trost et al. (2002) 11 year	< 1135	1135 - 3908	> 3908
Freedson et al. (1998)	< 1952	1952 - 5724	> 5724

Data Analysis

Data were analyzed using SPSS for windows (12.0). Test-retest reliability coefficients were determined using single measure intraclass correlation coefficients. Reliability coefficients were computed for the physical activity at school index of moderate to vigorous intensity (physical education included), the LTPA indexes, the two transportation indexes, the

total physical activity indexes and the sedentary index. For validity, Spearman rank-order correlation coefficients were computed to evaluate the correspondence between the physical activity reported in the questionnaire and the accelerometer data for moderate, vigorous and moderate to vigorous intensity; using the count cutoffs for adults (Freedson et al., 1998) and the age-specific count cutoffs (Troost et al., 2002). A paired sample *t* test was used to assess the accordance between the reported minutes of physical activity in the questionnaire and the objectively measured activity counts, expressed in minutes of physical activity. The level of statistical significance was set at $p < .05$.

Results

Reliability

Table 2 summarizes the single measure intraclass correlation coefficients (ICC's) for the different indexes. In general, ICC's were higher in the parent condition compared with the non-parent condition, except for the transportation index "walking and cycling in leisure time". The ICC for this index was .61 ($p < .01$) in the non-parent condition and .26 ($p < .05$) in the parent condition. Because of the low reliability coefficient of the transportation index "walking and cycling in leisure time" in the parent condition and as only 35% of the children answered these questions in the non-parent condition, this index was not included in the total physical activity index, active transportation included (see Table 2). Apart from this transportation index, ICC's of the other activity indexes ranged from .69 to .93 ($p < .01$) in the parent condition, showing a moderate to high reliability. ICC's in the non-parent condition ranged from .52 to .72 ($p < .01$), showing a low to moderate reliability. Highest ICC's in the parent condition were found for the LTPA indexes and the total physical activity indexes. In the non-parent condition, highest ICC was found for the LTPA index of vigorous intensity. The reliability coefficient for the sedentary index was .78 ($p < .01$) in the parent condition and .79 ($p < .01$) in the non-parent condition.

Validity

Table 3 summarizes the Spearman's rank correlation coefficients between the activity reported in the questionnaire and the accelerometer data, using the count cutoffs for adults (Freedson et al., 1998) and the age-specific count cutoffs (Troost et al., 2002). In general, the

Table 2. Single measure intraclass correlation coefficients (ICC's) for the questionnaire indexes (test-retest reliability).

Index name (and composition)	Items or summed indexes	Reliability (ICC)	
		Parent condition	Non-parent condition
PA at school index of moderate to vigorous intensity (PE included) (sum of 2 items)	<i>'How much time do you spend in sports or physical activity at school outside PE?'</i> <i>'How much time is weekly provided for PE?'</i>	.69**	.56**
LTPA index of moderate intensity (sum of 3 items)	<i>'How much time do you spend on these sports?'</i>	.92**	.54**
LTPA index of vigorous intensity (sum of 3 items)	<i>'How much time do you spend on these sports?'</i>	.93**	.72**
LTPA index of moderate to vigorous intensity (sum of 2 indexes)	<i>LTPA index of moderate intensity</i> <i>LTPA index of vigorous intensity</i>	.92**	.52**
Walking and cycling to school and back home (sum of 2 items)	<i>'How long do you cycle to school and back home per day?'</i> <i>'How long do you walk to school and back home per day?'</i>	.74**	.52**
Walking and cycling in leisure time (sum of 2 items)	<i>'How much time per day do you use cycling for transportation in leisure time?'</i> <i>'How much time per day do you use walking for transportation in leisure time?'</i>	.26*	.61**
Total PA index without active transportation (sum of 2 indexes)	<i>PA at school index (PE included); LTPA index of moderate to vigorous intensity</i>	.86**	.52**
Total PA index, active transportation included (sum of 3 indexes)	<i>PA at school index (PE included); LTPA index of moderate to vigorous intensity; walking or biking to school and back home</i>	.82**	.55**
Sedentary index (sum of 2 items)	<i>'How much hours per day do you spend watching TV or video, playing computer games... during a week day/weekend day?'</i>	.78**	.79**

Note. ICC = Intraclass Correlation Coefficient; PA = physical activity; PE = physical education; LTPA = leisure time physical activity; TV = television.
* $p < .05$. ** $p < .01$.

parent condition showed more significant correlations compared with the non-parent condition. For the condition with parental assistance, the total physical activity indexes, the LTPA index of vigorous intensity and the LTPA index of moderate to vigorous intensity were significantly correlated with the accelerometer data of moderate activity and moderate to vigorous activity, using both count cutoffs. Highest correlations were found for the LTPA index of vigorous intensity (ranging from $r = .39$ to $r = .50$, $p < .01$) and the total physical activity index, active transportation included (ranging from $r = .29$, $p < .05$ to $r = .41$, $p < .01$). The correlation coefficients were fairly similar in magnitude using the count cutoffs for adults and the age-specific count cutoffs. Correlations between the four above mentioned activity indexes and the accelerometer data of vigorous activity were only significant using the age-specific count cutoffs, ranging from $r = .27$ ($p < .05$) to $r = .42$ ($p < .01$). In the non-parent condition, significant correlations were only found between the LTPA index of vigorous intensity and the accelerometer data, using both count cutoffs and the LTPA index of moderate to vigorous intensity and the accelerometer data of vigorous intensity, using the count cutoffs for adults, ranging from $r = .39$ ($p < .01$) to $r = .45$ ($p < .01$). In the non-parent condition, no significant correlations were found between the total physical activity indexes, the LTPA index of moderate to vigorous intensity and the accelerometer data of moderate and of moderate to vigorous activity, using both count cutoffs. For both conditions, no significant correlations were found for the LTPA index of moderate intensity. The physical activity at school index showed only a significant correlation in the parent condition with the accelerometer data of vigorous activity, using the age-specific count cutoffs ($r = .27$, $p < .05$).

In the condition with parental assistance, the paired samples t tests showed significant differences between the total self-reported minutes of physical activity in the questionnaire (moderate to vigorous intensity, active transportation included) ($M = 449$ min/week, $SD = 222$) and the total registered activity minutes on the accelerometer (moderate to vigorous intensity), using the count cutoffs for adults ($M = 558$ min/week, $SD = 215$) ($t = 3.16$, $df = 50$, $p < .01$) and the age-specific count cutoffs ($M = 1109$ min/week, $SD = 310$) ($t = 14.83$, $df = 50$, $p < .001$). T-tests in the non-parent condition also showed significant differences between the total activity reported in the questionnaire ($M = 515$ min/week, $SD = 320$) and the total registered activity minutes on the accelerometer, using the age-specific count cutoffs ($M = 1111$ min/week, $SD = 245$) ($t = 11.09$, $df = 48$, $p < .001$). No significant difference was found between the self-reported activity and the recorded activity on the accelerometer, using the count cutoffs for adults ($M = 567$ min/week, $SD = 149$) ($t = 1.1$, $df = 48$, ns). The accelerometer recorded more physical activity counts of moderate to vigorous intensity than

Table 3. Spearman's rank correlation coefficients between the self-reported physical activity and the accelerometer activity counts, expressed in min of physical activity.

Activity indexes	Condition	Moderate activity		Vigorous activity		Moderate to vigorous activity	
		Adult count cutoffs	Age-specific count cutoffs	Adult count cutoffs	Age-specific count cutoffs	Adult count cutoffs	Age-specific count cutoffs
Total PA index, active transportation included	parent condition	.41**	.29*	.18	.35*	.40**	.33*
	non-parent condition	.24	.15	.21	.15	.23	.12
Total PA index without active transportation	parent condition	.39**	.30*	.19	.33*	.38**	.34*
	non-parent condition	.20	.17	.20	.10	.20	.12
LTPA index of moderate to vigorous intensity	parent condition	.35*	.27*	.12	.27*	.33*	.29*
	non-parent condition	.25	.18	.43*	.26	.28	.18
LTPA index of vigorous intensity	parent condition	.50**	.39**	.17	.42**	.49**	.44**
	non-parent condition	.41**	.39**	.45**	.42**	.42**	.41**
LTPA index of moderate intensity	parent condition	-.23	-.21	.01	-.21	-.24	-.25
	non-parent condition	-.18	-.21	.06	-.17	-.15	-.24
PA at school index of moderate to vigorous intensity (PE included)	parent condition	.26	.18	.21	.27*	.26	.22
	non-parent condition	.10	.06	-.04	-.02	0.08	0.01

Note. PA = physical activity; PE = physical education; LTPA = leisure time physical activity.

* $p < .05$. ** $p < .01$.

the physical activity reported in the questionnaire, especially when using the age-specific count cutoffs.

Discussion

The main purpose of the present study was to evaluate the reliability and validity of a questionnaire measuring usual physical activity in 9- to 11-year-old children, completed with and without the assistance of a parent. The results clearly indicated that the physical activity questionnaire, completed with parental assistance, is more reliable and shows higher validity coefficients than completed without parental assistance.

In general, the test-retest reliability of the physical activity questionnaire completed with parental assistance was better than completed without parental assistance, except for the transportation index “walking and cycling in leisure time”. In the non-parent condition, probably only the children (35%) whose leisure time transportation is well structured may have answered this questions, resulting in a higher reliability coefficient. In the parent condition, these items were answered in much more (67%) respondents. Probably parents may have tried to estimate these highly variable and unstructured transportation activities, but with low test-retest reliability. Compared with other studies (not including parental assistance) (Sallis, 1991; Sallis & Saelens, 2000), the reliability coefficients of the “total physical activity indexes” in the parent condition were relatively high (.82 – .86), while those in the non-parent condition (.52 - .55) were relative low. Mota et al. (2002) reported a test-retest reliability coefficient of .71 for the weekly activity checklist in 8- to 16-year-old children. Sallis, Buono, Roby, Micale, and Nelson (1993) reported a test-retest reliability of .47 for a 7-day recall interview with a 1-week interval and a test-retest reliability of .69 for the Godin-Shephard questionnaire with a 2-week interval in 36 fifth grade students. In another study, the reliability coefficients of two 1-day recalls in fifth-grade students ranged from .64 to .79 for both questionnaires (Sallis et al., 1996). It is very likely that the higher reliability coefficients in the parent condition are attributable to the cooperation of one of the parents in completing the questionnaire.

Most of the validity coefficients in the parent condition were significant and provided good support for the validity of the questionnaire. Conversely, in the non-parent condition, only significant correlations were found for the LTPA index of vigorous intensity, using both count cutoffs. This finding suggests that parental assistance in completing the physical

activity questionnaire results in higher validity coefficients compared with the physical activity questionnaire completed by children alone. Although questionnaires measuring usual physical activity often result in lower validity coefficients as compared to 1- or 3-day recalls, the validity results in the parent condition, using the age-specific count cutoffs (ranging from .27 to .44), were in line with other studies. Trost et al. (1999) reported correlations ranging from .35 to .43 between the previous day physical activity recall and the accelerometer data in fifth grade students. In the same line, Pate, Ross, Dowda, Trost, and Sirard (2003) reported correlations ranging from .27 to .51 between the 3-day physical activity recall instrument (3DPAR) and the accelerometer data in 13- to 16-year-old children. Using the count cutoffs for adults, the total physical activity index, active transportation included, showed a moderate but significant correlation with the accelerometer data ($r = .40$) in the parent condition. Compared with other studies, using a single axis accelerometer to validate self-administered self-reports in children, the correlation of the present study was slightly higher than the reported correlations in this age group (Kohl et al., 2000; Sallis & Saelens, 2000; Sirard & Pate, 2001). Mota et al. (2002) reported a correlation of .30 between the weekly activity checklist and the accelerometer data in 8- to 16-year-old children. Sallis, Condon, et al. (1993) who used a Caltrac accelerometer to validate a weekly activity checklist in fourth grade students, reported a correlation of .34. Kowalski, Crocker, and Faulkner (1997) reported a correlation of .39 between the “Physical Activity Questionnaire for Older Children” (M age = 11.06, $SD = 0.46$; 7-day recall) and the Caltrac accelerometer data. The slightly higher validity of the questionnaire in the parent condition, compared with the validity results of questionnaires in the literature completed by children alone, confirms the finding of the present study that parental assistance can result in better validity coefficients in fourth and fifth grade children. Moreover, in the present study a questionnaire was used measuring usual physical activity, which often results in lower reliability and validity coefficients. However, for health promotion perspective, measurement of usual physical activity is more relevant than 1- or 3-day recalls.

In the non-parent condition only vigorous activities correlated significantly with the accelerometer data. This supports previous findings in the literature (Sallis, Buono, et al., 1993) that activities of vigorous intensity are recalled more accurately than activities of moderate intensity in children. According to the literature (Sallis, Buono, et al., 1993; Sallis & Saelens, 2000; Trost et al., 1999), this could be explained by the high salience of vigorous intensity activities, which make them easier to recall than activities of moderate intensity. Moderate intensity activities are being accumulated throughout the day and the number and

diversity of these activities is large, making it difficult to recall all moderate intensity activities. Furthermore, physical activity questionnaires are especially insensitive to unstructured play and games, which are typical activities among this age group.

Generally, the validity coefficients between the physical activity reported in the questionnaire and the accelerometer data of moderate and moderate to vigorous intensity were similar in magnitude using the count cutoffs for adults (Freedson et al., 1998) and using the age-specific count cutoffs (Troost et al., 2002). However, for vigorous activity in the parent condition, the age-specific count cutoffs produced higher correlations with the questionnaire compared with those based on the count cutoffs for adults. The lower boundary of the vigorous-intensity count cutoff for adults ($> 5,724$ counts) was higher than those of the vigorous intensity age-specific count cutoff (e.g., 11 years: $> 3,908$ counts), and the adult cutoff may be too high to capture children's vigorous intensity activities. Therefore, these validity results support the concept that the use of age-specific count cutoffs is more appropriate to measure vigorous intensity activities in children. However, additional studies are needed to compare the different accelerometer cutoffs before a single method can be recommended to identify the time spent in different intensity activities in children. The significant correlations between the accelerometer data of vigorous activity, using the count cutoffs for adults, and the LTPA index of vigorous and of moderate to vigorous intensity in the non-parent condition, could be explained by differences in the type of activities reported by the children in the different conditions. Most children in the non-parent condition recorded only their organized sports practiced in leisure time, while children in the parent condition also reported unorganized activities (e.g., swimming, skating, cycling, etc.) which were particularly moderate to vigorous intensity activities. The reported organized activities in the non-parent condition were mostly vigorous to very vigorous intensity activities, what could explain the correlations with the accelerometer data of vigorous activity, using the adult count cutoffs.

Most studies reported an overestimation of physical activity on self-reports, when compared to objective measures (Sallis & Saelens, 2000; Sallis et al., 1996; Welk et al., 2000). However, in the present study, the comparison of self-reported minutes of physical activity to the accelerometer data suggests that the participants of both conditions did not overestimate their physical activity. Using the count cutoffs for adults, the subjects tended to accurately report their moderate to vigorous activity. However, when the age-specific count cutoffs were used, monitored physical activity minutes were much higher than the total self-reported minutes. A possible explanation could be that the objectively monitored minutes of

moderate to vigorous intensity, using the age-specific count cutoffs, contained more activities of low intensity, compared with the monitored minutes of moderate to vigorous intensity, using the count cutoffs for adults. On the other hand, the questionnaire only measured activities of moderate and vigorous intensity so low-intensity activities are not included in the total minutes of self-reported activity. In addition, accelerometers are known to overestimate low intensity activities and to underestimate vigorous intensity activities when compared to activity diaries (Sirard, Melanson, Li, & Freedson, 2000).

A limitation of the present study is that a “gold standard” for assessing physical activity levels in children is missing, which implies that any criterion physical activity measure will contain random measurement errors.

Based on the literature, the use of self-reports in young children is discouraged (Sallis, 1991; Sallis, Condon, et al., 1993). However, it can be concluded from the present study that parental assistance can improve children’s self-reports to an acceptable level. The questionnaire evaluated in the present study, completed with one of the parents, showed good test-retest reliability and acceptable validity to assess usual total physical activity levels and activity levels of vigorous intensity and of moderate to vigorous intensity in 9- to 11-year-old children. Nevertheless, the use of the questionnaire to measure moderate intensity activities and active transportation needs caution. To our knowledge, this is the first demonstration that a usual physical activity questionnaire, completed jointly by the child and a parent, can be reliable and valid. This questionnaire can be useful for assessing children’s usual physical activity levels and evaluating the effectiveness of interventions. However, more studies evaluating the validity of self-reports in children completed with one of the parents are necessary.

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Appendix 1 (questionnaire)

By answering the following questions, face a 'usual' week (7 days)

1. How do you usually go to school and back home?

(you can indicate several possibilities)

cycling

How long do you cycle to school and back home per day (back and forth together)?

..... minutes

walking

How long do you walk to school and back home per day (back and forth together).

..... minutes

2. How much time is weekly provided for PE?

..... minutes per week

3. When can you participate in sports or physical activities at school?

(you can indicate several possibilities)

- during lunch break and playtime
- after school hours
- on Wednesday afternoon
- on class- or school tournaments
- at none time **go to question 7**
- other times:

4. Do you participate in one of these activities? (indicate the right answer)

- yes
- no **go to question 7**

5. In which activities do you participate?

(indicate the right answer, you can indicate several possibilities)

- sports or physical activities during lunch break and playtime
- sports or physical activities after school hours
- sports or physical activities on Wednesday afternoon
- sports or physical activities on class- or school tournaments

6. How much time do you spend on all these activities? (indicate the right answer)

- now and then
- 2 hours per week
- 1 hour per month
- 3 hours per week
- 2 hours per month
- 4 hours per week
- 3 hours per month
- more than 4 hours per week
- 1 hour per week
- week

7. How much time per day do you use cycling for transportation in leisure time?

(cycling to school and back home is not included) (cycling as a sport is not included)

.....hour(s)..... minutes

8. How much time per day do you use walking for transportation in leisure time?

(walking to school and back home is not included)

(walking as a sport is not included)

.....hour(s)..... minutes

9. During a normal week, how much hours per day do you spend watching television or video, playing computer games...?

During a week day (=Monday to Friday)

During a weekend day (=Saturday to Sunday)

- none
- 0.5 hour
- 1 hour
- 2 hours
- 3 hours
- 4 hours
- 5 hours
- 6 hours or more

- none
- 0.5 hour
- 1 hour
- 2 hours
- 3 hours
- 4 hours
- 5 hours
- 6 hours or more

10. Give the three main sports you practiced most in leisure time.

(note: physical education and school sports do not count for your sports in leisure time)

My first sport

(the same for my second and third sport)

I don't practice a sport in leisure time

My first sport is:

<u>How often</u> do you practice this sport? (indicate only 1 option)	<u>How much time (hours)</u> do you spend on this sport?
<input type="radio"/> now and then hours per year
<input type="radio"/> one week per year	
<input type="radio"/> two weeks per year	
<input type="radio"/> three weeks per year	
<input type="radio"/> four weeks per year	
<input type="radio"/> one time per month hours per month
<input type="radio"/> two times per month	
<input type="radio"/> three times per month	
<input type="radio"/> one time per week hours per week
<input type="radio"/> two times per week	
<input type="radio"/> three times per week	
<input type="radio"/> four times per week	
<input type="radio"/> five times per week	
<input type="radio"/> six times per week	
<input type="radio"/> seven times per week	
<input type="radio"/> more than seven times per week	

Do you participate in organized training?
 yes no

Do you participate in organized competition?
 yes no

Thank you very much for your cooperation!!

Chapter 3

A comprehensive physical activity promotion program at elementary school: the effects on physical activity, physical fitness and psychosocial correlates of physical activity

Abstract

Objective: To evaluate the effects of a comprehensive physical activity (PA) promotion program in elementary schools on children's total PA levels, leisure time PA, physical fitness and psychosocial correlates of PA.

Design: A randomized controlled field trial, with school as the unit of randomization, with pretest and posttest over 2 school years.

Setting and subjects: Sixteen elementary schools ($N = 16$) (764 children, mean age: 11.2 ± 0.7) were randomly assigned to the intervention condition ($n = 8$) and the control condition ($n = 8$). The intervention included a health-related physical education program, an extracurricular PA promotion program and classroom-based PA education lessons. In the total sample, leisure time PA, psychosocial correlates of PA and physical fitness were measured, using a PA questionnaire and the Eurofit test battery. In a sub sample, total PA levels were measured, using accelerometers.

Results: According to the accelerometer data, children's moderate and moderate to vigorous PA (MVPA) levels decreased less in the intervention schools than in the control schools ($P < 0.01$). The average time spent on MVPA decreased with 9 min per day in the intervention schools, compared with 33 min per day in the control schools. Children in the intervention schools reported significantly more moderate PA in leisure time than the controls ($P < 0.05$). No overall improvement of physical fitness and no effects on the psychosocial correlates of PA were found.

Conclusions: The comprehensive PA promotion program was successful in preventing a decline in children's total activity levels. Furthermore, the intervention increased children's PA engagement in leisure time. Therefore, implementation needs to be encouraged.

Introduction

During childhood and adolescence, regular physical activity (PA) is associated with improvements in physiological and psychological health and is being promoted as an objective for disease prevention^{1,2}. Furthermore, increasing children's overall activity may increase children's health-related physical fitness³. Nevertheless, a substantial proportion of young people have lower PA levels than recommended for good health⁴. In Europe, the 'Health Behavior in School-aged Children' survey, executed in approximately 1500 11-, 13-, and 15-year-olds in each of the 35 participating countries, revealed that only 34% of all young people reported PA levels that meet the guideline of 'one hour or more of at least moderate intensity PA on five or more days a week'⁵. Furthermore, PA levels decline from childhood to adolescence and adulthood⁵⁻⁸. Therefore, the promotion of lifelong PA among youth is an important public health challenge.

The school environment is an ideal setting for the promotion of PA, since all children can be reached. Schools can provide opportunities to be physically active during physical education, during recess and before and after school hours^{9,10}. Furthermore, informing children and their parents about the importance of lifelong PA and the possibilities to be active in the community can contribute to the development of an active and healthy lifestyle.

Several intervention studies in elementary schools have attempted to increase children's PA levels at school by focusing on physical education (PE)^{11,12}. School-based PE interventions were evaluated as effective in increasing children's PA levels during PE classes and in improving children's physical fitness¹¹. Other intervention studies focused on school break periods to promote PA at school and reported an increase in children's activity levels during those periods⁹. However, to meet public health benefits and to promote lifelong PA, school-based interventions should also focus on the promotion of regular PA outside the school because children spend a lot of their time in non-school environments⁴. In the literature, only a few comprehensive studies in elementary schools could be located targeting children's out-of-school PA^{11,12}. In the United States, the SPARK program (Sports, Play and Active Recreation for Kids) was designed to increase children's PA levels during PE classes and out-of-school by implementing a health-related PE program and a self-management program¹³. In the same line, the PA component of the 'CATCH'^{14,15} (Child and Adolescent Trial for Cardiovascular Health) and 'Go For Health'¹⁶ programs was designed to increase children's moderate to vigorous PA (MVPA) engagement during PE classes and to promote generalization of PA. The PA component in both studies included a PE intervention and

classroom health curricula. These three United States studies were effective in increasing children's PA levels during PE classes. Only the CATCH study found a significant increase in children's vigorous PA out-of-school¹². The CATCH study also evaluated children's psychosocial correlates of PA. A short term effect was found early in the intervention for some of the psychosocial correlates of PA but these effects were not remained till the end of the intervention¹⁷. However, to maximize the effectiveness, interventions should also target changes in psychosocial correlates of PA to achieve a substantial behavioral change^{4,18,19}.

Since an increasing prevalence of overweight and obesity among children²⁰ and a PA decline with age^{5,7} is also present in Europe, the implementation of interventions promoting lifelong PA seems also necessary in Europe. Till now, the effectiveness of a comprehensive PA promotion program has not yet been evaluated in Europe. However, the American programs like 'SPARK', 'CATCH' and 'Go For Health', can not simply be implemented in different European countries because of educational and cultural differences. Therefore, adjustments are needed.

The purpose of the present study was to evaluate the effects of a comprehensive PA promotion program in elementary schools on total PA levels, PA levels in leisure time, physical fitness and psychosocial correlates of PA.

Methods

Participants and Setting

The present study was executed in Belgium, a nation located in the centre of Europe. Out of all elementary schools in East-Flanders ($n = 486$), 16 elementary schools were selected to participate in the study by simple randomization, taking the actual distribution over catholic and community schools into account. Participating schools were randomly assigned to the intervention condition ($n = 8$) and the control condition ($n = 8$). Pretest measurements were performed in all children of the fourth and fifth grade (399 boys and 411 girls, mean age: 9.7 ± 0.7). Posttest measurements were performed in all children of the fifth and sixth grade (373 boys and 391 girls, mean age: 11.2 ± 0.7). The 46 drop outs were caused by children who changed schools or who were not present at the days of data collection. The evaluation was considered to be part of the psychological, medical and social counseling provided by the school for which all parents signed a consent form ($n = 810$). All children present at school on the day of measurements participated in the study. A representative sub sample was selected

to evaluate children's total PA levels by accelerometers, including children of eight schools (four control schools, four intervention schools), randomly selected out of the 16 participating schools. The parents of all children ($n = 312$) were contacted by telephone to ask for participation of their child in the evaluation. The parents of 123 children (39%) gave approval for participation and returned the signed informed consent form. All 123 children participated in pretest measurements. At posttest, 12 children were excluded from the analyses, four due to accelerometer malfunctions and eight due to sickness on the days of measurement. Finally, a representative sub sample of 111 children (49 boys, 62 girls) was used. The study protocol was approved by the Ethics Committee of the University.

Intervention

The intervention evaluated in the present study was developed to promote physically active lifestyles and was based on the SPARK program (Sports, Play, and Active Recreation for Kids) of San Diego State University¹³. SPARK was designed to increase children's PA during PE classes and outside of school by implementing a health-related PE intervention and a self-management program. For the intervention in the present study, the original SPARK program was adjusted to the educational system and the culture of Belgium (Flanders). Additionally, PA was also promoted during recess periods and lunch break, because elementary schools in Belgium organize several recess periods per day and have longer lunch breaks compared to the elementary schools in the United States, making it important school environmental factors for the promotion of PA.

The intervention in the present study included: (1) a health-related PE program, (2) classroom-based health education lessons and (3) an extracurricular PA promotion program. Like in the SPARK PE program, the main goal of the present **health-related PE program** was to promote high levels of PA for all children during PE lessons. Additionally, the intervention was intended to make teachers aware of the health-promoting role of PE. In the original SPARK PE program, structured PE curricula were provided and implemented because a substantial amount of the PE teachers were classroom teachers. In the present study, the PE teachers were not asked to follow the entire SPARK PE-curriculum since all the PE teachers in the present study were PE specialists and since public schools in Flanders have a mandatory PE curriculum. The PE teachers of the intervention schools received a manual, containing didactical guidelines and sample lessons promoting health-related PE and high activity levels, based on the SPARK principles. The PE teachers were asked to implement the didactical guidelines in all the PE lessons. Additionally, the teachers were asked to give at

least six of the 49 elaborated sample lessons. **The health-education component**, based on the self-management program of SPARK, consisted of six lessons and three repetition lessons and was implemented by a research staff member within the existing health promotion curriculum. The lessons were designed to promote lifelong PA. Like in the SPARK self-management program, the purpose of the health-education lessons was to increase knowledge and to develop and maintain an active and healthy lifestyle by teaching skills including goal-setting, time planning, problem solving and self-talk. Children also received homework to promote PA outside school and to stimulate parental support for PA. Furthermore, children were informed through a brochure about sport clubs in the neighborhood to stimulate sports participation in leisure time. The **extracurricular PA promotion program** focused on recess periods and after school hours to promote PA. During lunch break and recesses, game equipment was provided to increase children's activity levels. Each class group of the intervention schools received a set of game equipment. Children were allowed to play outdoors with the game equipment during recesses and lunch break. The organization was assigned to the classroom teachers. Furthermore, extracurricular physical activities were provided once a week during lunch break and after school hours. The organized physical activities were given by an external PE teacher. Participation was on voluntary base. The extracurricular activities promoted positive attitudes toward PA and encouraged the children to be active in leisure time by providing activities and games that can be easily transferred towards leisure time (e.g. rope skipping, Frisbee, ball games).

Procedure

The intervention in the present study was implemented over two school years, starting in November 2002 and ending in April 2004. Pretest measurements were performed from September to October 2002, posttest measurements from April to June 2004. In the total sample, children's PA levels in leisure time and their psychosocial correlates of PA were measured using a PA questionnaire. The 'Eurofit', a standardized physical fitness test battery was used to evaluate children's physical fitness levels. Children's total PA levels were evaluated in a representative sub sample of 111 children, using accelerometers.

A sub sample of 111 children wore the accelerometers for five consecutive days. On the first day, children were familiarized with the accelerometer. They were requested to wear the accelerometer during waking hours, removing the monitor only for water based activities and sleeping. The accelerometers were worn just above the right hipbone underneath clothes and were held in place by an elastic belt. The children were also asked to record each activity

performed without wearing the accelerometer on a record form (e.g. swimming, contact sports, showering), including the duration and the intensity. An accelerometer instruction form for the parents was included to ensure correct accelerometer use. After five days, accelerometers and record forms were collected at school.

All children received the PA questionnaire at school. They were asked to complete the PA questionnaire the same day at home together with one of their parents. A letter for the parents was added, clearly instructing that one of the parents had to assist the child in completing the entire PA questionnaire. The questionnaires were collected at school the next day.

The fitness testing was performed at all schools during PE classes in the gym room, following a standardized protocol²¹.

Instruments

Accelerometer. The accelerometer has been shown to be a valid, reliable and objective method for monitoring PA in children^{22,23}. In the present study, the MTI Actigraph model 7164 (Manufacturing Technologies Inc., Shalimar, FL) was used. The accelerometers were programmed to record activity counts in a 1-min sampling interval. The 1 min movement counts were downloaded into a personal computer and converted into an Excel file for subsequent analyses. To convert the total activity counts into light (< 3 METs), moderate (3.0–5.9 METs) and vigorous intensity activity (> 6.0 METs), the accelerometer count cutoffs of Trost *et al.*⁸ for children were used. MVPA engagement was calculated by summing the moderate and vigorous intensity activities. Low, moderate and vigorous intensity activities were summed to indicate total PA engagement. The accelerometer data were expressed in min per day.

PA questionnaire. In previous research, the PA questionnaire, completed with parental assistance, has shown good reliability (ranging from ICC = 0.68, $P < 0.01$ to ICC = 0.93, $P < 0.01$) and acceptable validity (ranging from $r = 0.27$, $P < 0.05$ to $r = 0.44$, $P < 0.01$)²⁴.

Leisure time PA (LTPA) was assessed by asking pupils for their main sports practiced in leisure time (with a maximum of three sports). Both organized and non-organized sports were included. For each sport, the frequency and the usual time spent on that activity were reported. For coding physical activities of the questionnaire by intensity, the compendium of Ainsworth *et al.*²⁵ was used. Activities of 3.0 to 5.9 METs were defined as moderate activities and activities of more than 6.0 METs were defined as vigorous activities. *A LTPA index of*

moderate intensity and a *LTPA index of vigorous intensity* were calculated, expressed in min per day, summing up the three main sports. A *LTPA index of moderate to vigorous intensity* was composed by summing the two indexes above. Finally, questions were included on children's psychosocial correlates of PA. Children were asked about their general attitude toward PA, social support, self-efficacy, perceived barriers and benefits²⁶.

The Eurofit test battery. The Eurofit test battery is a valid and reliable test of physical fitness, applicable in school situations, and designed primarily for children²¹. The Eurofit test battery contains nine tests that measure different components of physical fitness: the flamingo balance test (general balance), plate tapping (speed of limb movement), sit and reach (flexibility), standing broad jump (explosive strength), hand grip (static strength), sit-ups (trunk strength and abdominal muscular endurance), bent arm hang (functional strength, arm and shoulder muscular endurance), 10 x 5m shuttle run (running speed and agility) and 20-m endurance shuttle run (cardio-respiratory endurance). In the present study the sit-up was excluded because the sit-up strongly increases loading of the discs through activation of the iliopsoas²⁷. The Eurofit test battery also contains anthropometric measures (height, body mass, and body fat by the sum of five skin folds: biceps, triceps, subscapular, suprailiac, calf). All tests were administered by trained research staff members.

Data Analysis

All data were analyzed using SPSS for Windows (12.0). To evaluate the main effects of the intervention on children's activity levels, physical fitness and psychosocial correlates of PA, linear mixed models analysis was used on the posttest values, with condition entered as factor. School was nested within condition to take school variance into account. In addition, gender was entered as a second factor to evaluate gender differences (gender x condition). All analyses were adjusted for baseline values. The level of statistical significance was set at $P < 0.05$.

Results

Table 1 presents the effects of the intervention on children's total PA levels, measured by accelerometers. Significant effects of the intervention were seen at posttest for the time spent on moderate intensity PA ($F = 15.3, P < 0.01$) and moderate to vigorous intensity PA (F

= 10.3, $P < 0.01$). The time spent on moderate and on moderate to vigorous intensity PA was significantly higher in the intervention schools than in the control schools. This represents a smaller decrease in moderate and moderate to vigorous PA engagement from baseline for the intervention schools, compared with the control schools. A trend toward significance was found for the total PA engagement ($F = 3.6$, $P = 0.06$), revealing that children's total PA engagement in the intervention schools was higher at posttest measurements, compared with those in the control schools. This represents an increase in the total PA engagement from baseline for the intervention schools, while it decreased in the control schools. No significant effects of the intervention were seen at posttest measurements for low and vigorous intensity PA. No significant gender differences were found on the accelerometer data, which shows that the intervention effects were similar for boys and girls.

Table 1. Mean scores, standard deviations (SD) and main effects (F -values) of the intervention on total physical activity levels, measured by accelerometers.

Accelerometer (min/day)	Condition	Pretest (Mean \pm SD)	Posttest (Mean \pm SD)	F
Low intensity PA	Intervention	532.73 \pm 61.29	547.75 \pm 57.55	0.35
	Control	527.28 \pm 57.31	537.88 \pm 70.98	
Moderate intensity PA	Intervention	129.28 \pm 38.40	122.90 \pm 37.86	15.32**
	Control	137.53 \pm 26.89	107.45 \pm 27.11	
Vigorous intensity PA	Intervention	21.48 \pm 12.74	18.59 \pm 12.76	0.01
	Control	20.98 \pm 11.60	17.68 \pm 11.28	
Moderate to vigorous PA (= MVPA engagement)	Intervention	150.75 \pm 48.17	141.50 \pm 46.84	10.26**
	Control	158.51 \pm 30.84	125.13 \pm 33.52	
Low to vigorous PA (= total PA engagement)	Intervention	683.48 \pm 64.52	689.25 \pm 64.83	3.57 ^(*)
	Control	685.79 \pm 57.27	663.01 \pm 72.84	

Note. PA = physical activity; MVPA = moderate to vigorous physical activity.
*, $P < 0.05$; **, $P < 0.01$; ^(*) = trend toward significance.

The effects of the intervention on the leisure time PA (LTPA) and the psychosocial correlates of PA, measured by the PA questionnaire, are presented in Table 2. A significant intervention effect was found for the LTPA index of moderate intensity ($F = 5.2$, $P < 0.05$). At posttest, children in the intervention schools engaged in more moderate intensity PA in leisure time, compared with those in the control schools. This represents an increase in the

time spent on moderate intensity PA in leisure time from baseline in the intervention schools, while it slightly decreased in the control schools. A trend toward significance was found for the LTPA index of moderate to vigorous intensity ($F = 4.5$, $P = 0.06$), revealing a higher MVPA engagement in leisure time in the intervention schools, compared with the control schools. This represents a larger increase from baseline in MVPA engagement in the intervention condition, than in the control condition. No significant intervention effects were found for the LTPA index of high intensity at posttest. No significant gender differences were

Table 2. Mean scores, standard deviations (SD) and main effects (F -values) of the intervention on leisure time physical activity and psychosocial correlates of physical activity, measured by the physical activity questionnaire.

Questionnaire	Condition	Pretest (Mean \pm SD)	Posttest (Mean \pm SD)	F
Physical activity (min/day)				
LTPA index of moderate intensity	Intervention	9.70 \pm 16.19	12.25 \pm 18.44	5.23*
	Control	8.99 \pm 16.57	8.66 \pm 15.40	
LTPA index of high intensity	Intervention	14.10 \pm 18.77	15.96 \pm 20.01	0.33
	Control	12.31 \pm 17.76	14.01 \pm 19.04	
LTPA index of moderate to high intensity	Intervention	23.80 \pm 21.68	28.20 \pm 24.66	4.50 ^(*)
	Control	21.30 \pm 22.44	22.67 \pm 21.83	
Psychosocial correlates of PA †				
Attitude: PA is pleasant	Intervention	4.22 \pm 0.81	4.22 \pm 0.78	0.49
	Control	4.18 \pm 0.84	4.26 \pm 0.79	
Attitude: PA is safe	Intervention	3.65 \pm 0.65	3.67 \pm 0.66	0.24
	Control	3.56 \pm 0.59	3.67 \pm 0.61	
Self-efficacy for PA	Intervention	3.60 \pm 0.99	3.71 \pm 0.93	0.53
	Control	3.45 \pm 1.00	3.65 \pm 0.94	
Social support	Intervention	3.47 \pm 0.90	3.43 \pm 0.89	0.12
	Control	3.41 \pm 0.90	3.50 \pm 0.89	
Perceived barriers	Intervention	1.98 \pm 0.80	1.91 \pm 0.70	0.51
	Control	2.22 \pm 0.86	2.03 \pm 0.74	
Perceived benefits	Intervention	3.55 \pm 0.71	3.54 \pm 0.61	0.08
	Control	3.58 \pm 0.71	3.57 \pm 0.62	

Note. † Response is on a 5-point scale (1 = strongly disagree, 5 = strongly agree).
PA = physical activity; LTPA = leisure time physical activity.
*, $P < 0.05$; **, $P < 0.01$; ^(*) = trend toward significance.

found. For the psychosocial correlates of PA, no significant effects of the intervention were seen at posttest measurements and no significant gender differences were found.

Table 3 presents the intervention effects on physical fitness, measured by the Eurofit test battery. No significant effects of the intervention were seen at posttest for the different physical fitness tests. Significant intervention effects were found for the anthropometric measures. Children's height ($F = 5.8, P < 0.01$) and the sum of skin folds ($F = 5.2, P < 0.05$) were significantly higher in the control schools, than in the intervention schools. This represents a slightly larger increase from baseline in height and the sum of skin folds in the control condition, compared with the intervention condition. A significant gender difference was found for the explosive strength (standing broad jump) ($F = 4.6, P < 0.05$). In girls, explosive strength at posttest measurements was significantly higher in the intervention schools, compared with the control schools.

Discussion

The aim of the present study was to evaluate the effects of a comprehensive PA promotion program in elementary school children. The present study findings indicated that the intervention was effective in promoting PA. The intervention was successful in preventing a decline in children's total MVPA engagement. Furthermore, the intervention increased children's leisure time PA.

The accelerometer data showed a clear intervention effect on children's total activity levels. The intervention succeeded in preventing a decrease in children's daily moderate and MVPA engagement. The average daily time spent on MVPA decreased with only 9 min per day in the intervention schools, compared to 33 min per day in the control schools. Furthermore, a trend of significance was found for children's total daily PA engagement, revealing an increase in children's total activity levels in the intervention condition with 6 min per day, while it decreased with 23 min per day in the control condition. The results of the control condition support previous findings that PA levels decline with age⁵⁻⁸. From the beginning of the intervention (mean age: 9.7 ± 0.7) till the end of the intervention (mean age: 11.2 ± 0.7), a clear decrease in PA levels was found. This is in line with the study of Trost *et al.*⁸, who argued that the age-related decline in PA already starts during elementary schools. The PA intervention, evaluated in the present study, was able to reduce this decrease to a

Table 3. Mean scores, standard deviations (SD), main effects ($F_{\text{intervention effects}}$) of the intervention and gender differences ($F_{\text{gender differences}}$) on physical fitness, measured by the Eurofit test battery.

Eurofit	Condition	Pretest			Posttest			F	F	gender differences
		Total sample (mean \pm SD)	Boys (mean \pm SD)	Girls (mean \pm SD)	Total sample (mean \pm SD)	Boys (mean \pm SD)	Girls (mean \pm SD)			
Balance (trials/60 sec)	Intervention	16.01 \pm 5.28	16.52 \pm 5.21	15.54 \pm 5.32	15.37 \pm 5.09	15.71 \pm 4.76	15.05 \pm 5.38	0.01	0.38	
	Control	18.04 \pm 4.48	18.18 \pm 4.30	17.91 \pm 4.64	15.87 \pm 4.78	15.93 \pm 4.38	15.82 \pm 5.12			
Plate tapping (sec)	Intervention	16.35 \pm 2.49	16.41 \pm 2.52	16.30 \pm 2.48	13.35 \pm 1.58	13.45 \pm 1.54	13.25 \pm 1.61	0.05	0.01	
	Control	16.21 \pm 2.44	16.04 \pm 2.36	16.37 \pm 2.50	13.35 \pm 1.53	13.33 \pm 1.35	13.36 \pm 1.69			
Sit and reach (cm)	Intervention	17.96 \pm 6.90	15.98 \pm 6.63	19.84 \pm 6.63	16.69 \pm 7.56	13.92 \pm 6.61	19.33 \pm 7.48	0.01	1.03	
	Control	17.56 \pm 7.13	16.31 \pm 6.43	18.69 \pm 7.55	16.32 \pm 7.67	14.51 \pm 6.74	17.97 \pm 8.10			
Standing broad jump (cm)	Intervention	144.62 \pm 19.98	150.87 \pm 17.98	138.69 \pm 20.04	155.74 \pm 20.85	160.83 \pm 18.19	150.91 \pm 22.17	0.44	4.63*	
	Control	140.42 \pm 19.56	146.30 \pm 17.27	135.07 \pm 20.02	150.93 \pm 22.08	158.34 \pm 18.61	144.18 \pm 22.87			
Hand grip strength (kg)	Intervention	16.49 \pm 3.46	17.08 \pm 3.49	15.93 \pm 3.35	20.05 \pm 4.26	20.20 \pm 3.90	19.91 \pm 4.57	1.32	0.55	
	Control	16.18 \pm 3.74	17.00 \pm 3.82	15.42 \pm 3.51	20.26 \pm 4.79	20.96 \pm 4.79	19.62 \pm 4.72			
Bent arm hang (sec)	Intervention	12.92 \pm 12.48	15.70 \pm 13.41	11.14 \pm 10.99	14.01 \pm 12.89	17.02 \pm 14.16	11.14 \pm 10.84	0.41	2.72	
	Control	11.37 \pm 12.61	13.86 \pm 13.07	9.02 \pm 11.67	12.40 \pm 12.85	16.30 \pm 14.32	8.72 \pm 10.02			
Speed shuttle run (sec)	Intervention	21.61 \pm 1.95	21.24 \pm 1.92	21.96 \pm 1.91	22.26 \pm 1.62	21.96 \pm 1.61	22.55 \pm 1.58	0.55	0.01	
	Control	23.19 \pm 2.17	22.92 \pm 2.01	23.71 \pm 2.19	22.63 \pm 1.58	22.89 \pm 1.54	23.71 \pm 1.56			
Endurance shuttle run (min)	Intervention	3.94 \pm 1.89	4.71 \pm 1.99	3.21 \pm 1.46	4.23 \pm 1.77	4.91 \pm 1.85	3.58 \pm 1.41	0.13	1.07	
	Control	3.34 \pm 1.87	3.90 \pm 1.99	2.81 \pm 1.59	3.72 \pm 1.85	4.41 \pm 1.95	3.08 \pm 1.49			

Note. *, $P < 0.05$; **, $P < 0.01$.

Table 3 (continued). Mean scores, standard deviations (SD), main effects ($F_{\text{intervention effects}}$) of the intervention and gender differences ($F_{\text{gender differences}}$) on physical fitness, measured by the Eurofit test battery.

Eurofit Anthropometric parameters	Condition	Pretest			Posttest			F	gender differences
		Total sample (mean \pm SD)	Boys (mean \pm SD)	Girls (mean \pm SD)	Total sample (mean \pm SD)	Boys (mean \pm SD)	Girls (mean \pm SD)		
Height (m)	Intervention	1.40 \pm 0.07	1.40 \pm 0.07	1.40 \pm 0.08	1.48 \pm 0.08	1.48 \pm .07	1.50 \pm 0.08	5.77**	1.84
	Control	1.40 \pm 0.08	1.40 \pm 0.08	1.40 \pm 0.08	1.49 \pm 0.08	1.49 \pm 0.08	1.50 \pm 0.08		
Body mass (kg)	Intervention	33.78 \pm 7.10	33.08 \pm 6.66	34.42 \pm 7.45	40.11 \pm 8.80	38.83 \pm 8.31	41.30 \pm 9.09	3.19	0.37
	Control	34.62 \pm 7.91	34.03 \pm 6.95	35.16 \pm 8.70	42.07 \pm 10.74	40.91 \pm 9.43	43.16 \pm 11.75		
Sum of skin folds (mm)	Intervention	50.77 \pm 25.00	44.25 \pm 24.30	56.93 \pm 24.13	55.56 \pm 27.79	49.39 \pm 26.62	61.39 \pm 27.67	5.24*	2.22
	Control	52.01 \pm 27.30	44.88 \pm 24.94	58.83 \pm 27.79	64.04 \pm 39.67	54.93 \pm 35.19	72.74 \pm 41.81		

Note. *, $P < 0.05$; **, $P < 0.01$.

large extent. No gender differences were found for children's total activity levels, implying that the intervention was as effective in boys as in girls. This is an important finding from a public health perspective, since girls are typically at risk for low activity levels, even at young age^{4,7}. On the other hand, no significant effects were found for vigorous PA in the current study. A possible explanation could be that the intervention was especially designed to promote lifelong PA and that most lifetime activities are typically of moderate intensity. In addition, accelerometers averaged children's activity over a 1-min epoch, leveling down vigorous intensity activities. However, additional attention may be needed for the promotion of vigorous intensity activities.

Self-reported PA measurements indicated that the intervention was effective in increasing children's moderate and moderate to vigorous PA in leisure time. Again, no effects were found on vigorous activities. Furthermore, no gender differences were found, implying that the intervention was as effective in boys as in girls. In the literature, only one intervention study in elementary schools could be located being effective in increasing children's leisure time PA¹². Luepker *et al.*^{14,15}, reporting the effects of the CATCH program in fifth grade children, indicated that children in the intervention group reported significantly more daily vigorous activity than the control group. The SPARK program and 'Go for Health' study found no changes in children's out-of-school PA¹². Donnelly *et al.*²⁸, evaluating a nutrition and physical activity program in elementary school children, found that the self-reported out-of-school PA increased in the control condition and decreased in the intervention condition.

The intervention in the present study was expected to improve children's physical fitness by increasing children's activity levels. However, no overall improvement of physical fitness was found in the intervention condition. A possible explanation can be that both conditions had already good scores for the different fitness tests at pretest, when compared to the Eurofit profile charts of Flemish youth²⁹. Furthermore, the primary aim of the study was to improve children's activity levels. In addition, significant intervention effects for PA were mainly found for moderate intensity activities and not for vigorous intensity activities. Because improvements in physical fitness are associated with the participation in both moderate and vigorous intensity physical activities³, the lack of increased vigorous intensity activity in the intervention condition could also explain this finding. Other intervention studies in elementary schools also reported no effects on children's physical fitness^{14,15,28}. The anthropometric parameters showed a slightly more favorable evolution in the intervention schools, compared to the control schools. However, the inclusion of measurements of

children's puberty stage and maturation would be required to examine if this evolution can be attributed to the intervention or not.

In the present study, no significant effects were found on children's psychosocial correlates of PA, which is probably due to a ceiling effect. Children's psychosocial correlates of PA were already quite positive in both conditions at pretest, making it difficult to find significant improvements. These results were in line with the CATCH study that also failed to find effects on children's psychosocial correlates of PA after two years of intervention¹⁷.

Drawbacks of the present study were the quasi-experimental design of the study and the small number of schools involved.

A strong point of the present study is that the PA intervention integrated several school environmental factors to promote lifelong PA, including PE lessons, health-education lessons, recess periods and after school hours. Furthermore, the intervention is not expensive and most components can be implemented within the existing school programs by the schools themselves. However, it may be useful to incorporate health education regarding PA promotion in the professional course of future primary school teachers, enabling them to implement the health principles in their daily work and to enter into a professional career with a positive attitude toward PA promotion. In the present study, positive intervention effects were found for children's total PA and PA performed in leisure time. However, more research is needed to further evaluate which aspects of the intervention were most successful and which aspects need to be adjusted or improved. Although the more comprehensive approach makes it difficult to identify which aspects of the intervention were successful, we believe that such an approach is more appropriate to target children's physical activity behavior, which is influenced by a diversity of factors.

It can be concluded that the comprehensive PA intervention, combining a health-related PE intervention, health-education lessons and an extracurricular PA promotion program was effective in promoting PA in elementary school children. Because a lot of European young people have lower PA levels than recommended for good health, the implementation of such an intervention needs to be encouraged.

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Chapter 4

Effectiveness of a 2 year health-related physical education
intervention in elementary schools

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Abstract

The study aim was to evaluate the effectiveness of a 2 year health-related physical education intervention in a pretest-posttest design. Sixteen elementary schools (764 pupils, mean age: 11.2 ± 0.7) participated in the study. Schools were randomly assigned to the intervention condition ($n = 8$) and the control condition ($n = 8$). Making use of direct observation data according SOFIT (System for Observing Fitness Instruction Time), the moderate to vigorous physical activity engagement during physical education classes was significantly higher in the intervention condition than in the control condition. Children's moderate to vigorous physical activity engagement during physical education lessons increased with 14% in the intervention condition (from 42 to 56%). No significant effects were found on the accelerometer data. The health-related physical education intervention was found to be promising in promoting physical activity during physical education classes.

Key words: children, physical activity, health promotion

Introduction

Regular physical activity (PA) is an important component of a healthful lifestyle in children and adolescents (Cavill, Biddle, & Sallis, 2001; Harsha, 1995). Although many young people are more active than adults, a substantial proportion of young people have lower PA levels than recommended for good health (Biddle, Gorely, & Stensel, 2004). Moreover, it is well documented in the literature that girls are less active than boys (Biddle et al., 2004; Riddoch et al., 2004). In Europe, a large survey of approximately 1500 11-, 13-, and 15 year olds in each of the 35 participating countries, revealed that only 27% of all girls and 40% of all boys reported PA levels that meet the guideline of ‘1 hr or more of at least moderate intensity activity on five or more days a week’ (Roberts, Tynjala, & Komkov, 2004). The results for Belgium (Flanders) were even worse, ranging from 19% for girls to 26% for boys (Roberts et al., 2004). Furthermore, PA levels decline from childhood to adolescence and adulthood (Pate et al., 2002; Riddoch et al., 2004; Roberts et al., 2004; Trost et al., 2002). Therefore, the promotion of lifelong PA should be emphasized at an early age, and all young people should be encouraged to participate in moderate to vigorous physical activity (MVPA) for 1 hr per day (Beunen, De Bourdeaudhuij, Vanden Auweele, & Borms, 2001; Biddle, Sallis, & Cavill, 1998). Moderate to vigorous activities are defined as those that require at least as much effort as brisk or fast walking (Armstrong & Van Mechelen, 1998). Examples of MVPA may include walking, swimming, cycling, most sports, and dance.

Schools are ideal settings for the promotion of PA, since they have the possibility to reach a large number of young people. To reach the recommended daily PA time of 1 hr, schools can provide opportunities to engage in PA during recess periods, after school hours and in physical education classes. Furthermore, informing children, parents and other educational team members about the importance of lifelong PA and the possibilities to be active in the community can contribute to the development of an active and healthy lifestyle.

School-based physical education interventions were evaluated as effective in increasing pupils’ PA levels and consequently recommended as a means for enhancing PA (Kahn et al., 2002). However, whereas “Healthy People 2010” calls for pupils to engage in MVPA for at least 50% of the physical education class time (United States Department of Health and Human Services, 2000), several studies in the United States and in Europe found lower MVPA levels (Barnett, van Beurden, Zask, Brooks, & Dietrich, 2002; Cardon, Verstraete, De Clercq, & De Bourdeaudhuij, 2004; McKenzie, Marshall, Sallis, & Conway,

2000; Simons-Morton, Taylor, Snider, & Huang, 1993; Simons-Morton, Taylor, Snider, Huang, & Fulton, 1994). In a study by Friedman et al. (2003), 9 year old children engaged in MVPA during 15 to 37% of the physical education class time. Cardon et al. (2004) found that fourth and fifth grade children (mean age: 9.7 ± 0.7) engaged in MVPA during 40% of the physical education class time.

Since it is difficult to increase the frequency or duration of physical education classes within existing school program, it is important to use the scheduled time for physical education optimally and efficiently to promote high activity levels. According to the literature, health-related physical education programs can enhance children's MVPA levels during physical education classes (Donnelly et al., 1996; McKenzie et al., 1996). Health-related physical education curricula strive to keep all children as active as possible during physical education classes and to develop children's knowledge and movement skills promoting engagement in an active lifestyle leading to lifelong PA. Furthermore, physical education can play an important role in reducing gender differences in PA engagement by providing equitable opportunities to engage in health-related PA for boys and girls (McKenzie et al., 1996; Sarkin, McKenzie, & Sallis, 1997). In the United States, several health-related physical education programs like SPARK (Sports, Play and Active Recreation for Kids), CATCH (Child and Adolescent Trial for Cardiovascular Health) and "Go for Health" were found to be effective in increasing children's PA levels during physical education classes (Kahn et al., 2002). The SPARK and CATCH programs included externally developed health-related physical education curricula. To ensure adequate implementation of the curricula, in-service trainings for the teachers were organized. Moreover, it was important to not only provide enough support and supervision to the teachers but also to allow the teachers enough flexibility to adjust the program to the needs and interests of their own students. A too extensive program that requires a lot of efforts and changes of the teachers will demotivate and discourage the teachers to implement the program (McKenzie, 1999).

Since several studies reported low levels of MVPA engagement during European physical education classes (Cardon et al., 2004; Fairclough, 2003; Warburton & Woods, 1996), the implementation of health-related physical education programs seems also necessary in Europe. In Europe, the relation between physical education and health promotion is a relatively new concept and different studies indicated that many physical education teachers are not sufficiently aware of the health-promoting role of physical education (Cardon & De Bourdeaudhuij, 2002; Harris, 2005). Moreover, to our knowledge, no health-related physical education interventions were evaluated in Europe. However, American health-related

physical education programs like “SPARK, CATCH and Go for Health”, can not simply be implemented in different European countries because of educational curricula and cultural differences. They need to be adjusted to the educational system and culture of the European countries.

In Flanders, Belgium, the long term goals of the physical education curriculum have recently been reviewed by the government, and the development of a healthy and active lifestyle was adopted as an important mission of physical education. Despite the fact that elementary school children in Flanders receive a weekly average of 70 min of physical education and that 85% of the physical education classes are led by physical education specialists (Cardon & De Bourdeaudhuij, 2002), direct observation data showed that MVPA levels during physical education classes in elementary schools in Flanders were lower than the recommended 50% MVPA engagement (Cardon et al., 2004). Because health-related physical education programs can provide children with substantially more PA and physical education teachers in Flanders need to be advised about health-related physical education, a health-related physical education program was implemented in Flanders.

The purpose of the present study was to evaluate the effectiveness of a 2 year health-related physical education intervention. In a pretest-posttest design, children’s PA levels during physical education classes were evaluated with direct observation and accelerometers.

Methods

Participants and Setting

The present study was performed in Flanders, Belgium. Flanders is the Dutch-speaking part of Belgium, a nation located in the center of Europe. Out of all elementary schools in East-Flanders ($n = 486$), 16 elementary schools were selected to participate in the study by simple randomization, taking the actual distribution over parochial and community schools into account. Participating schools were randomly assigned to the intervention condition ($n = 8$) and the control condition ($n = 8$). Pretest measurements were performed in 39 class groups of fourth and fifth grade children (intervention condition: 20 class groups; 203 boys, 209 girls, mean age: 9.7 ± 0.7 ; control condition: 19 class groups; 189 boys, 190 girls, mean age: 9.8 ± 0.8). Due to reorganizations of the class groups between the two school years, 39 classes were remodeled into 38 class groups. As a result, 38 class groups of fifth and sixth grade children participated in the posttest measurements (intervention condition: 19

class groups; 196 boys, 203 girls, mean age: 11.2 ± 0.7 ; control condition: 19 class groups; 175 boys, 190 girls, mean age: 11.3 ± 0.8). Participating schools had an average of three class groups involved in the study (ranging from 1 to 5 class groups). In the present study, all physical education classes were led by a physical education specialist (intervention condition: three men, five women; control condition: four men, four women) and all the teachers had more than 10 years experience in teaching physical education. All participating schools provided two physical education classes per week and the scheduled lesson time for each physical education class was 50 min.

Intervention

The intervention evaluated in the present study was a physical education intervention, based on the physical education component of the SPARK program (Sports, Play, and Active Recreation for Kids) of San Diego State University (Sallis et al., 1997). The original SPARK program is a 2-year health-related physical education program for elementary school children. The SPARK physical education program was designed to increase PA during physical education classes. The program was implemented by providing the teachers a SPARK manual, training sessions and follow-up consultations. In the SPARK manual, specially designed lessons are described, including health-fitness activities and skill-fitness activities. These SPARK physical education lessons are designed to promote high levels of physical activity for all children during physical education classes, to teach movement skills and to be enjoyable. For the physical education intervention in the present study, the original SPARK physical education program was adjusted to the educational system and culture of Flanders. In the original SPARK physical education program, structured curricula were provided because a substantial number of the physical education teachers were classroom teachers. The teachers were asked to implement the curricula and they received training sessions to facilitate the implementation. Because all physical education classes in the present study were taught by physical education specialists and Flanders has a mandatory physical education curriculum, the teachers were not asked to implement the entire SPARK physical education curriculum. The present physical education intervention focused on providing the teachers with didactical guidelines to teach health-related physical education and to increase children's MVPA levels during physical education lessons. In addition, some SPARK lessons were provided as sample lessons. The didactical guidelines were based on the SPARK principles and included organization (e.g., not letting students choose their teams), management (e.g., forming smaller groups or using more equipment) and interaction guidelines (e.g., keeping instructions brief)

to promote health-related physical education and high levels of PA for all children. The sample lessons consisted of SPARK lessons that fit in the obligatory physical education curriculum of Flanders and were divided into health-fitness activities (cooperative games, astronaut drills, rope skipping, parachute games) and skill-fitness activities (Frisbee, soccer, basketball, volleyball, gymnastics).

The physical education intervention in the present study was implemented over two school years, starting in November 2002 and ending in April 2004. The main goal of the intervention was to promote high levels of student PA during physical education classes. Additionally, the intervention was intended to create teacher awareness of the health-promoting role of physical education. During the first intervention year, there were three contacts between the physical education teachers and a research staff member throughout the year. The research staff member had a master degree in physical education and was trained to teach the SPARK principles. During the first contact, at the start of the intervention, the teachers of the intervention schools received a manual, containing didactical guidelines and sample lessons. The goals of the physical education intervention and the content of the manual were explained to each teacher separately by the research staff member. The teachers were asked to implement the didactical principles of SPARK in all the physical education lessons and to give at least six sample lessons during the first intervention year. Three months after the first contact and at the end of the first intervention year, the same research staff member visited each teacher again to discuss the content and the usefulness of the manual and to provide motivational support to follow the didactical principles of SPARK. At the beginning of the second intervention year, the same research staff member visited each teacher again and repeated the goals of the physical education intervention. The teachers were asked to implement the didactical principles of SPARK in all the physical education lessons during the second intervention year. Approximately three months later, a 2 hr training was provided for all the physical education teachers of the intervention schools, including a repetition of the didactical guidelines promoting health-related physical education and illustrations of strategies to increase students' MVPA during physical education lessons, at recess and outside of school.

Procedure

Since the physical education intervention in the present study was implemented over two school years, pretest measurements were performed at the beginning of the first school

year (from September to October 2002) and posttest measurements at the end of the second school year (from April to June 2004). Accelerometers and the System for Observing Fitness Instruction Time (SOFIT) were used to measure children's PA level. At pretest and posttest, in each class group involved in the study, one physical education lesson was evaluated.

Before the start of each physical education class, five girls and five boys were randomly selected from the class group to wear an accelerometer during the entire physical education class. If classes contained less than five girls or five boys, the gender specific selection was adjusted. As a result, 390 students (200 boys and 190 girls) wore an accelerometer at pretest and 380 students (189 boys and 191 girls) at posttest.

For the SOFIT observations, six children (three boys and three girls) were randomly selected from each class group and the entire lesson was videotaped according to SOFIT. In line with the SOFIT protocol (McKenzie, Sallis, & Nader, 1991), students were selected as they arrived in the instructional station. In classes with fewer than 25 students, student 4, 8, 12, 16, 20 and 24 were selected. In classes with more than 25 students, student 5, 10, 15, 20, 25 and 30 were selected. If necessary, selection numbers were readjusted to ensure an equitable number of boys and girls. As a result 234 students (117 boys and 117 girls) were observed during pretest and 228 students (114 boys and 114 girls) during posttest. Afterwards, videotapes were synchronized with a tape recorder, which was used to cue the investigators when to observe and when to record. Based on McKenzie et al. (1991), PA levels and lesson contexts were observed every 20 s. In line with the SOFIT instructions (McKenzie et al., 1991), the actual physical education lesson time started when 51% of the pupils had reached the instructional station and ended when half of the class had departed from the area. All the physical education teachers consented to have their classes videotaped. Teachers were asked not to alter their teaching behavior or lesson contents in function of video recording. The evaluations were considered to be part of the psychological, medical and social counseling provided by the school for which all parents signed a consent form. The study protocol was approved by the Ethics Committee of the institution.

Instruments

Accelerometer. The accelerometer has been shown to be a valid, reliable and objective method for monitoring PA in children in field settings (Janz, 1994). In the present study, the MTI Actigraph model 7164 (Manufacturing Technologies Inc., Shalimar, FL) was used. The accelerometer was worn just above right hipbone underneath clothes and was held in place by an elastic belt. For the present study, a 1 min sampling interval was used. The 1 min

movement counts were stored in memory, downloaded into a personal computer and converted into an Excel file for subsequent analyses. To convert the total activity counts into moderate (3.0 – 5.9 METs) and vigorous activity (> 6.0 METs), the accelerometer count cutoffs of Trost et al. (2002) for children were used. Accelerometer data were expressed in percentages of physical education class time.

SOFIT. SOFIT was used to obtain information on student activity levels (lying down, sitting, standing, walking and being very active) and the lesson context in which they occurred (management, general knowledge, physical fitness knowledge, fitness, skill practice, game play, free play). The lesson contexts “physical fitness knowledge” and “free play” were not observed during any physical education lesson and therefore not included in the analysis.

According to the literature, SOFIT is found to be a valid observation instrument to measure PA levels in physical education classes (Rowe, Schuldheisz, & van der Mars, 1997). One doctoral student and two graduate students were trained to use the SOFIT system. Observer training consisted of approximately 2 hr studying definitions and coding conventions and 4 hr practicing coding vignettes from videotapes of physical education classes with a trainer. In a preliminary study (Cardon et al., 2004), the interrater and intrarater agreement were evaluated. The intraclass correlation coefficient for interrater agreement for the different activity levels varied from .96 to 1 ($p < .01$) and for the lesson contexts from .99 to 1 ($p < .001$). The intraclass correlation coefficient for intrarater agreement for the different activity levels varied from .80 to 1 ($p < .05$) and for the lesson contexts from .99 to 1 ($p < .01$). Additionally, interrater agreement was conducted throughout data analysis to prevent observer drift. To evaluate interrater agreement, four physical education lessons were randomly selected from all video-taped lessons, and observed by two independent raters on the videotapes. The intraclass correlation coefficients for all activity and lesson context variables in both conditions were found to be above .95 ($p < .01$).

SOFIT variables were expressed in percentages of physical education class time. The activity scores “walking” and “very active” were summed to indicate MVPA engagement. MVPA engagement was also calculated within specific lesson contexts.

Data Analysis

All data were analyzed using SPSS for Windows (12.0). To evaluate the effectiveness of the physical education intervention, linear mixed models analysis were used on the posttest

values of the SOFIT activity scores, lesson context variables, activity scores within specific lesson contexts and accelerometer data, with condition entered as factor. School was nested within condition to take school variance into account. In addition, gender was entered as a second factor to evaluate gender differences (gender x condition). All analyses were adjusted for baseline values. The level of statistical significance was set at $p < .05$. Descriptive statistics were used to evaluate the number of physical education classes reaching the 50% MVPA engagement.

Results

Table 1 presents the percentages of physical education class time spent at various student activity levels and in different lesson contexts for the intervention condition and control condition at pretest and posttest measurements. Significant effects of the intervention were seen at posttest for students' activity level "very active", $F(1, 14) = 7.23, p < .01$, and for children's MVPA engagement, $F(1, 14) = 15.78, p < .001$. The proportion of class time spent on "very active" activities was significantly higher in the intervention condition than in the control condition. This represents a smaller decrease from baseline in the physical education class time spent on "very active activities" in the intervention condition, compared to the control condition. The proportion of physical education class time spent on MVPA was significantly higher in the intervention condition, compared to the control condition. The average MVPA engagement increased from 42% to 56% in the intervention condition and from 37% to 41% in the control condition. Descriptive data showed that the number of physical education classes reaching the 50% MVPA engagement increased from 27% at pretest to 64% at posttest in the intervention condition and from 20% at pretest to 27% at posttest in the control condition. No significant differences between both conditions were found for the proportion of class time spent on "lying down, sitting, standing and walking". No gender differences were found on the SOFIT data. With regard to the lesson context, no significant effects of the intervention were seen at posttest measurements.

Table 2 presents the percentages of MVPA engagement within specific lesson contexts for the intervention condition and control condition at pretest and posttest measurements. At posttest, the proportion of MVPA engagement within the lesson contexts management, $F(1, 14) = 5.34, p < .05$, general knowledge, $F(1, 14) = 4.51, p < .05$, fitness activities, $F(1, 14) = 7.14, p < .01$, and game play, $F(1, 14) = 4.74, p < .05$, was significantly higher in the

intervention condition, compared to the control condition. This represents a larger increase from baseline in MVPA engagement within the lesson contexts management, general knowledge and game play in the intervention condition, compared to the control condition.

Table 1. Means and standard deviations (SD) of percentages of physical education class time spent at various student activity levels and lesson contexts.

Category	Condition	Pretest mean % (SD)	Posttest mean % (SD)	F (condition)	p
Student activity					
Lying down	Control	0.75 (1.61)	0.17 (0.34)	0.01	.94
	Intervention	1.47 (2.85)	0.35 (0.84)		
Sitting	Control	28.30 (15.49)	17.87 (13.34)	2.56	.13
	Intervention	13.14 (13.07)	10.12 (10.42)		
Standing	Control	32.99 (13.89)	40.38 (12.83)	0.84	.37
	Intervention	42.84 (14.65)	33.24 (11.36)		
Walking	Control	16.24 (10.64)	29.32 (8.14)	1.73	.21
	Intervention	19.32 (10.75)	36.73 (9.79)		
Very active	Control	21.72 (6.69)	12.26 (6.80)	7.23**	.01
	Intervention	23.22 (7.99)	19.56 (5.89)		
MVPA (walking + very active)	Control	37.26 (14.43)	41.48 (8.52)	15.78***	.001
	Intervention	42.34 (17.13)	56.29 (9.20)		
Lesson context					
Management	Control	20.03 (5.29)	14.21 (7.19)	0.04	.85
	Intervention	18.37 (8.17)	14.75 (4.87)		
General knowledge	Control	23.76 (11.89)	15.97 (7.79)	0.31	.58
	Intervention	26.29 (12.85)	20.24 (10.16)		
Fitness activity	Control	28.07 (15.68)	13.50 (12.19)	0.25	.62
	Intervention	32.53 (26.99)	14.37 (13.18)		
Skill practice	Control	16.64 (15.60)	25.46 (25.12)	0.03	.86
	Intervention	11.32 (15.78)	23.17 (21.70)		
Game play	Control	11.50 (16.37)	30.86 (31.04)	0.88	.36
	Intervention	11.50 (10.91)	27.47 (23.73)		

Note. MVPA = moderate to vigorous physical activity.
* $p < .05$. ** $p < .01$. *** $p < .001$.

MVPA engagement during fitness activities remained fairly similar in the intervention condition, while it decreased in the control condition. No significant effect was found for the proportion of MVPA engagement within the lesson context skill practice.

Table 2. Means and standard deviations (SD) of percentages of physical education class time engaged in moderate to vigorous physical activity within specific lesson contexts.

Category	Condition	Pretest	Posttest	<i>F</i> (condition)	<i>p</i>
		mean % (SD)	mean % (SD)		
Management	Control	26.75 (12.90)	28.84 (19.63)	5.34*	.03
	Intervention	26.95 (12.61)	47.21 (13.51)		
General knowledge	Control	2.28 (2.38)	7.35 (9.02)	4.51*	.05
	Intervention	2.58 (3.87)	19.15 (26.42)		
Fitness activity	Control	60.18 (26.43)	34.86 (31.58)	7.14**	.01
	Intervention	69.16 (18.26)	66.68 (35.63)		
Skill practice	Control	32.33 (32.12)	31.23 (27.89)	1.23	.28
	Intervention	19.94 (24.48)	41.14 (31.69)		
Game play	Control	24.08 (32.14)	33.36 (27.79)	4.74*	.04
	Intervention	30.66 (30.23)	61.45 (30.24)		

Note. * $p < .05$. ** $p < .01$.

Table 3 presents the accelerometer data, expressed as percentages of physical education class time spent on moderate, vigorous and moderate to vigorous intensity activities for the intervention condition and control condition at pretest and posttest measurements. With regard to the accelerometer data, no significant effects of the intervention were seen at posttest. No significant gender differences were found on the accelerometer data.

Table 3. Means and standard deviations (SD) of percentages of physical education class time spent at moderate, vigorous and moderate to vigorous activity.

Accelerometer data	Condition	Pretest	Posttest	<i>F</i> (condition)	<i>p</i>
		mean % (SD)	mean % (SD)		
Moderate intensity activity	Control	44.25 (13.78)	42.35 (16.08)	0.01	.92
	Intervention	41.01 (9.91)	44.40 (14.32)		
Vigorous intensity activity	Control	26.22 (12.24)	18.11 (14.35)	1.11	.31
	Intervention	33.11 (17.81)	22.56 (14.24)		
Moderate to vigorous intensity activity	Control	70.47 (10.71)	60.46 (19.27)	0.77	.39
	Intervention	74.12 (14.81)	66.95 (12.58)		

Note. * $p < .05$. ** $p < .01$.

Discussion

The goal of this study was to evaluate the effectiveness of a 2 year health-related physical education intervention on children's PA levels during physical education classes. The results indicated that the intervention was effective in promoting PA during physical education classes. Children in the intervention schools engaged in more MVPA during physical education classes than those in the control schools, obtained through direct observation. However, no significant effects were found on the accelerometer data.

In general, the observational data of children's "very active" activities and children's MVPA engagement showed significant intervention effects and the changes from baseline were in a direction that favored the intervention condition. The intervention was effective in increasing the time spent on MVPA and in reducing the decrease in time spent on vigorous intensity activities (being very active). Furthermore, no gender differences were found for the different "student activity levels" during physical education classes, implying that the health-related physical education intervention was as effective in increasing PA levels in boys as in girls. The mean percent of MVPA engagement increased with 14% in the intervention condition, while it increased by only 4% in the control condition. These results are in line with other studies, using direct observation to evaluate physical education interventions in elementary school children. McKenzie et al. (1996), evaluating the health-related physical education component of CATCH in fifth grade students, showed that pupils in the intervention schools increased their MVPA engagement during physical education classes with 14%, while those of the control schools increased their MVPA engagement with 8%. Sallis et al. (1997) reported the effects of a 2 year physical education program (SPARK) in fourth and fifth grade children. Results showed higher levels of MVPA in the intervention classes ranging from 32.7 min/week (teacher-led) to 40.2 min/week (specialist-led), compared to the control classes (17.8 min/week). Simons-Morton, Parcel, Baranowski, Forthofer, and O'Hara (1991), evaluating the effect of the 2 year "Go for Health" program, reported an increase in MVPA engagement in the intervention condition from less than 10% of physical education class time at baseline to about 40% of physical education class time in third and fourth grade children.

In the present study, the increase in children's PA engagement during physical education classes in the intervention condition, which was in line with other studies, demonstrated that a health-related physical education program can also be useful for physical education specialists, since most of the physical education classes in both conditions showed

low activity levels at pretest. However, because all the teachers in the present study were physical education specialists, who are better educated to teach physical education than classroom teachers, the physical education intervention in the present study was less intensive compared to the original physical education program of SPARK. The observed increase in the control condition could possibly be due to a test effect. Another explanation could be that the obligatory physical education curriculum contains more active lesson contents at the end of the school year.

In the present study, no significant differences between the two conditions were found in the amounts of time the teachers allocated to the different lesson contexts. While the overall time spent on some lesson contexts decreased in both conditions, children's MVPA engagement within the different lesson contexts was significantly higher in the intervention condition than in the control condition, specifically during the lesson contexts management, general knowledge, fitness activities and game play. In the present study, the teachers of the intervention condition did not change their current curriculum to enhance children's PA levels for example, by increasing fitness activities. They succeeded in maximizing the opportunities for PA engagement by implementing the didactical guidelines within the different existing lesson contexts, what resulted in higher proportions of physical education class time children engaged in PA. Apparently, the physical education teachers enhanced the efficiency of time spent on management activities (e.g., team selection, changing equipment or activities within a lesson) and knowledge activities (e.g., keeping instructions brief). During fitness activities and game play, teachers for example increased children's activity levels by providing enough material in proportion to the number of students, by reducing group sizes, by not using games that eliminate children, by adjusting game rules, and so forth. However, although the physical education teachers in the intervention condition verbally reported that they implemented the didactical guidelines in their lessons, the implementation fidelity was not objectively assessed, which is a limitation of the present study.

This study appears to be the first in using uni-axial accelerometers to evaluate the effectiveness of a health-related physical education intervention on children's PA levels during physical education classes in elementary schools. The accelerometer data showed no intervention effects on children's activity levels during physical education classes. As no other studies used uni-axial accelerometers to assess changes in children's MVPA levels during physical education classes, it is difficult to compare the results with other studies. Going et al. (2003) used the Tritrac-R3D accelerometer to evaluate the effect of the "Pathways obesity prevention program" on PA in fifth grade children. No significant

differences between intervention and control schools were found for children's activity levels during physical education classes. Since only the "average vector magnitude" was reported as accelerometer unit, it is not possible to make absolute comparisons with the present study.

Results from the accelerometer data showed remarkably higher percentages of MVPA engagement, compared to the SOFIT data. This higher proportion of MVPA is caused by the high percentages of class time spent on moderate intensity activities as measured by the accelerometer. The accelerometer count cutoffs used to convert the total activity counts of the accelerometer into moderate and vigorous intensity activity can possibly explain these high levels of moderate intensity activities. In the present study, the accelerometer count cutoffs for children were used (Troost et al., 2002), which were more sensitive for children's moderate intensity activities than the adult count cutoffs. A further explanation could be that the accelerometers averaged children's activity over a 1 min epoch, leveling down vigorous intensity activities. For the SOFIT observations children's activity levels were coded every 20 s. More research is needed to evaluate children's PA levels during physical education classes as a result of an intervention by using uni-axial accelerometers. However, since direct observation methods, like the SOFIT instrument, have the ability to record the type of children's PA (beside intensity and duration) and to record contextual variables associated with children's PA, direct observation methods seems to be more appropriate to measure children's PA behavior during physical education lessons (Rowe et al., 1997).

An important goal of the current physical education intervention was to promote high levels of PA during physical education classes, implying that children should be engaged in MVPA for at least 50% of the physical education class time as recommended by Healthy People 2010 (United States Department of Health and Human Services, 2000). In the present study, the SOFIT observations showed that the mean MVPA engagement in both conditions was less than 50% of the physical education class time at pretest measurement. However, after 2 years of intervention, the intervention classes surpassed the Healthy People 2010 objective. These results were in line with other studies using direct observation (McKenzie et al., 1996; McKenzie et al., 2004). In the present study the recommended 50% MVPA engagement was achieved in 64% of the observed physical education classes in the intervention condition, suggesting that the 50% MVPA objective is realistic. However, since the variety of the lesson contents was not evaluated in the present study, more research is needed to investigate whether this objective is realistic for the different lesson contents.

Drawbacks of the present study were the limited number of observed physical education lessons, the quasi-experimental design of the study and the small number of schools involved. Evaluating the physical education intervention in a larger number of schools including more regions is needed before results can be generalized.

In conclusion, the results of the present study demonstrated that the health-related physical education intervention provided the children with substantially more PA during the physical education classes, using the existing time and staff for school physical education classes. This effect was found, even in the situation that all the physical education teachers in the present study were physical education specialists. To our knowledge, this is the first demonstration in Europe that a health-related physical education intervention is effective in increasing children's PA levels during physical education classes. Since several studies in Europe also reported low levels of MVPA engagement during physical education classes (Cardon et al., 2004; Fairclough, 2003; Warburton & Woods, 1996), the implementation of health-related physical education interventions needs to be encouraged.

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Chapter 5

Increasing children's physical activity levels during recess periods in elementary schools: the effects of providing game equipment

Abstract

Background: during recess, children can be active on a daily basis, making it an important school environmental factor for the promotion of health-related physical activity. The aim of the present study was to investigate the effects of providing game equipment on children's physical activity levels during morning recess and lunch break in elementary schools.

Methods: seven elementary schools were randomly assigned to the intervention group (four schools), including 122 children (75 boys, 47 girls, mean age: 10.8 ± 0.6 years) and to the control group (three schools), including 113 children (46 boys, 67 girls, mean age: 10.9 ± 0.7 years). Children's activity levels were measured before and three months after providing game equipment, using MTI accelerometers.

Results: during lunch break, children's moderate and vigorous physical activity significantly increased in the intervention group (moderate: from 38 to 50%, vigorous: from 10 to 11%), while it decreased in the control group (moderate: from 44 to 39%, vigorous: from 11 to 5%). At morning recess, providing game equipment was effective in increasing children's moderate physical activity (from 41 to 45%), while it decreased in the control group (from 41 to 34%).

Conclusion: providing game equipment during recess periods was found to be effective in increasing children's physical activity levels. This finding suggests that promoting physical activity through game equipment provision during recess periods can contribute to reach the daily activity levels recommended for good health.

Keywords: children, game equipment, health promotion, physical activity, school playtime

Introduction

Regular physical activity (PA) during childhood and adolescence is associated with improvements in physiological and psychological health.^{1,2} Nevertheless, a substantial proportion of young people have lower PA levels than recommended for good health.³ The ‘Health Behavior in School-aged Children’ survey, executed in approximately 1500 11-, 13- and 15-year-olds in each of the 35 participating countries in Europe and America, revealed that only 27% of all girls and 40% of all boys reported PA levels that met the guideline of ‘one hour or more of at least moderate intensity activity on five or more days a week’.⁴ Furthermore, it is well documented in the literature that PA levels decline from childhood to adolescence and adulthood,⁴⁻⁷ and tracking studies have revealed that low levels of PA remain stable from adolescence into adulthood.⁸ Therefore, the promotion of regular PA among youth is an important public health challenge.

Schools are ideal settings for the promotion of PA since all children can be reached. Schools can provide opportunities to engage in PA during physical education (PE) classes, during recess periods and after school hours (extracurricular activities).^{9,10} Furthermore, informing children and their parents about the importance of lifelong PA and the possibilities to be active in the community can contribute to the development of an active and healthy lifestyle.

A lot of intervention studies have focused on PE classes to increase children’s PA levels at school.¹¹⁻¹⁴ However, in most countries PE classes can not provide sufficient activity for children to meet the health-related recommendation of 60 min or more of moderate to vigorous physical activity (MVPA) engagement each day.^{3,15-17} While school time allocated to PE is limited, recess is scheduled for more periods each day, making it an important school environmental factor for the promotion of PA. During recess, all children can be active on a daily basis. Furthermore, children are typically engaged in unstructured PA during recess, preparing them for adult activity, which is also typically unstructured.³ Only a few studies have investigated children’s PA levels during recess, revealing that children spent less than 50% of recess time engaged in MVPA.¹⁸⁻²⁰ Moreover, boys were more active during recess periods than girls.^{3,21} In the literature, different opportunities were proposed to increase children’s activity levels at recess. McKenzie *et al.*¹⁸ measured children’s activity levels and social prompts (encouragement) for PA during recess in four- and six-year-old children over 2 years. The results indicated that elementary school children were responsive to social prompts for PA from both adults and peers. This implies that training teachers and peers to encourage

children to be active during recess can promote PA. Furthermore, playground markings significantly increased five- to seven-year-old children's MVPA engagement during recess periods.¹⁹ Additionally, Connolly *et al.*²² reported that elementary school children were significantly more active after playground supervisors implemented a games curriculum during recess. Scruggs *et al.*²³ found that structured fitness training breaks provide high-activity levels for both boys and girls. Furthermore, some authors suggested that providing extra game equipment during recess and lunch break may promote high-activity levels.^{9,10,21} In most schools, the availability of game equipment during recess is mostly limited to the toys children bring along from home. Providing game equipment for everyone and having teachers encouraging the children to use the equipment may promote children's MVPA engagement during recess. However, in the literature, no study could be located evaluating the effect of providing extra game equipment on children's activity level at recess periods. Since most European elementary schools organize several recess periods per day, stimulating PA during recess can contribute to reach the daily activity levels recommended for good health.

The purpose of the present study was to evaluate the effects of providing game equipment on children's activity levels during recess and lunch break. In a controlled pretest-posttest design, children's activity levels were evaluated, using MTI accelerometers.

Methods

Participants and Setting

The present study was executed in Belgium. A random sample of seven elementary schools participated in the study. Participating schools were randomly assigned to the intervention group (four schools) and the control group (three schools). The study population included 249 fifth and sixth grade children. During data gathering, three children were excluded from further analyses due to accelerometer malfunctions and 11 due to sickness on the days of measurement. As a result, a sample of 235 children was evaluated. The intervention group consisted of 122 children (seven class groups; 75 boys, 47 girls, mean age: 10.8 ± 0.6 years) and the control group consisted of 113 children (six class groups; 46 boys, 67 girls, mean age: 10.9 ± 0.7 years). All participating schools had a morning recess (mean length: 16 ± 1 min), a lunch break (mean length: 86 ± 6 min) and an afternoon recess (mean length: 13 ± 2 min). The playtime during lunch break was 53 ± 7 min. All schools had comparable playground space and no schools had extra game equipment at baseline. In both

groups, no organized activities were conducted at recess or at lunch break during the intervention. The evaluation was considered to be part of the psychological, medical and social counseling provided by the school for which all parents signed a consent form. The study protocol was approved by the Ethics Committee of the University.

Research Design

Each class group in the intervention group received a set of game equipment and ‘activity cards’ including examples of games and activities that can be performed with the equipment. Children were allowed to play outdoors with the equipment during recesses and lunch break. Before providing the game equipment, the different play toys and ‘activity cards’ were presented to the children of each class group by a research staff member. The teachers were asked to stimulate the children to play with the game equipment. The teachers agreed on rules with the children about the use and the loss or damage of the game equipment to assure its endurance. The teachers were also advised to divide the game equipment into different sets and to exchange those sets regularly to prevent children losing interest in the equipment. Children were only allowed to play with the equipment of their own class. This made it easier for the teacher to control the equipment and to solve problems (e.g. when children quarrel about the material). The set of game equipment for each class group included two jump ropes, two double dutch ropes, two scoop sets, two flying discs, two catchballs, one poco bal, one plastic bal, two plastic hoops, two super grips, three juggling scarves, six juggling rings, six juggling beanballs, one diabolo, one angel-stick, four spinning plates, two sets of badminton racquets and two sets of oversized beach paddles.

Instruments

Accelerometers were used to measure children’s PA levels. The accelerometer has been shown to be a valid, reliable and objective method for monitoring PA in children.²⁴ In the present study, the MTI Actigraph model 7164 (Manufacturing Technologies Inc., Shalimar, FL) was used. The MTI Actigraph is small (5 x 4 x 1.6 cm³), lightweight (37.5 g) and unobtrusive to wear. It is a uniaxial accelerometer designed to measure and record time varying vertical accelerations ranging in magnitude from 0.05 to 2 Gs, with a frequency response ranges from 0.25 to 2.5 Hz. These frequencies were chosen to detect normal human motion and to reject motion from other sources. For the present study, a one-minute sampling interval was used. The one-minute movement counts were downloaded into a personal computer and converted into an Excel file for subsequent analyses. To convert the total

activity counts into light (< 3 METs), moderate (3.0 – 5.9 METs) and vigorous intensity activity (> 6.0 METs), the accelerometer count cutoffs of Trost *et al.*⁷ for children were used. Moderate and vigorous intensity activities were summed to indicate MVPA engagement. To control for the differences in recess length, accelerometer data were expressed in percentages of recess time.

Children's PA levels in both groups were measured before (pretest) and three months after providing the game equipment in the intervention schools (posttest). A research staff member put the accelerometers on in the morning (before the lessons started) and collected them the same day at school after lunch break. The accelerometer data of morning recess and lunch break were used. The accelerometer was worn just above the right hipbone underneath clothes and was held in place by an elastic belt. To prevent the children from increasing their activity level by wearing the accelerometer, they were only informed about the purpose of the measurements after the posttest measurement. Pretest en posttest measurements were organized on day's with dry weather conditions, allowing the children to play outdoors.

Data Analysis

All data were analyzed using SPSS for Windows (12.0). The accelerometer data of morning recess and lunch break were analyzed separately because of the different break length, possibly resulting in different play involvement and equipment use. To evaluate the effects of the extra game equipment on children's PA levels during recess periods, repeated measures ANOVA was used, with time (pretest-posttest) as within-subject factor and group (intervention, control) as between-subject factor. To investigate gender differences, gender was included as a second between-subject factor (time x group x gender). Additionally, to investigate whether intervention effects differed between 'active' (= participating in at least 60 min MVPA per day at baseline) and 'less active' children (= not participating in 60 min MVPA per day at baseline), baseline MVPA engagement was included as a second between-subject factor (time x group x baseline MVPA). The level of statistical significance was set at $P < 0.05$.

Results

Descriptive data of the total sample at pretest showed that the children were engaged in MVPA during 56% (SD 26) of the time at recess and during 51% (SD 24) of the time at

lunch break. Boys engaged in MVPA during 68% (SD 21) of the time at recess and during 57% (SD 24) of the time at lunch break. Girls engaged in MVPA during 42% (SD 23) of the time at recess and during 44% (SD 22) of the time at lunch break.

Table 1 presents the percentages of time spent on low, moderate, vigorous and moderate to vigorous intensity PA during morning recess for the intervention and the control group at pretest and posttest measurements. Significant intervention effects were found for the time spent on low ($F = 4.7, P < 0.05$), moderate ($F = 10.6, P < 0.001$) and moderate to vigorous intensity PA ($F = 6.5, P < 0.01$). The time spent on moderate intensity activities increased significantly in the intervention group, while it decreased in the control group. The time spent on moderate to vigorous intensity activities decreased significantly more in the control group, compared with the intervention group. The time spent on low intensity activities increased significantly more in the control group, compared with the intervention group. No significant intervention effect was found for the time spent on vigorous intensity activities. Significant gender differences (time x group x gender) were found for low ($F = 12.6, P < 0.001$), moderate ($F = 6.8, P < 0.01$) and moderate to vigorous intensity activities ($F = 13.3, P < 0.001$), revealing only intervention effects for girls. In girls, the time spent on moderate intensity activities significantly increased in the intervention group, while it decreased in the control group. In boys, no change was found on moderate intensity activities. In girls, the time spent on low intensity activities decreased in the intervention group, while it increased in the control group. In boys, the time spent on low intensity activities increased in the intervention and in the control group. In girls, the time spent on moderate to vigorous intensity activities significantly increased in the intervention group, while it decreased in the control group. In boys, the time spent on moderate to vigorous intensity activities decreased in both groups. No significant differences between 'active' and 'less active' children were found (time x group x baseline MVPA), revealing that the intervention effects were similar for 'active' and 'less active' children (all $F < 2.4, ns$)

Table 2 presents the percentages of time spent on low, moderate, vigorous and moderate to vigorous intensity activities during lunch break for the intervention and the control group at pretest and posttest measurements. Significant intervention effects were found for low ($F = 50.5, P < 0.001$), moderate ($F = 28.3, P < 0.001$), vigorous ($F = 13.1, P < 0.001$) and moderate to vigorous ($F = 44.2, P < 0.001$) intensity activities. The time spent on moderate, vigorous and moderate to vigorous intensity PA increased significantly in the intervention group, while it decreased in the control group. The time spent on low intensity PA decreased in the intervention group and increased in the control group.

Table 1. Means, standard deviations (SD) and *F*-values of the percentages of time spent on low, moderate, vigorous and moderate to vigorous intensity physical activity during morning recess.

Morning recess	Condition	Pretest			Posttest			<i>F</i>	gender differences
		Total sample (mean % ± SD)	Boys (mean % ± SD)	Girls (mean % ± SD)	Total sample (mean % ± SD)	Boys (mean % ± SD)	Girls (mean % ± SD)		
Low intensity PA	Control	43.20 ± 22.43	33.15 ± 18.90	50.09 ± 22.17	54.54 ± 26.37	35.73 ± 24.17	67.44 ± 19.14	4.73*	12.64**
	Intervention	42.10 ± 28.29	29.63 ± 23.63	61.99 ± 23.44	45.82 ± 24.93	37.25 ± 22.49	59.49 ± 22.57		
Moderate intensity PA	Control	41.10 ± 18.99	44.15 ± 19.02	38.99 ± 18.81	33.90 ± 21.14	43.20 ± 21.52	27.51 ± 18.46	10.60**	6.77**
	Intervention	41.05 ± 22.74	49.53 ± 20.29	27.50 ± 19.82	45.16 ± 21.55	50.66 ± 20.02	36.39 ± 21.17		
Vigorous intensity PA	Control	14.82 ± 17.42	22.55 ± 21.46	9.51 ± 11.42	9.57 ± 17.10	19.97 ± 22.18	2.42 ± 5.75	0.61	2.38
	Intervention	15.53 ± 18.40	20.51 ± 21.01	7.56 ± 8.68	8.24 ± 15.29	11.78 ± 18.20	2.56 ± 5.27		
Moderate to vigorous PA	Control	55.92 ± 22.87	66.71 ± 19.05	48.50 ± 22.43	43.47 ± 27.62	63.17 ± 25.38	29.94 ± 19.95	6.48**	13.31**
	Intervention	56.58 ± 29.37	70.05 ± 23.73	35.07 ± 24.38	53.40 ± 25.63	62.45 ± 22.88	38.95 ± 23.21		

Note. PA = physical activity.
* $P < 0.05$; ** $P < 0.01$.

No significant gender differences (time x group x gender) were found for the accelerometer data during lunch break. No significant differences between 'active' and 'less active' children were found (time x group x baseline MVPA) (all $F < 1.6$, ns).

Discussion

The aim of the present study was to evaluate the effects of providing game equipment on children's PA levels during morning recess and lunch break. At pretest, children in the present study were engaged in MVPA for about half of the time during morning recess (56%) and lunch break (51%). These results were slightly higher than those reported in other studies, using objective measures.¹⁸⁻²⁰ McKenzie *et al.*¹⁸ found that elementary school children in the United States (mean age 6.6 year) engaged in MVPA during 48% of recess time. In a study by Stratton¹⁹ 5- to 7-year-old British children spent 35-41% of total recess time (including morning, lunch and afternoon playtime) engaged in MVPA. Sleaf *et al.*²⁰ found lower activity levels in 5- to 11-year-old British children during lunch break (46%), but similar MVPA engagement during recess (ranging from 55 to 59%). Furthermore, the results of the present study confirmed previous findings that boys were more active than girls during unstructured recess periods.^{18,21,25}

The higher percentages MVPA engagement in the present study is a positive finding. However, since children spent only an average of 50% of recess time engaged in MVPA, increasing children's activity levels during recess periods is an essential and realistic objective. The results of the present study clearly indicated that providing game equipment was effective in increasing children's activity levels during recess and lunch break. During lunch break, the intervention was effective in increasing the proportion of time children engaged in MVPA by increasing the time spent on moderate and high intensity activities and by decreasing the time spent on low intensity activities. The mean proportion of MVPA engagement increased with 13% in the intervention group (from 48 to 61%), while it decreased with 10% in the control group (from 55 to 45%). At recess, providing game equipment was effective in increasing children's moderate intensity activities and reducing the decrease in the time spent on moderate to vigorous intensity activities. No effects were

Table 2. Means, standard deviations (SD) and *F*-values of the percentages of time spent on low, moderate, vigorous and moderate to vigorous intensity physical activity during lunch break.

Lunch break	Condition	Pretest			Posttest			<i>F</i>	gender differences
		Total sample (mean % ± SD)	Boys (mean % ± SD)	Girls (mean % ± SD)	Total sample (mean % ± SD)	Boys (mean % ± SD)	Girls (mean % ± SD)		
Low intensity PA	Control	43.21 ± 22.36	40.66 ± 22.28	44.96 ± 22.40	53.81 ± 21.28	45.48 ± 23.78	59.53 ± 17.36	50.50**	2.39
	Intervention	50.55 ± 23.46	41.95 ± 22.08	64.25 ± 18.73	37.81 ± 20.46	29.44 ± 17.18	51.15 ± 18.17		
Moderate intensity PA	Control	44.03 ± 18.45	41.61 ± 18.77	45.69 ± 18.17	39.29 ± 17.82	44.39 ± 18.43	35.78 ± 16.63	28.34**	2.24
	Intervention	38.19 ± 18.67	42.80 ± 17.57	30.81 ± 18.17	49.56 ± 17.68	55.54 ± 16.08	39.99 ± 15.94		
Vigorous intensity PA	Control	10.90 ± 14.14	15.24 ± 17.06	7.91 ± 10.88	5.46 ± 8.76	9.65 ± 11.29	2.57 ± 4.76	13.09**	0.53
	Intervention	9.67 ± 12.43	14.05 ± 13.94	2.67 ± 3.47	11.17 ± 14.92	14.35 ± 17.12	6.08 ± 8.42		
Moderate to vigorous PA	Control	54.93 ± 23.89	56.86 ± 24.69	53.60 ± 23.41	44.74 ± 21.89	54.05 ± 23.85	38.35 ± 17.97	44.23**	2.91
	Intervention	47.86 ± 24.43	56.85 ± 22.83	33.49 ± 19.71	60.72 ± 21.95	69.89 ± 18.08	46.07 ± 19.62		

Note. PA = physical activity.

** $P < 0.01$.

found on vigorous intensity activities. As no other studies evaluated the effect of providing game equipment on children's activity levels during recess periods, the present results cannot be compared with other studies.

The stronger intervention effects during lunch break, compared with the morning recess, may be due to the length of the lunch break. The longer duration of lunch breaks may enable the children to organize and to play complete games with the equipment resulting in higher proportions of active time. However, more research is needed to investigate the effect of the duration of recess periods when game equipment is provided.

In both recess periods, the game equipment increased especially children's moderate intensity activities, while children's vigorous PA only slightly increased during lunch break (1.5%). This could be explained by the nature of the chosen game equipment, stimulating moderate intensity activities (e.g. flying discs, angle-stick, juggling material, etc.). Other game equipment may be needed to increase children's vigorous PA engagement.

According to the present study and the literature, girls are less active than boys during recess periods.^{21,25} Therefore it is a challenge for schools to promote PA among both boys and girls. During lunch break, the intervention was as effective in boys as in girls, suggesting that the intervention suited both genders. At morning recess, providing game equipment was effective in girls, but not in boys. A possible explanation could be that boys were already very active at pretest, making it difficult to find significant improvements. In addition, the game equipment in the present study may mainly respond to girls' interests, which can also explain this finding. Furthermore, the results of the present study indicated that providing game equipment was as effective in 'active' as in 'less active' children during morning recess and lunch break.

A drawback of the present study was the quasi-experimental design of the study. Another limitation of the study was that the influence of teacher's encouragement to be active with the game equipment was not investigated. Since children seem to be responsive to encouragement for PA from adults,¹⁸ further research is needed to explore the role of teacher encouragement in using the game equipment. Further research should also examine the effect of increased activity levels at school on children's activity levels at home since it is suggested in the literature that children compensate increased activity levels at school by decreasing their activity levels at home.²⁶ On the other hand, *Dale et al.*²⁷ indicated that children did not compensate for a sedentary school day by increasing their activity levels after school, emphasizing the importance of providing opportunities to be active at school.

Since all children can be active on a daily basis during recess, recess periods are important opportunities to promote PA at school. The results of the present study demonstrated that providing game equipment can increase children's activity levels during recess periods. To our knowledge, this is the first demonstration that providing game equipment can be effective in increasing children's PA levels during recess periods. Since a lot of European children are less active than recommended for good health, providing game equipment during recesses and lunch breaks are an easy way to improve children's physical activity levels. Additionally, schools should also maximize children's activity levels during PE classes and after school hours (extracurricular activities) and promote lifelong PA participation at home. Evaluating the effects of providing game equipment over longer time periods is recommended.

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Chapter 6

Evaluation of a school-based self-management program promoting an active lifestyle: perceptions of elementary school children, teachers, and parents

Abstract

The promotion of lifelong physical activity through classroom-based self-management lessons is still a rare concept. The aim of the present study was to investigate how a self-management program promoting an active lifestyle was perceived among children, classroom teachers and parents and to evaluate their perceptions of the impact of the lessons on children's physical activity awareness and children's activity levels. The self-management lessons were implemented by a research staff member in 20 class groups of eight elementary schools. Program perceptions were evaluated in 412 fourth- and fifth-grade children (mean age = 9.7 ± 0.7 years) using a questionnaire, and in 20 classroom teachers and 50 parents, using interviews. Most children were enthusiastic about the program and more than half of them perceived being more active as a result of the lessons. The teachers and the parents perceived the lessons as meaningful. An improvement in children's physical activity awareness as a result of the lessons was reported by half of the teachers and by half of the parents. Most teachers (80%) reported an increase in children's physical activity levels at school as a result of the lessons, while only 32% of the parents perceived an increase in children's activity levels at home. Since a self-management program can promote an active lifestyle in children and since the teachers in the present study seem to be receptive to such a program, the implementation of the self-management program by the teachers needs further evaluation.

Introduction

Regular physical activity (PA) is an important component of a healthful lifestyle in children and adolescents.^{1,2} While children are more active than adults, a substantial proportion of young people have lower activity levels than those desirable for good health.³ Furthermore, it is well documented that PA levels decline from childhood to adulthood⁴⁻⁷ and tracking studies have revealed that low levels of PA remain stable from adolescence into adulthood.^{8,9} Therefore, all young people should be encouraged to participate in PA of at least moderate intensity for 1 hour per day and the importance of lifelong PA should be emphasized at an early age.¹⁰

Schools are ideal settings for the promotion of lifelong PA because all children can be reached. Schools can provide opportunities to engage in PA during physical education (PE) classes, during recess periods and after school hours (extracurricular activities). Additionally, schools can teach the children behavioral skills necessary to develop and maintain an active lifestyle, leading to lifelong PA.

Many programs to modify health behavior are based on the social cognitive theory¹¹ and self-regulation models of behavior change.¹² Self-management programs mostly combine techniques that involve the three basic processes of self-regulation namely self-monitoring, self-evaluation and self-reinforcement.^{12,13} Self-management has frequently and successfully been used in the treatment of chronic diseases such as diabetes and asthma.^{14,15} Furthermore, self-management techniques are also promising in primary prevention programs because the use of cognitive-behavioral techniques is a more effective approach to facilitate behavioral changes than only providing knowledge.¹⁶ Some PA promotion intervention studies in elementary schools included classroom curricula in which some aspects of self-management were taught to promote lifelong PA.^{17,18} The Sports, Play and Active Recreation for Kids (SPARK) program of San Diego State University is a comprehensive PA promotion program for elementary schools, designed to increase children's PA during PE classes and out-of-school.¹⁹ The SPARK program included a health-related PE program and a self-management program. The purpose of the self-management program was to promote PA out-of-school by teaching children cognitive and behavioral skills necessary to develop and maintain an active lifestyle.²⁰ The children learned to take responsibility for their own PA and they were instructed on how to plan and follow a realistic activity program. The self-management curriculum was implemented by the teachers and included goal-setting, behavioral skills training, a reward system, and parental involvement. The teachers received an in-service

training to facilitate the implementation of the self-management curricula. Although the teachers were pleased about the clarity of the self-management program, they perceived the actual implementation in the class as more difficult, what discouraged some teachers to implement the complete program. This emphasizes the importance of teachers' acceptance and enthusiasm about the program for an effective implementation, before an in-service program can start.

In Europe, the promotion of lifelong PA within the school context has received more attention during the last decade. In several European countries, the promotion of a physically active lifestyle was recently recognized as an important mission of PE²¹⁻²³ and there has been a greater emphasize on health-related exercises in the PE curriculum.^{22,23} However, additional classroom-based self-management lessons promoting lifelong PA are a new concept in Europe. Existing health curricula of elementary schools mostly include health topics such as nutrition, dental hygiene and drugs prevention, but not PA promotion. However, because the development of an active lifestyle implies behavior change and the scheduled lesson time for PE is mostly too limited to add specific behavior change skills (like goal-setting, problem solving), the implementation of self-management lessons additionally to PE lessons seems also useful in European schools to promote lifelong PA.

However, the SPARK self-management program of the United States can not simply be implemented in different European countries because of cultural differences and since most elementary schools have mandatory educational curricula. Therefore, the program needs to be adjusted to the educational system and culture of the European countries.

In the present study, the self-management program was part of a comprehensive PA promotion intervention which was implemented over 2 school years in 20 class groups of eight elementary schools. Besides the self-management program, the intervention also included a health-related PE program and an extracurricular PA promotion program. The results of the health-related PE program and extracurricular PA promotion program were reported elsewhere.^{24,25} In the present study, the receptiveness of the self-management program was investigated.

The purpose of the present study was to investigate the perceptions of the self-management lessons among children, classroom teachers and parents and their perceptions of the impact of the lessons on children's PA awareness and activity levels.

Methods

Participants

A random sample of eight elementary schools participated in the study. The study population included 20 class groups of fourth- and fifth-grade children (203 boys, 209 girls; mean age: 9.7 ± 0.7 years). The self-management lessons were evaluated in all children, 20 classroom teachers (6 men, 14 women) and 50 parents (5 men, 45 women). The parents were randomly selected from three participating elementary schools. The evaluations were considered to be part of the psychological, medical and social counseling provided by the school for which all parents signed a consent form. The study protocol was approved by the Ethics Committee of the University.

Intervention

The self-management lessons evaluated in the present study were based on the self-management program of the SPARK program of San Diego State University.^{19,20} The original self-management program was designed to promote generalization of PA out-of-school by teaching fourth- and fifth-grade children cognitive and behavioral skills such as goal-setting, self-monitoring, self-reward, self-talk, activity planning and problem solving. The self-management program was largely based on the social cognitive theory and applied methods that have been shown to be effective in other studies.²⁰ For the intervention in the present study, some adaptations were made to adjust the SPARK self-management program to the educational system and culture of Belgium (Flanders). In the SPARK self-management program, lesson topics included both PA and nutrition subjects and each lesson contained one topic. In the present program, only topics about PA were taught because lessons about nutrition are already included within the existing health promotion curriculum. Furthermore, mostly more than one new topic was taught during one lesson since the scheduled lesson time was longer. In the SPARK program, 31 lessons were taught in weekly 30 minutes classroom sessions over 1 school year. In the present program, nine lessons of 50 minutes each were implemented within the existing health curriculum over 1 school year. Furthermore, in the SPARK program, the lessons were taught by the teachers. In the present program, the lessons were given by a research staff member since the goal of the present study was to investigate the receptiveness to the self-management lessons and since the teachers in the present study did not have the necessary background knowledge and expertise to teach behavioral skills regarding PA promotion. The classroom teachers were asked to be present during the lessons

because they were expected to give the lessons in the future. Furthermore, based on the teachers' less positive evaluation of the reward system in the SPARK program, no eccentric reward system for being active was included in the present program. Finally, the United States orientated examples and trigger situations used in the lessons were adapted to the European context to enhance the relevance of the program.

In the present study, the self-management lessons were implemented within the existing health promotion curriculum over 1 school year. Between October and January, six lessons of 50 minutes were provided with a 1 week interval. Between February and June, three repetition lessons of 50 minutes were provided with an interval of 2 months. Like in the SPARK program,²⁰ the lessons in the present program were taught in an interactive fashion and each lesson began with a brief review of the skills or information presented during the previous lesson and a discussion of the children's homework. After the repetition, one or two new subjects were presented. At the end of the lesson, the teacher explained children's homework for the next week or month.

Like in the SPARK program,²⁰ the present program included PA homework tasks regarding goal-setting to increase PA levels. During the first six lessons, children set PA goals each week to increase their PA at school (during recess periods and lunch break) and at home. For their PA goals at school, they could choose any activity allowed on the playground by the teachers. For their PA goals at home, the children could choose from a group of "lifetime activities" (walking, jogging, swimming, skating, dancing, cycling, rope skipping). These activities were chosen because they are not expensive, they do not require the participation of others and they can also be carried out during adulthood. After setting their PA goals for the week, children self-monitored on the homework sheet if they performed their activity goals or not during the week. During the repetition lessons, children received an "activity card" to increase their PA at home. Children had to record on their "activity card" every time they were physically active for 20 minutes or more during each week of the month. Their goal was to be active for at least five times a week for minimum 20 minutes. Despite the repetition lessons were given with an interval of 2 months, children received homework every month. After 1 month, children took the "activity card" back to school and discussed their activity with the teacher. Table 1 presents the main subjects and PA homework tasks of the self-management lessons.

Before the start of the lessons, parents were informed by a letter about the purpose and the content of the lessons and the homework tasks. The importance of family support was also emphasized in the letter and parents were asked to support their children to be physically

Table 1. Main subjects and homework tasks of self-management lessons.

Lesson	Main Subject	Homework Task
Lesson 1	Introduction: benefits of being active, meaning of PA and sports and the difference between both, possibilities to be active at school and at home	Record personal reasons and parents' reasons to be active on a check list
Lesson 2	Safety during PA Goal-setting: what is a good activity goal	Record current PA engagement during a week on an activity sheet
Lesson 3	Goal-setting: setting personal activity goals Problem solving: solving problems that make it harder to reach the activity goals/to be physically active (overcoming barriers)	Set PA goals to increase PA at school and at home on a goal sheet (=goal-setting)
Lesson 4	Scheduling: learning techniques for scheduling personal activity engagement	Goal-setting
Lesson 5	Self-talk: how can self talk be used to enhance personal activity engagement	Goal-setting
Lesson 6	Quiz: repetition of the previous lessons	Goal-setting
Repetition lesson 1	Activity breaks: problem solving: techniques for staying active during the vacation or being active again after a "break"	Record PA engagement and goal attainment on the "activity card" (=activity card)
Repetition lesson 2	How can other people (family and peers) influence someone's activity engagement (positive, negative, habit) (social support and peer pressure)	Activity card
Repetition lesson 3	Signs: creating personal reminders to increase PA engagement at home Summer planning: staying active during the summer	Activity card

Note. PA = physical activity.

active. Furthermore, one parent had to sign the PA homework task and children were instructed to discuss their activity goals with their parents to stimulate parental support for PA.

Instruments and Procedure

The self-management lessons were implemented over 1 school year (2002-2003). The evaluations were performed at the end of the school year (June 2003). The perceptions of the self-management lessons were evaluated using a questionnaire and interviews. All participating children completed a questionnaire in the classroom containing questions about how they perceived the lessons and PA homework tasks and about their perceived activity level during recess periods and at home. Furthermore, children were asked if they perceived family support to be physically active. A trained research staff member remained in the classroom during questionnaire administration and gave instructions on how to complete the questionnaire.

The classroom teachers were interviewed by a research staff member about their perceptions of the lessons. They were asked if they perceived the different lesson subjects as meaningful or not and if they supported the PA homework tasks. Furthermore, teachers were asked how they perceived the impact of the lessons on children's PA awareness and activity level at school. Teachers were also asked if they would be willing to give the lessons themselves.

The parents were interviewed by telephone about their perceptions of the self-management program. The parents were asked if they received and read the information letter concerning the lessons. They were asked if they perceived the self-management lessons as meaningful or not, if they support the PA homework tasks and how they perceived the impact of the lessons on children's PA awareness and activity levels out-of-school.

Data Analysis

All data were analyzed using SPSS for Windows (12.0). Descriptive statistics were used to evaluate the perceptions of the self-management lessons. In addition, Pearson correlation coefficients were calculated to evaluate the correlation between age and program perceptions. Independent samples *t* tests were executed to assess gender differences in the program perceptions. The level of statistical significance was set at $p < .05$.

Results

With regard to the self-management lessons, 76% of the children evaluated the lessons as pleasant to very pleasant, 83% as interesting to very interesting and 83% as important to very important. The PA homework tasks were perceived as pleasant by 67% of the children and 88% evaluated the tasks as not difficult. During recess periods, 61% of the children reported an increase in their activity level and 63% reported an increase in their activity level out-of-school. Family support to be physically active was reported by 47% of the children. The gender and age differences in children's program evaluation are presented in Table 2. Compared to boys, girls found the lessons more pleasant ($t_{(401)} = 2.7, p < .01$) and more important ($t_{(410)} = 2.6, p < .01$). Furthermore, girls liked the PA homework tasks ($t_{(405)} = 2.6, p < .01$) more than boys. No gender differences were found for children's perceived activity levels during recess periods and at home and for the difficulty of the homework tasks. Pearson correlation coefficients indicated that the younger children perceived the lessons as more pleasant ($r = 0.18, p < .01$), more interesting ($r = 0.17, p < .01$) and more important ($r = 0.11, p < .05$) than the older children. The younger children also reported more increase in their activity level during recess periods ($r = 0.11, p < .05$) than the older children.

Table 3 presents teachers' perceptions of the self-management program. In general, 95% of the teachers perceived the self-management lessons as meaningful for the children. The lesson about the importance of PA and the possibilities to be active, and the lesson about self-talk were perceived as meaningful by 90% of the teachers, while the lesson about time planning (scheduling) was perceived as meaningful by 65% of the teachers. Half of the teachers (55%) reported that PA awareness was improved in most of the children and 80% of the teachers reported that most children increased their activity level at school during the period that the lessons were given. The PA homework tasks were supported by 80% of the teachers. Seventy percent of the teachers reported that they are willing to teach the lessons themselves.

In general, 96% of the parents received and read the information letter at the beginning of the school year and perceived the extra focus on PA at school as meaningful. With regard to the PA homework tasks, 83% of the parents were informed about the tasks and 88% supported the tasks. An increased PA awareness in the children as a result of the lessons was reported by 56% of the questioned parents and 32% of the parents reported increased activity levels of their child at home.

Table 2. Gender and age differences in children’s program evaluations.

Questions	Response Options		Gender Differences (Independent <i>t</i> test)		Age Differences (Pearson Correlation)	
			Boys	Girls		<i>t</i>
			Mean (SD)	Mean (SD)		
I perceived the self-management lessons as:	Very pleasant (1) to completely not pleasant (4)	Very pleasant (1) to completely not pleasant (4)	2.21 (0.84)	2.00 (0.75)	2.71**	0.18**
	Very interesting (1) to completely not interesting (4)	Very interesting (1) to completely not interesting (4)	2.06 (0.71)	1.96 (0.69)	1.44	0.17**
	Very important (1) to completely not important (4)	Very important (1) to completely not important (4)	2.03 (0.71)	1.84 (0.74)	2.61**	0.11*
Are you now more active during recess periods?	Yes! (1) to no! (4)	Yes! (1) to no! (4)	2.37 (0.94)	2.27 (0.84)	1.10	0.11*
Are you now more active outside of school?	Yes! (1) to no! (4)	Yes! (1) to no! (4)	2.32 (0.89)	2.23 (0.87)	1.04	0.01
I perceived the PA homework tasks as:	Very pleasant (1) to completely not pleasant (4)	Very pleasant (1) to completely not pleasant (4)	2.37 (0.86)	2.16 (0.79)	2.57**	0.07
	Very easy (1) to very difficult (4)	Very easy (1) to very difficult (4)	1.76 (0.70)	1.76 (0.70)	-0.37	0.01

Note. PA = physical activity.

Discussion

The aim of the present study was to investigate the perceptions of the self-management lessons promoting an active lifestyle among children, classroom teachers and parents and to evaluate their perceptions of the impact of the lessons on children's PA awareness and activity levels.

In general, the results indicated that the self-management lessons were well perceived by the children, classroom teachers and parents. Most children were enthusiastic about the program and perceived the lessons as pleasant, interesting and important. This is a positive study finding because a positive attitude towards a health promotion program can exert a positive influence on behavioral change. Nevertheless, some program adaptations are advocated for the older pupils since the younger children perceived the lessons as more pleasant, interesting and important compared with the older children. Adding specific lesson topics (such as body image) and using lesson examples triggering more the interests of the older children could possibly increase the enthusiasm for the program in fifth-grade children. Compared with the boys, the girls' perceptions of the self-management lessons were more positive. Because girls are typically at risk for low activity levels, this is a positive finding from a public health perspective.^{3,6} A possible explanation could be that girls are more appealed to health-related topics than boys, which is in line with the study of Vandongen et al.²⁶ Nevertheless, additional attention may be needed to enhance boys' enthusiasm for the program.

Almost all classroom teachers perceived the total self-management program as meaningful. However, the lessons about goal-setting and scheduling were perceived as less meaningful compared with the lessons about the importance of PA (introduction lesson) and self-talk. Furthermore, 14 of the 20 teachers were willing to give the lessons themselves. These findings indicate that the teachers were receptive to the program. Previous studies showed that the implementation of health education programs was poor when teachers were not receptive to the program, implying that teachers' enthusiasm about the program is an important condition for a good implementation.^{27,28} However, it is not sure if teachers' enthusiasm in the present study would be similar if they had to implement the lessons themselves. The evaluation of the SPARK self-management lessons revealed that the teachers perceived some difficulties by the actual implementation of the lessons.²⁰ An important finding was that teachers had problems with teaching "behavioral skills" instead of teaching "facts". Therefore, it will be important to make classroom teachers aware of the importance of

Table 3. Teachers' Perceptions of the Self-management Program (n = 20).

Questions	Response Options	Freq (%)
Did you perceive the total of self-management lessons as meaningful for the children?	yes	95.0
	no	5.0
Did you perceive following lesson subjects as meaningful?		
Benefits of being active	yes	90.0
Meaning of PA and sports and the difference between both	no	10.0
Possibilities to be active at school and at home		
Goal-setting: what is a good activity goal	yes	75.0
	no	25.0
Goal-setting: setting personal activity goals	yes	70.0
Problem solving: solving problems that make it harder to reach the activity goals/to be physically active (overcoming barriers)	no	30.0
Scheduling: learning techniques for scheduling personal activity engagement	yes	65.0
	no	35.0
Self-talk: how can self-talk be used to enhance personal activity engagement	yes	90.0
	no	10.0
Activity breaks: problem solving: techniques for staying active during the vacation or being active again after a "break"	yes	85.0
	no	15.0
How can other people (family and peers) influence someone's activity (positive, negative, habit) (social support and peer pressure)	yes	85.0
	no	15.0
Did you support the PA homework tasks?	yes	80.0
	no	20.0
Did you perceive an improvement in children's PA awareness (for example, children were more conscious about the importance and benefits of PA)?	yes	55.0
	no	45.0
Did the children increase their activity at school during the period that the lessons were given?	yes	80.0
	no	20.0
Are you willing to teach the self-management lessons yourself?	yes	70.0
	no	30.0

Note. PA = physical activity.

teaching behavioral skills to promote lifelong PA and to learn them how to teach “behavioral skills”. Moreover, in-service training will be necessary to ensure a complete implementation of the self-management program by the teachers.

In most European countries, homework tasks for PA are a new concept. Children receive homework for most school subjects (such as mathematics, language) but not for PA or PE. In the present study, the PA homework tasks were well perceived by the children and most classroom teachers and parents supported those tasks. The PA homework tasks included goal-setting to increase children’s PA levels. Because PA homework tasks can increase children’s awareness of the importance of daily PA engagement and goal-setting can help them to develop an active lifestyle, PA homework tasks need to be encouraged in Europe. Furthermore, parental involvement can be stimulated through PA homework tasks.

The self-management lessons were designed to increase children’s PA awareness and to promote regular PA out-of-school by teaching the children behavioral skills. An improvement in children’s PA awareness as a result of the lessons was reported by half of the teachers and by half of the parents. The self-reported data indicated that more than half of the children perceived being more active at school and at home as a result of the lessons. Teachers’ and parents’ evaluations revealed that most teachers reported an increase in children’s PA levels at school during the period that the lessons were given, while only 32% of the parents perceived an increase in children’s activity levels at home as a result of the lessons. Most parents reported that their child was already active at home before the lessons started. These results were in line with the SPARK study, revealing that 70% of the parents reported no increase in children’s out-of-school PA as a result of SPARK.²⁰ From the present study results, it seems that the classroom-based self-management lessons were more successful in promoting children’s PA at school than at home. However, in the present study, it was not possible to objectively measure the isolated effect of the self-management program on children’s activity levels because other program aspects were implemented simultaneously with the self-management program, which is a limitation of the present study. Therefore, further research should replicate the self-management program in a school context without other PA promotion elements and children’s activity levels should be evaluated using objective measurements.

According to the literature,^{3,29} family involvement in the promotion of leisure time PA is recommended because the family can have a strong influence on children’s activity levels. However, several family-based health promotion programs reported low parent participation rates, indicating that it is difficult to get parents involved in child health promotion

programs.²⁹ The SPARK study also revealed low parent participation in the program.²⁰ In the present study, parental involvement was limited to one information letter in which the importance of family support was emphasized and parents were asked to support their child to be active. Nevertheless, the self-report data revealed that family support to be physically active was reported by half of the children. However, these results need to be interpreted with caution because social desirability could possibly have influenced the answers. Additional efforts to involve the parents more intensively to the program are advocated (for example, by providing information sessions or newsletters).

In conclusion, the results of the present study demonstrated that the self-management program was well perceived by the children, the teachers and the parents. Because the classroom teachers are expected to give the lessons in the future, their receptiveness to the program was an important study finding. To our knowledge, only two other US studies evaluated a classroom-based self-management program for children's PA.^{17,20} Self-management lessons to promote lifelong PA in elementary schools are a new concept in Europe. Since the promotion of regular PA is also necessary in European young people and the development of an active lifestyle implies behavioral change, further evaluation of the classroom-based self-management lessons in Europe seems useful. Evaluating the receptiveness of the self-management program was only a first step. Moreover, it is not sure that teacher's enthusiasm will be similar if they have to implement the lessons themselves. Further research is necessary, evaluating the implementation of the self-management program by the teachers. The implementation of the self-management program should be investigated in a randomized controlled study involving a large number of teachers and the effectiveness of the lessons on children's out-of-school PA should objectively be evaluated.

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Chapter 7

General discussion

The main purpose of this thesis was to evaluate the effectiveness of a comprehensive physical activity promotion intervention in elementary school children. Additionally, to get more insight into which aspects of the intervention were successful, the effectiveness of some of the intervention components was evaluated. The multi-component intervention evaluated in the present thesis was developed to promote physically active lifestyles by encouraging physical activity participation at school as well as in leisure time.

Within the school context, physical activity was promoted during physical education lessons by implementing a health-related physical education program, based on the SPARK physical education program (Sallis et al., 1997). Additionally, game equipment was provided during recess periods and lunch break to stimulate children's physical activity participation. Moreover, extracurricular physical activities were provided once week during lunch break. Participation was on voluntary base.

To promote children's physical activity in leisure time, the intervention included classroom-based health-education lessons, based on the self-management program of SPARK (Sallis et al., 1997). The lessons were designed to increase children's physical activity awareness and to promote regular physical activity in leisure time by teaching the children behavioral skills. Additionally, children were informed through a brochure about the sports clubs (competitive and recreational) in the neighborhood. Furthermore, the extracurricular activities promoted positive attitudes towards physical activity and encouraged the children to be active in leisure time by emphasizing and providing activities and games that can be easily transferred into leisure time (e.g., rope skipping, Frisbee, ball games).

This chapter starts with a short description of the results of the preliminary study, performed to evaluate the validity of the questionnaire measuring children's usual physical activity. Subsequently, an overview of the main findings of the multi-component physical activity promotion intervention is presented. Further, the separate effects of some components of the intervention are discussed. Finally, limitations, recommendations for further research and practical implications are formulated.

The validity of the questionnaire measuring children's usual physical activity

The purpose of this study was to compare the validity and reliability of the physical activity questionnaire, completed with and without parental assistance (chapter 2). The MTI accelerometer was used as validity criterion. The results indicated that the physical activity questionnaire, completed with one of the parents, was more reliable and showed higher validity coefficients than the questionnaire completed without parental assistance, implying that parents can improve self-reports in children. In general, for the condition with parental assistance, the total physical activity levels and physical activity levels of vigorous and of moderate to vigorous intensity were significantly correlated with the accelerometer data. However, no significant correlations were found for moderate intensity activities. A possible explanation could be that moderate intensity activities are being accumulated throughout the day and the number and diversity of these activities is large, making it difficult to recall all moderate intensity activities. Furthermore, physical activity questionnaires are especially insensitive to unstructured play and games, which are typical activities among this age group. Based on the literature, the use of self-reports in children of this age-group is discouraged (Kohl, Fulton, & Caspersen, 2000; Sallis, 1991). However, it can be concluded from this study that parental assistance can improve children's self-report to an acceptable level. Nevertheless, the use of the questionnaire to measure physical activity of moderate intensity needs caution. Therefore, it remains preferably to combine the use of self-reports in large field studies with objective measurements like accelerometers. Accelerometers can objectively measure the intensity, duration and frequency of children's physical activity and self-reports can provide additional information concerning the type of activities performed. However, when using a questionnaire in children of this age group, parental assistance in completing the questionnaire is advocated.

This study demonstrated that the physical activity questionnaire, completed with one of the parents, showed good reliability and acceptable validity to assess usual total activity levels and activity levels of vigorous intensity and of moderate to vigorous intensity in 9- to 11-year-old children. Nevertheless, the use of the questionnaire to measure physical activity of moderate intensity needs caution.

The main findings of the comprehensive physical activity promotion intervention

In chapter 3, the effects of the physical activity promotion intervention on children's activity levels, physical fitness and psychosocial correlates were evaluated. Children's total activity levels were evaluated using *accelerometers*. At pretest, the accelerometer data indicated that the children of both the intervention and control group (mean age: 9.7 ± 0.7) were engaged in moderate to vigorous physical activity for an average of 155 minutes per day. Moreover, boys were more engaged in daily moderate to vigorous physical activity (171 ± 37 min/day) than girls (139 ± 37 min/day). These results were comparable with those reported in other European countries, but higher than those reported in the United States, using MTI accelerometers (Riddoch et al., 2004; Trost et al., 2002). Riddoch et al. (2004) found that 9-year-old children from Denmark, Portugal, Estonia and Norway were daily engaged in moderate to vigorous physical activity for an average of 176 minutes (boys: 192 ± 66 min/day; girls: 160 ± 54 min/day). Trost et al. (2002) reported mean values of daily moderate to vigorous physical activity in American elementary school children, ranging from 130 minutes per day in boys to 100 minutes per day in girls (mean age: 10.4 ± 1.0). The high levels of daily moderate to vigorous physical activity engagement in the present study are a positive finding, suggesting that at pretest most of the children engaged in sufficient physical activity as recommended for good health. However, since children's activity levels in both genders decline dramatically from childhood to adolescence and adulthood and the greatest decline takes place during adolescence (Riddoch et al., 2004; van Mechelen, Twisk, Post, Snel, & Kemper, 2000), it is important to prevent this age-related decline by promoting lifelong physical activity at an early age. Moreover, this age-related decline is also present in Flanders (Philippaerts et al., 2001). Therefore, promoting the development and maintenance of a physically active lifestyle in elementary school children of both genders is an essential objective.

After two school years, a clear intervention effect on children's total activity levels was found. The comprehensive physical activity promotion intervention succeeded in preventing a decrease in children's daily moderate and daily moderate to vigorous physical activity engagement. The average daily time spent on moderate to vigorous physical activity decreased with only nine minutes per day in the intervention group, compared with 33 minutes per day in the control group. Furthermore, a trend towards significance was found for children's total daily physical activity engagement, revealing an increase of children's total

activity levels in the intervention group with six minutes per day, while it decreased with 23 minutes per day in the control group. The results of the control group support previous findings that physical activity levels decline with age. However, in contrast with previous European and United States studies who reported that the largest decline in physical activity occurs during adolescence (13-18 year) (Sallis 2000), we already observed a decline in physical activity in elementary school children. From the beginning (mean age: 9.7 ± 0.7) till the end of the intervention period (mean age: 11.2 ± 0.7), a clear decrease in physical activity levels was found. This is in line with the study of Trost et al. (2002), who argued that the age-related decline in physical activity already starts during elementary school. The physical activity intervention, evaluated in the present study, was able to reduce this decrease. No gender differences were found for children's total activity levels, implying that the intervention was as effective in boys as in girls. From a public health perspective, this is important finding as girls are typically at risk for low activity levels, even at young age (Biddle, Gorely, & Stensel, 2004; Riddoch et al., 2004). No significant effects were found for vigorous intensity activities in the current study. A possible explanation could be that the intervention was especially designed to promote lifelong physical activity and that most lifetime activities are typically of moderate intensity. In addition, the accelerometers may underestimate children's short bouts of vigorous intensity activities since a one-minute sampling interval was used in the present study. Accelerometers averaged children's activity over the one-min sampling interval, leveling down vigorous intensity activities. However, additional attention may be needed for the promotion of vigorous intensity activities since vigorous intensity activities may be necessary at this young age to enhance and maintain muscular strength and flexibility, and bone health.

With regard to children's activity levels in leisure time, *self-reported physical activity measurements* indicated that the intervention was effective in increasing children's moderate intensity activities in leisure time. Moreover, a trend towards significance was found for children's moderate to vigorous physical activity engagement, revealing a larger increase in moderate to vigorous physical activity engagement in leisure time in the intervention group, than in the control group. However, because the questionnaire was found to be invalid to measure moderate intensity activities, probably due to the difficulty of recalling moderate intensity activities, this results needs to be interpreted with caution. Furthermore, the results of the questionnaire indicated a general increase in children's activity levels in leisure time, in contrast with the accelerometer data who revealed a general decrease in children's total

activity levels. These opposite findings may reflect some response bias in the questionnaire. Again, no effects were found on vigorous intensity activities and no gender differences were found.

In the present study, no overall effect on children's physical fitness was found in the intervention group. A possible explanation can be that all children had already good scores for the different fitness tests at pretest, when compared to the Eurofit profile charts of Flemish youth (Lefevre et al., 1993). This could have led to a ceiling effect. Furthermore, the intervention was expected to improve children's physical fitness by increasing children's activity levels. The lack of an overall increase in children's activity levels can also explain this finding. Moreover, significant intervention effects for physical activity were mainly found for moderate intensity activities and not for vigorous intensity activities. Since improvements in physical fitness are associated with the participation in both moderate and vigorous intensity physical activities (Sallis, McKenzie, & Alcaraz, 1993), the lack of increased vigorous intensity activity in the intervention group could also explain this finding. Additional attention may be needed for the promotion of vigorous intensity activities.

In the present study, no significant effects were found on children's psychosocial correlates of physical activity, which is probably due to a ceiling effect. Children's psychosocial correlates of physical activity were already quite positive in both groups at pretest, making it difficult to find significant effects. In general, children in both groups reported at both measurement periods that they enjoyed being physically active. They perceived few barriers and many benefits of being active. They reported being confident that they could continue with sports or physical activity for 30 minutes to 1 hour per day (self-efficacy) and they perceived social support from family and friends to be physically active. These positive correlates of physical activity were in line with the study of Cardon et al. (2005), evaluating the psychosocial correlates of physical activity in a sample of 1124 10- and 11-year-old children. In addition, children of this age group may show only limited cognitive control over their behavior and limited cognitive self-reflection. Therefore, the relevance of using cognitive models, such as the ASE model (attitude, social support, self-efficacy), in studying correlates of physical activity in young children may be questioned (De Boudeaudhuij, 1998). Looking at the mediating relationship between the targeted correlates and physical activity, and using models including structural/environmental and emotional/habit components may be more appropriate.

This study found positive intervention effects for children's total activity levels and activity levels in leisure time. Significant intervention effects were mainly found for moderate intensity activities and not for vigorous intensity activities. Moreover, no gender differences were found, implying that the intervention suited both genders. This is an important finding from a public health perspective since girls are typically at risk for low activity levels, even at young age (Biddle et al., 2004; Riddoch et al., 2004). Moreover, no effects were found on children's physical fitness and psychosocial correlates, possibly due to the positive scores at pretest, making it difficult to find significant improvements. Moreover, this study indicated that the general principles of a school-based physical activity intervention developed in the United States can be generalized to Europe after adjusting for the European culture and educational system.

Evaluation of the intervention components promoting physical activity at school

At school, physical activity was promoted during physical education classes, recess periods and extracurricular activities. The study described in chapter 4 investigated the effects of the health-related physical education program on children's activity levels during physical education classes. The observational data of this study indicated that the health-related physical education program provided the children with substantially more physical activity during the physical education classes, using the existing time and staff for school physical education classes. Moreover, this effect was found, even in the situation that all the physical education teachers in the present study were physical education specialists. The mean percent of moderate to vigorous physical activity engagement increased with 14% in the intervention schools (from 42 to 56%), compared with only 4% in the control schools (from 37 to 41%). These results are in line with other studies. McKenzie et al. (1996), evaluating the health-related physical education component of CATCH in fifth-grade students, showed a larger increase in children's moderate to vigorous physical activity engagement in the intervention schools (14%), compared with the control schools (8%). Sallis et al. (1997) reported the effects of a 2 year physical education program (SPARK) in fourth- and fifth-grade children. Results showed higher levels of moderate to vigorous physical activity in the intervention classes ranging from 32.7 min/week (teacher-led) to 40.2 min/week (specialist-led), compared

to the control classes (17.8 min/week). Moreover, in the present study the recommended 50% moderate to vigorous physical activity engagement was achieved in 64% of the observed physical education classes in the intervention schools at posttest, compared with 27% in the control schools. The increase in children's moderate to vigorous physical activity engagement did not result from teachers changing their current curriculum, for example by increasing the time spent on fitness activities. Instead, the mechanism of effect appeared to be the increased proportion of time children were active within the different lesson contexts, specifically during management, general knowledge, fitness activities and game play. Apparently, the teachers succeeded in providing more opportunities for physical activity engagement by implementing the didactical guidelines within the different existing lesson contexts, resulting in higher proportions of active time. Similar results were found in the study of McKenzie et al. (2004). However, according to Biddle et al. (2004) it may not be expected that all physical education lessons are highly active. Skill learning for example may require varying approaches in this regard. Furthermore, no gender differences were found, implying that the health-related physical education program provided equitable opportunities to engage in physical activity for boys and girls. A limitation of the study was the lack of a definitive explanation for the discrepant findings of direct observation and accelerometers.

The study described in chapter 5 revealed that providing game equipment during recess periods can increase children's activity levels. During lunch break, providing game equipment was effective in increasing the proportion of time children engaged in moderate to vigorous physical activity. The mean proportion of moderate to vigorous physical activity engagement increased with 13% in the intervention group (from 48 to 61%), while it decreased with 10% in the control group (from 55 to 45%). At recess, providing game equipment was effective in increasing children's moderate intensity activities and reducing the decrease in the time spent on moderate to vigorous physical activity (intervention group: from 57 to 53%; control group: from 56 to 43%). During lunch break, the intervention was as effective in boys as in girls, suggesting that the intervention suited both genders. At morning recess, providing game equipment was successful in increasing physical activity levels in girls, but not in boys. A possible explanation could be that boys were already very active at pretest, making it difficult to find significant improvements. In addition, the game equipment in the present study may mainly respond to girls' interests, which can also explain this finding. In the present study, only the short term effects of providing game equipment were evaluated (3 months).

Evaluating the effects of providing game equipment on children's activity levels over longer time periods is recommended.

Data concerning children's activity levels during the extracurricular activities were not available. Registration data revealed that over the two school years, an average of 60% of all children participated in the organized activities during lunch break. Since participation was on voluntary base, this high participation rate demonstrates the importance of providing organized activities during lunch break for all children. However, till now, the organization of those activities in elementary schools occurs on voluntary base and consequently, they are not provided in all schools. The study of Cardon and De Bourdeaudhuij (2002) revealed that only 17% of the elementary schools in Flanders organize supervised sports activities during lunch break.

These two studies demonstrated that children in the intervention group were significantly more active during physical education classes, lunch break and recess periods as compared to those of the control group. Because all children can be active on a daily basis during recess periods and physical education classes are required for all children, these findings emphasize the importance of maximizing physical activity participation during these school periods. Moreover, the high participation rate in the extracurricular activities demonstrates the importance of providing organized activities during lunch break to promote physical activity in children. Furthermore, it is suggested in the literature that children compensate increased activity levels at school by decreasing their activity levels at home (Donnelly et al., 1996). However, the results of the present thesis (chapter 3, 4, 5) revealed a positive evolution of children's activity levels both at school and in leisure time.

Evaluation of the classroom-based health-education lessons promoting physical activity in leisure time

Physical activity in leisure time was mainly promoted during the classroom-based health-education lessons. It was not possible to measure the isolated effect of the health-education lessons on children's activity levels in leisure time because other program aspects promoting children's activity levels in leisure time were implemented simultaneously. The promotion of

lifelong physical activity through classroom-based health-education lessons is a new concept in elementary schools in Belgium. Existing health curricula of elementary schools mostly include health topics such as nutrition, dental hygiene and drugs prevention, but not physical activity promotion. However, the development of an active lifestyle implies behavior change. Therefore, children need to be taught specific techniques to attain this behavior change. The scheduled lesson time for physical education is often too limited to add specific behavioral change skills. Providing extra physical education lessons teaching behavioral skills may decrease children's activity levels during those physical education classes. Therefore, the implementation of classroom-based lessons promoting lifelong physical activity within the existing health-curricula of elementary schools seems useful. The study described in chapter 6 showed that the health-education lessons were well received. More than half of the children reported being more active as a result of the lessons. An improvement of children's physical activity awareness as a result of the lessons was reported by half of the teachers and by half of the parents. Most teachers (80%) reported an increase in children's physical activity levels at school as a result of the lessons, while most parents did not perceive an increase in children's activity levels at home (68%).

In conclusion, the classroom-based lessons promoting physical activity were well received. Since the classroom teachers are expected to give the lessons in the future, their receptiveness to the program was an important study finding. However, it is not sure if teachers' enthusiasm in the present study would be similar if they had to implement the lessons themselves. The evaluation of the SPARK self-management lessons revealed that the teachers perceived some difficulties by the actual implementation of the lessons (Marcoux et al., 1999). An important finding was that teachers had problems with teaching "behavioral skills" instead of teaching "facts". Therefore, it will be important to make classroom teachers aware of the importance of teaching behavioral skills to promote lifelong physical activity and to learn them how to teach "behavioral skills". Moreover, in-service training will be necessary to ensure a complete implementation of the self-management program by the teachers.

Summary of the intervention effects

The intervention evaluated in the present thesis was designed to promote physically active lifestyles by encouraging physical activity participation at school and in leisure time. The intervention was based on the Social Cognitive Theory (Bandura, 2004) and the ASE model (Kok et al., 1991). The ASE model is an extension of the theory of Planned Behavior and includes concepts of both the Theory of Planned Behavior and the Social Cognitive Theory. The applied cognitive-behavioral intervention strategies to target behavior change were based on those two models of behavior change and included: creating a positive attitude towards physical activity, increasing knowledge, enhancing self-efficacy, stimulating social support and teaching self-change skills. These strategies were applied in the different intervention components. Additionally, the intervention also focused on several environmental factors to target physical activity. During the past decade, ecological approaches to target physical activity behavior received more attention. Ecological models emphasize the role of the environment in influencing behavior (Green, 1996). Based on the study of Sallis et al (2003), targeted environmental changes in the present study included providing game equipment during recess periods and providing organized physical activities during lunch break. The multi-component intervention focused on physical education classes, health-education lessons and recess periods. The results revealed positive intervention effects on children's activity levels. However, to better understand the practical importance of the intervention effects, standardized effect sizes (δ) were calculated. Effect sizes were interpreted as small (0.20), medium (0.50) and large (0.80) (Cohen, 1988). In the present thesis, positive intervention effects were found for children's total physical activity and physical activity performed in leisure time. Effect sizes for children's total activity levels ranged from 0.38 to 0.46, showing a small to medium effect of the intervention on children's total activity levels. For children's leisure time physical activity, effect sizes ranged from 0.24 to 0.29, revealing a small to medium effect of the intervention on children's leisure time physical activity. The evaluation of the health-related physical education program revealed positive effects on children's activity levels during physical education classes. Effect sizes ranged from 1.27 to 1.76, revealing a large effect of the physical education program on children's activity levels. The evaluation of providing game equipment revealed positive effects on children's activity levels during recess periods. Effect sizes for children's activity levels during morning recess ranged from 0.36 to 0.57, and during lunch break from 0.53 to 0.78. Providing game equipment had a

small to medium effect on children's activity levels during morning recess and a medium to large effect on children's activity levels during lunch break.

From these results, it can be concluded that targeting both behavioral and environmental changes and including several school factors (physical education classes, health-education classes, recess periods and lunch break) to promote physical activity was an effective strategy to target children's activity behavior. That means that the Social Cognitive Theory, the ASE model and ecological models provide a good basis to develop school-based interventions promoting physical activity. Based on those models, we expected that targeting social-cognitive variables and environmental variables would result in a physical activity behavior change. In the present study, the targeted environmental change, providing game equipment, was effective in increasing children's activity levels during recess periods. Moreover, an average of 60% of all children participated in the organized physical activities during lunch break. Since participating was on voluntary base, this high participation rate demonstrates the importance of providing organized activities during lunch break for all children to promote physical activity. Moreover, the results of the study revealed positive intervention effects on children's activity levels, but no effects were found on children's correlates of physical activity. Children's correlates of physical activity were already quite positive at baseline, what can possibly explain this finding. In addition, the measurement of social-cognitive correlates in children of this age group may be limited by their cognitive development. However, further research is necessary to further investigate the mediating relationship between the targeted social-cognitive variables and physical activity.

Limitations

Limitations of the present study were the quasi-experimental design of the study and the relatively small number of schools involved. Because a randomized controlled field trial was used, with school as unit of randomization, it was necessary to take the clustering of students within schools into account. A mixed model analysis accounts for the nested design and takes into account the variability and error at both the individual and school level (= multilevel analysis). Therefore, linear mixed model analysis was used to evaluate the intervention effects in chapter 3 and 4. However, to conduct multi-level analyses a sample size of 16 schools, with an average of 50 children per school, was necessary. Because the effects of providing game

equipment on children's activity levels during recess periods was evaluated in only seven elementary schools, these data were evaluated using repeated measures ANOVA (chapter 5).

Another limitation is that teacher behavior was not objectively evaluated in this study (e.g., by using direct observation). More specifically, physical education teachers in the intervention group verbally reported that they implemented the didactical guidelines in their lessons, but the implementation fidelity was not objectively assessed. Moreover, children seem to be responsive to encouragement for physical activity from adults (McKenzie et al., 1997). Therefore, further research is needed to explore the role of teachers' encouragement to be active during the school day (e.g., during recess periods).

A last limitation of this thesis is that a "gold standard" for assessing physical activity levels in children is missing, which implies that any criterion physical activity measure will contain random measurement errors. Additionally, when measuring children's activity levels with accelerometers, the use of age-specific activity thresholds (=count cutoffs) have been recommended to convert the total activity counts into low, moderate and vigorous intensity activities. In response, varying accelerometer count cutoffs have been proposed (Puyau, Adolph, Vohra, & Butte, 2002; Trost et al., 2002) and using different count cutoffs may influence the time estimates of activity associated with accelerometer data. However, till now, there is no clear consensus regarding the most appropriate count cutoffs to use in field studies involving children. In the present study, the count cutoffs of Trost et al. (2002) were used, which are more sensitive for children's moderate and vigorous intensity activities than the adult count cutoffs (Freedson, Melanson, & Sirard, 1998) (see chapter 2). However, in this thesis a 1-min sampling interval (= epoch time) was used. Several authors have noted that the use of a 1-min epoch time in children may underestimate their short bouts of vigorous intensity activities (Nilsson, Ekelund, Yngve, & Sjöström, 2002; Trost, Mciver, & Pate, 2005). When a child alternates between vigorous intensity physical activity and rest within a given minute, the accumulation of counts for that minute will only reflect an average activity level during that period, and the short burst of vigorous intensity physical activity remains undetected. Therefore, future studies using accelerometers to evaluate children's activity levels should use a shorter sampling interval (e.g., 5- or 10- seconds) to get a more detailed picture of children's activity intensity patterns.

Future research

In the present thesis, the effectiveness of a multi-component physical activity promotion intervention was evaluated. The results indicated that the intervention had favorable effects on children's activity levels, which means that the intervention can be considered as an evidence-based intervention. Future research is necessary to evaluate the implementation of the intervention by the schools themselves. Furthermore, the effects of some of the intervention components were evaluated because they could be studied within a more isolated context. Despite the fact that these components were embedded within the larger intervention, we wanted to receive more information concerning whether these components of the intervention were successful. Therefore, the effect of the health-related physical education intervention on children's activity levels during physical education lessons and the effect of providing game equipment during recess periods on children's activity levels during those periods were evaluated. The results indicated that the health-related physical education intervention was promising in promoting physical activity during physical education classes and that providing game equipment during recess periods was successful in increasing children's activity levels during those periods. However, because the different components were simultaneously implemented to promote physical activity, they may have taken place in a context more favorable than normal. Therefore, caution is necessary if schools would implement only one of the components of the intervention. In this case, additional research is necessary to evaluate the isolated effect of the components in a school context without other physical activity promotion elements. However, according to the literature, a multi-component intervention including several school environmental factors to promote physical activity in children is recommended (Biddle et al., 2004; Stone, McKenzie, Welk, & Booth, 1998; Wechsler, Devereaux, Davis, & Collins, 2000). Although a more comprehensive approach makes it difficult to identify which aspects of an intervention were successful, such an approach is more appropriate to target children's physical activity behavior, which is influenced by a diversity of factors.

The purpose of the physical activity promotion intervention was to promote physically active lifestyles leading to lifelong physical activity by encouraging physical activity participation at school and in leisure time. In this thesis, only the short-term effects of the physical activity promotion program were evaluated, revealing that the intervention was found to be effective in promoting physical activity in 9- to 11-year-old children. Although we did not evaluate the

long-term effects, we expect that the age-related decline in children's activity levels during adolescence will be less pronounced in the children of the intervention group. Therefore, further follow-up of this study sample is needed to explore the long-term effects of the physical activity promotion intervention in the prevention of the age-related decline in physical activity.

According to the literature, schools should involve parents and the community in the promotion of physical activity in children (Biddle et al., 2004). In the present intervention, parental involvement was limited to information letters and activity homework that parents and children did together. To stimulate children's participation in local sports clubs, children were only informed through a brochure about the sports clubs in the neighborhood (competitive and recreational). More parental involvement in such an intervention study may be warranted. Parents should be made aware of their powerful influence as role models for active lifestyles and their role in supporting their children's physical activity participation at home. Moreover, it may be warranted that schools work together with the community to promote children's physical activity in leisure time. Schools can allow sports organizations and agencies of the community to use the school facilities after school hours to organize a wide range of developmentally-appropriate sports and recreation programs that are attractive to young people. An important benefit of providing activity programs organized by the community at school, immediately after school hours is that all children have access to the activity programs and parents don't have to drive their children to sports clubs.

Practical implications

In the present thesis, the comprehensive physical activity promotion intervention was evaluated as effective in promoting physical activity in elementary school children. Therefore, favorable effects on children's physical activity levels can be expected when elementary schools implement this multi-component intervention, including a health-related physical education program, health-education lessons and an extracurricular physical activity promotion program in fourth- and fifth-grade children. The implementation of the multi-component intervention requires the involvement of both physical education teachers and classroom teachers. The principle will have an important role because the principle will be responsible to ensure that the requirements will be fully implemented by all teachers.

Based on the findings of the studies described in this thesis, some evidence-based recommendations for elementary schools to promote physical activity were formulated:

- Encourage and support physical education teachers to teach health-related physical education by providing them didactical guidelines, promoting high activity levels for all children during physical education classes and the development of a healthy, active lifestyle. In-service training for physical education teachers will be necessary for a successful implementation of the health-related didactical guidelines. For the future physical education teachers, it may be useful to incorporate health-related physical education in their professional course. The government should provide adequate resources, including budget and facilities, necessary to organize in-service trainings.
- Encourage elementary schools to create active playgrounds by providing game equipment during recess periods. Moreover, teachers should encourage the children to be active and to play with the game equipment. Informing the teachers on how they can efficiently organize and manage the set of game equipment will be necessary to ensure an optimal use of the game equipment. The government should provide financial support to buy the game equipment.
- Encourage elementary schools to organize extracurricular activities during lunch break for all children. The offered activities should include a broad range of health-related activities meeting the needs and interests of both boys and girls. Moreover, activities that can be easily transferred towards the playground and leisure time (e.g., rope skipping, Frisbee, ball games) should be emphasized. To promote a positive attitude towards physical activity, the provided activities should be enjoyable. As providing extracurricular activities are not part of the current mandatory job description of physical education teachers, a structured solution is needed for the problem of organizing and supervising those activities. A possible solution may be that the government provides physical education teachers with an additional valorized function to promote a healthy, active lifestyle in children.
- Besides providing opportunities to be active at school, children should learn at school how they can develop and maintain a physically active lifestyle, leading to lifelong

physical activity. Within the existing health education curricula, schools can offer classroom-based health-education lessons promoting lifelong physical activity. During those lessons, it is important to teach the children the importance of being active, to emphasize that they are responsible for their own physical activity, to make them aware of their current activity levels and to learn them how they can be active in leisure time by teaching them behavioral skills (e.g., goal-setting). Within this framework, homework tasks for physical activity should be encouraged because homework tasks can enhance children's activity levels in leisure time and increase their awareness of the importance of daily physical activity engagement. Moreover, parental involvement can be stimulated through physical activity homework tasks. Classroom-based lessons promoting physical activity are a completely new concept in Belgium. Therefore, it will be important to make the classroom teachers aware of the importance of teaching behavioral skills to promote lifelong physical activity and to learn them how to teach "behavioral skills" instead of "teaching facts". To ensure a complete implementation of the classroom-based lessons promoting physical activity by the teachers, in-service training will be necessary. Furthermore, it may be useful to incorporate health education regarding physical activity promotion in the professional course of future primary school teachers, enabling them to implement the health principles regarding physical activity promotion in their daily work and to enter into a professional career with a positive attitude towards physical activity promotion.

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