PHYSICAL ACTIVITY, BODY COMPOSITION AND PHYSICAL SELF-ESTEEM AMONG CHILDREN AND ADOLESCENTS

Anders Raustorp

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ABSTRACT

The increasing prevalence of overweight and obesity poses a global health problem. Special concern is focused on overweight during youth since it may cause negative impact on health both during childhood, adolescence and later life. Physical activity is a key component in preventing overweight and associated with major health benefits and therefore crucial in youth health. An important personal factor for being physically active is the individual perceived physical self-esteem.

Aim The aims of this thesis were to measure physical activity level by means of daily pedometer steps, body composition, expressed as body mass index (BMI) and Bioelectrical Impedance as percent body fat, and individual perceived physical self-esteem. It was also, to test for reliability and validity the Swedish translation of Children and Youth Physical Self-Perception Profile (CY-PSPP). Further, to compare activity and BMI levels between three countries and establish BMI referenced pedometer determined cut points. An additional aim was to evaluate eventual predictors for a healthy lifestyle i.e. highly physically active, normal weighted and a high physical self-esteem in a follow-up group (FUG).

Methods During autumn 2000 physical activity level (daily mean steps) was assessed in 892 school children aged 7-14 years in south-eastern Sweden, additionally BMI was calculated and in 501 of these children physical self-esteem was also assessed. Using the same protocol, data was gathered in United States from 711 children and in Australia from 593 children. In Sweden during autumn 2003, a total of 375 adolescents aged 15-18 years were assessed using the same methodology and together with that, percent body fat was measured. Ninety-three of these adolescents, (46 girls), were also measured in 2000 (FUG).

Results The results provided baseline information useful as reference data on levels of physical activity, BMI (age 7-18) perceived physical self-esteem (age 10-17) and percent body fat (age 15-18). A drop in physical activity was seen in boys during early adolescents. Physical activity (accumulating daily steps) correlated, in most age groups poor to fair negatively to BMI and poor to fair to physical self-esteem. In boys, there was a poor negative, and in girls, a fair negative correlation between physical self-esteem and BMI. BMI criterion-referenced cut points indicated, for each sex and age group, the optimal median cut point for steps per day for 6-12 year olds to be 12 000 steps per day for girls and 15 000 steps per day for boys. In the FUG the strongest predictor to be highly physically active, maintain a normal BMI and a high physical self-esteem three years later, was for girls increased physical self-esteem and for boys a decreased BMI.

Conclusion Instruments used herein, pedometers and the Swedish translation of the CY-PSPP, were useful to measure and classify levels of physical activity and perceived physical self-esteem in children and adolescents. With these instruments it was possible to identify individuals “at risk” for physical inactivity and low physical self-esteem. Based on pedometer steps per day, understandable recommendations could be given to professionals in health care and education, parents, children and adolescents and thereby support actions formed to influence healthy habits.

Key words: child obesity, healthy lifestyle predictors, pedometer, physical activity, physical self-esteem

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SAMMANFATTNING

Den ökade förekomsten av övervikt och fetma är ett globalt hälsoproblem. Speciellt intresse är riktat mot övervikt under barn och ungdomsåren då övervikt kan inverka negativt på hälsan både tidigt och senare i livet. Fysisk aktivitet är en nyckelkomponent i viktkontroll och är kopplat till stora hälsovinster och därför avgjort viktig för barns och ungdomars hälsa. En betydande faktor för att vara fysiskt aktiv anses vara den upplevda fysiska självkänslan.

Syfte Syftet med denna avhandling var att mäta fysisk aktivitetsnivå i dagligt antal steg, kroppskonstitution uttryckt som body mass index (BMI) och Bioelektrisk impedans som procent kroppsfett och individuellt upplevd fysisk självkänsla. Syftet var också att validitets- och reliabilitetstesta den svenska översättningen av Children and Youth Physical Self-Perception Profile (CY-PSPP) samt att jämföra fysisk aktivitetsnivå och BMI hos barn i tre länder och att etablera BMI refererade brytpunkter för antal steg per dag bestämda med stegräknare. Ett ytterligare syfte var att utvärdera möjliga prediktorer för hälsosam livsstil d.v.s. hög fysisk aktivitet, normalvikt och hög fysisk självkänsla i en treårsuppföljning.

Metoder Under hösten 2000 mättes fysisk aktivitetsnivå (genomsnittligt antal steg per dag) hos 892 skolbarn i ålder 7-14 år i sydöstra Sverige, dessutom beräknades BMI och hos 501 av dessa barn bedömdes även upplevd fysisk självkänsla. Med samma metod samlades data in i USA från 711 barn och i Australien från 593 barn. I Sverige mättes under hösten 2003 totalt 375 ungdomar i åldern 15-18 år med samma metod dessutom mättes procent kroppsfett. Nittiotre av dessa ungdomar (46 flickor) hade testats också år 2000 (FUG).

Resultat Resultatet gav baseline information, användbar som referens data, för fysisk aktivitetsnivå och BMI nivåer (ålder 7-18 år), upplevd fysisk självkänsla (ålder 10-17 år) och procent kroppsfett (ålder 15-18 år). En nedgång i fysisk aktivitetsnivå sågs hos pojkar under början av tonåren. Fysisk aktivitetsnivå korrelerade, i de flesta åldersklasser, dåligt/svagt negativt mot BMI och dåligt/svagt mot fysisk självkänsla. Hos pojkar var det en dålig negativ och hos flickor en svagt negativ korrelation mellan fysisk självkänsla och BMI. BMI refererade brytpunkter indikerade för varje köns- och åldersgrupp hos 6-12 åringar att den optimala median brytpunkten var för flickor 12 000 steg per dag och för pojkar 15 000 steg per dag. I uppföljningsgruppen (FUG) var den starkaste prediktorn för kombinationen hög fysisk aktivitet, normalvikt och hög fysisk självkänsla, tre år senare, för flickor ökning av fysisk självkänsla och för pojkar sänkning av BMI nivån.

Slutsats De mätmetoder som använts (stegräknare och den svenska översättningen av CY-PSPP) ansågs användbara för att bedöma och klassificera nivåer av fysisk aktivitet och upplevd fysisk självkänsla hos barn och ungdomar. Med dessa instrument var det möjligt att identifiera individer i riskzonen för fysisk inaktivitet och låg fysisk självkänsla. Baserat på steg per dag kunde lättförståeliga rekommendationer ges till yrkesverksamma inom vård och utbildning, föräldrar, barn och ungdomar och därmed främja stödjande åtgärder för att påverka hälsosamma vanor.

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LIST OF ORIGINAL PAPERS

This thesis is based on the following original papers, which will be referred to in the text by their Roman numerals. Studies I-IV are reprinted with kind permission from the journals.

STUDY I

Anders Raustorp, Robert P. Pangrazi, Agneta Ståhle

Physical activity level and body mass index among schoolchildren in south-eastern Sweden.

Acta Paediatr 2004; 93: 400-404

STUDY II

Anders Raustorp, Agneta Ståhle, Helena Gudasic, Anneli Kinnunen, Eva Mattsson

Physical activity and self-perception in school children assessed with
the Children and Youth - Physical Self-Perception Profile.

Scand J Med Sci Sports Online publication date: 19-Jul-2004
doi: 10.1111/j.1600-0838.2004.00406.x

STUDY III

Susan D. Vincent, Robert P. Pangrazi, Anders Raustorp, L. Michaud Tomson, Thomas Cuddihy

Activity Levels and Body Mass Index of Children in the United States, Sweden, and Australia.

Med Sci Sports Exerc 2003; 35:1367-1373

STUDY IV

Catrine Tudor-Locke, Robert P. Pangrazi, Charles B. Corbin, William J. Rutherford, Susan D. Vincent, Anders Raustorp, L. Michaud Tomson, Thomas F. Cuddihy

BMI-referenced standards for recommended pedometer-determined steps/day in children.

Prev Med 2004; 38: 857-864

STUDY V

Anders Raustorp, Eva Mattsson, Kjell Svensson, Agneta Ståhle

Physical activity, body composition and physical self-esteem
A three year follow-up study among adolescents in Sweden.

Submitted

CONTENTS

IMPORTANT DEFINITIONS

Physical Activity is defined as any bodily movement produced by skeletal muscles that result in energy expenditure (Caspersen et al 1985). Physical activity can be seen as an umbrella term of human behaviour with multiple dimensions and sub-categories such as exercise, sport, leisure activities, dance, transportation etc. (Corbin et al 2000).

Exercise (training) is defined as a subset of physical activity that is planned, structured and repetitive bodily movement done to improve or maintain one or more components of physical fitness (Caspersen 1985).

Physical fitness (capacity) is defined as a set of attributes that individuals possess or achieve that relates to their ability to perform physical activity (Caspersen et al 1985).

Health is defined as a state of being associated with freedom from disease and illness that also includes a positive component (wellness) that is associated with the quality of life and positive well-being (Corbin et al 2000). **Wellness** is a state of being describing a state of positive health in the individual and comprising biological and psychological well-being (Corbin et al 2000).

Metabolic fitness is defined as the state of metabolic systems and variables predictive of the risk for diabetes and cardiovascular disease which can be favourably altered by increased physical activity or regular endurance exercise without the requirement of training-related increase in maximal oxygen uptake (ACSM 1998).

Self-description or self-concept is defined as “a person’s perception of him or herself”.
Self-esteem or self-worth is defined as “a person’s evaluation of the good or worth in his or her self-description” (Fox 1997).

Body Composition is the relative amounts of muscle, fat, bone and other vital parts of the body. There are different methods to explore body composition (Wilmore and Costill 2004 p 449). The two component model where body fat and the **fat free mass** (FFM), i.e. muscles, bone, soft tissue, are used when calculating percent body fat (BF) (Wilmore and Costill 2004 p 449).

Obesity is defined as an excess of body fat mass (Bellizzi and Dietz 1999). In adults it is defined as body mass index (BMI) greater than 30 kg/m^2 . **Overweight** is in adults defined as BMI 25 to 30 kg/m^2. In youth overweight and obesity are defined as cut off points, which passes through 25 and 30 respectively, at the age of 18 (Cole et al 2000).

In this study, **children** are 6-14 years of age and **adolescents** are 15-18 years of age.

ABBREVIATIONS

ANOVA	Analysis of Variance
BIA	Bioelectrical Impedance analysis
BMI	Body Mass Index
CY-PSPP	Children and Youth Physical Self-Perception Profile
DXA	Dual Energy X-ray Absorptiometry
DLW	Doubly Labelled Water
FFM	Fat Free Mass
GSE	Global Self-Esteem
MET	Metabolic Energy Turnover
MRI	Magnetic Resonance Imaging
PSPP	Physical Self-Perception Profile
PSW	Physical Self-Worth
USDHHS	United States Department of Health and Human Services

INTRODUCTION

Modern lifestyle decreases physical activity opportunities for man. Research consensus and recommendations have been established to promote physical activity as a strong and important factor to reach and maintain good health and well-being. Already moderate, daily physical activity provides substantial health benefits (USDHHS 1996). This knowledge might increase the interest for specific recommendations for children and adolescents and how this knowledge can be brought into practise.

Activity patterns established at an early age have a tendency to follow into adulthood (Raitakari et al 1994, Telema et al 1997, Malina 2001). Physical activity patterns are governed by personal, social and cultural factors (Engström 1999, Sallis et al 2000). Body composition as personal factor and its impact on physical activity levels, and vice versa, is an interesting area of research since physical activity is a key component in weight control (USDHHS 1996 p 135, Wilmore and Costill 2004 p 682). A change in body composition of Swedish children and adolescents has occurred during the last decades (Mårild et al 2004, Rasmussen et al 1999, Ekblom et al 2004a). Obese and overweight children and adolescents have an increased risk for several diseases during their youth (Williams et al 1992) as well as adulthood (Gunnell et al 1998).

Another interesting personal factor is self-esteem. Our global self-esteem consists of sub-domains where the physical self-esteem is one among others (Harter 1985). Levels of self-esteem have been identified as an important factor in predicting reactions to feedback, motivation and behaviour (Kernis et al 1993). Physical activity is reported a valuable tool to increase and maintain physical self-esteem (Fox 2000). Studies have shown that overweight and obese teenagers have lower self-esteem than their normal weighted school mates (Strauss 2000).

Urgently (WHO 2004) calls for actions to monitor data and key influences on physical activity, including methods for evaluation of intervention programs.

Therefore, increased knowledge of physical activity levels in children and adolescents and its relation to body composition and to individuals perceived physical self-esteem ought to be of interest for professionals working with physical activity and sciences dealing with human bodily movement. To find and follow individuals at risk for future disease and identify predictors for a healthy life style can help prioritizing the efforts and individualise program.

Physical Activity
Regular physical activity is reported a protective factor against cardiovascular diseases. In several diseases, such as; obesity, hypertension, diabetes type II, osteoporosis, cancer and depression, it is an important component of treatment as well as in prevention (USDHHS 1996 p 85-150, WHO 2004).

For large groups of individuals, thirty minutes of accumulated moderate physical activity, (i.e. 3-4 kcal/kg/day) performed daily has been reported enough to reach important health benefits (Pate et al 1995, USDHHS 1996, Blair et al 2004). The health related physical activity recommendations are based on a dose-response relation between physical activity (product of intensity, duration and frequency which can be expressed as energy, kcal or kJ) and morbidity and mortality in for example coronary heart disease (USDHHS 1996).

Moderate, age-dependent, intensity for adults is defined as three to six METs (metabolic energy turnover) (USDHHS p 33). For young people, five to seven METs are suggested as moderate intensity (Riddoch and Boreham 1995). One MET is about 3.5 ml oxygen per kilo and minute corresponding to the body at rest (Ainsworth et al 1993, Wilmore and Costill 2004 p 620). American College of Sports Medicine (2000 p 307) lists horizontal walking at 3 miles per hour equivalent to 3.3 METs. Adding, at least, 150 kcal in daily energy expenditure is communicated in the recommendation "thirty minutes of daily brisk walking" and the dose response relation is expressed as "little is better than nothing and more is even better" (USDHHS 1996 p 6). However, the dose response curve is somewhat different under different disease conditions and the type of physical activity must be considered when giving consultation (Kesaniemi et al 2001).

Every bout of physical activity is reported to have a positive effect even if it is performed for a short period of time, each lasting 8-10 minutes (Pate et al 1995, Murphy et al 2002). Greater benefits are accrued if the next bout appears before the effects of the last one have dissipated.

An intensity level lower than the one required for cardio-respiratory fitness is reported to give positive effects for metabolic fitness and thereby health benefits of physical activity (Deprés and Lamarche 1994, ACSM 1998). The difference today compared to earlier recommendations is the emphasis on frequency (i.e. daily), the acceptance of the possibility to accumulate physical activity and that many of the health benefits are related to the total amount of physical activity (Blair et al 2004, Erlichman et al 2002, ACSM 2000 p 151).

Health beneficial adaptations from physical activity are reported for children and adolescents (USDHHS 1996 p 102, Kahle et al 1996, Sundberg et al 2001) although the reports are limited due to ethical and methodological reasons. Regular physical activity is necessary for normal growth and the development of functional qualities such as aerobic capacity, muscle strength, flexibility and motor skills. Further benefits are weight management, reduced anxiety and stress, improved self-esteem and self-efficacy, social interactions, fun and enjoyment (ACSM 2000 p 220).

Although most individuals from age two are included in the general recommendations of 30 minutes (USDHHS 1996) specific guidelines for physical activity levels in children and adolescents recommends at least 60 minutes of accumulated moderate to vigorous physical activity per day (Corbin and Pangrazi 1998, Biddle et al 1998). Such activity can be intermittent in nature and accumulated throughout the day. Intermittent physical activity is reported to be important because such activity has a positive impact on the growth and development of children (Bailey et al 1995).

Children and adolescents are urged to participate in a variety of age-appropriate physical activities from a physical activity pyramid (Corbin and Pangrazi 1998) to achieve health benefits as well as fitness benefits (NASPE 2004). The reason for asking children to perform twice the minutes of daily activity as compared to adults is that all youngsters show a natural decline in physical activity as they mature (Rowland 1990, Sallis 2000). Recommending at least 60 minutes of daily activity during childhood will, hopefully, result in 30 minutes of activity as youngsters become less active adults (Corbin and Pangrazi 1998).

For adolescents, an additional guideline exists based on a consensus panel recommendation that call for three or more sessions of physical activities that requires moderate to vigorous levels of exertion (Sallis and Patrick 1994). A recent report (Institute of Medicine 2002) reinforces a higher recommendation i.e. at least 60 minutes for adults, adolescents and children if weight control is the goal.

Physical Activity assessment

Several techniques have been proposed for measuring the activity levels of children some of them subjective, such as direct observation, self-report, and some objective like heart rate monitoring, and accelerometers (motion sensors) (Welk 2002). Direct observation has been found valid and reliable, but is labour intensive and time consuming (Kilanowski et al 1999).

Self-reports are useful because it is easy to administer and cost effective. However, the reliability and validity of self-reports have been questioned due to subject bias and children's difficulty in recalling activities accurately (Sallis and Saelens 2000, Sirard and Pate 2001).

Heart rate monitoring of children in activity settings has been used because it is easy to collect data over long periods of time by recording heart rate minute by minute (Freedson and Miller 2000). However, children's activity patterns are intermittent and increased heart rates was reported not to sustain for long duration (Bailey et al 1995). Another method, used to measure physical activity as energy expenditure, is Doubly Labelled Water (DLW) (Westerterp et al 1984), a valid and reliable, but expensive method.

Accelerometers have been used because they are unobtrusive, unbiased, can store information, and measure a whole day without much inconvenience (Melanson and Freedson 1995). The accelerometers measure movements in vertical axis (uni-axial accelerometer) or in addition horizontal and sagital (tri-axial accelerometer) axis. An advantage is its possibility to measure intensity of the physical activity performed. However, one of the disadvantages of accelerometers is the high cost of the devices and an uncertainty in the ability to measure bicycling and swimming, common child and adolescent activities (Welk 2002).

Pedometers

Pedometers offer a cost-effective, unobtrusive and convenient way for objectively and direct measure of physical activity in field studies. Advances in technology have further improved the accuracy of the device (Bassett et al 1996). The new electronic pedometers contain a horizontal spring suspended lever arm and measure vertical movement. Normal ambulatory movements (i.e walking, running) make the lever arm move up and down closing an electric circuit. With each movement detected, an accumulated step is displayed digitally on a feed back screen (Tudor-Locke 2002). In a step cycle (i.e. from right leg toe-off until next right leg toe-off) two steps are displayed. Steps per day are universally adopted as standard unit for pedometer data (Tudor-Locke and Myers 2001a).

Pedometers are reported to be a valid and reliable measure of physical activity (Welk, et al 2000, Tudor-Locke 2002b, Tudor-Locke et al 2004). Tudor-Locke and Bassett (2004 p 2) concludes "aggregated evidence of convergent validity (relative to other measures of physical activity) and construct validity (relative measures of healthy outcomes) provides abundant support for using pedometers to assess physical activity".

Various types of pedometers are available. Yamax Digiwalker SW-series have consistently been found among the most accurate (Bassett et al 1996, Schneider et al 2003, Schneider et al 2004, Crouter et al 2003, Le Masurier et al 2004) and the Yamax SW-200 is commonly used in applied research (Eston et al 1998, Tudor-Locke et al 2002a, Wilde et al 2004). Yamax pedometers require a force of 0.35 *g* to register and record data. At very low walking speed, less than one mile per hour, the accuracy is reported to decrease (Melanson et al 2004).

In children 7-12 years of age, activity levels during classroom activities and recreational activities were compared by Kilanowski et al (1999) using a pedometer (Yamax Digiwalker SW-200) a Tritrac accelerometer and direct observation (Children's Activity Rating System, CARS). Significant correlations were found between all measures.

In a study of nine-year-old children, pedometers (Yamax Digiwalker SW-200) were compared to accelerometers, heart rate monitoring and scaled oxygen uptake (sVO_2, ml x kg $^{-0.75}$ x min). All the devices correlated significantly with scaled oxygen uptake in both regulated (walking and jogging) and unregulated activities (free play activities). The correlation of the pedometer were reported very good in regulated (r=0.80) and unregulated activities (r =0.92). In unregulated activities it was found higher than that of a uni-axial accelerometer (r=0.85) and in line with that of tri-axial accelerometer (r=0.93) (Eston et al 1998).

One of the disadvantages with pedometers is that they do not measure intensity and activities like bicycling, swimming and horse riding. However, taking into consideration the intermittent activity patterns of children (Bailey et al 1995), and given the current emphasis on the need to accumulate activity throughout the day, it makes sense to record a total activity count at the end of the day (Rowlands et al 1997).

Pedometers give a total step count, which can be evaluated for each child based on normal patterns of activity in the population. Another advantage is its outcome; steps or steps per day, which is reported immediately understandable and thereby forming a bridge between research and practice (Tudor-Locke and Myers 2001b). This facilitates goal-settings and self-monitoring, in for instance physical activity interventions.

Body Composition

The increasing prevalence of overweight and obesity has become a global health problem. Overweight may cause negative impact on health both during childhood, adolescence (Williams et al 1992) and later on in life (Gunnell et al 1998). A special concern should therefore be focused on overweight during youth. Over the past 15 years the prevalence of overweight and obesity has increased more than twofold in Swedish children 10 to 16 years of age (Ekblom et al 2004a). In 10 year-old children a fourfold increase in obesity is reported between 1984 and 2000 (Mårild et al 2004).

Weight control is a complex matter since genetic factors as well as factors such as cultural, environmental and lifestyle influence overweight and obesity. The heredity for body composition is reported to be about 25-40 percent (Bouchard 1997). Lower level of physical activity in the modern society combined with changes in diet habits are believed to be the main reasons for the increased prevalence of overweight and obesity among children and adolescent (Bar-Or 2000, Welk and Blair 2000). The genetic differences to gain weight might make children more or less "vulnerable" to the modern inactive lifestyle.

Body Composition assessment

When measuring body composition such as body fat mass and fat free mass several methods are available, such as hydrostatic densiometry, skin fold test, dual energy X-ray absorptiometry (DXA), magnetic resonance imaging (MRI) and Bioelectrical impedance analysis (BIA)(Wilmore and Costill 2004). In field studies calculating BMI has been a recommended method when studying overweight and obesity (WHO 1998).

Overweight in adults is defined as a BMI of 25 to 30 kg/m^2, and obesity as greater than 30 kg/m^2 . In youth, they are defined as cut off points, which passes through 25 and 30 at the age of 18 (Cole et al 2000). However, it is the increased amount of body fat that causes the major health risk, thus, questions have been raised if BMI is an adequate method to measure body fat (SBU 2002, Viikari 2004, Deurenberg et al 2001). Therefore, the recent development of bioelectrical impedance instruments makes an alternative to measurements of BMI when measuring body fat (Wilmore and Costill 2004, Sun et al 2003, Kyle et al 2004). Bioelectrical impedance is considered a reliable and precise method to measure resistance in biological tissue even in children and adolescents (Sun et al 2003, Lintsi et al 2004).

Self-esteem and Physical Self-esteem

The self-concept or self-description can be defined as “a person’s perception of himself” while self-esteem is a person’s evaluation of the good or worth in his/her self-description (Fox 1997). High self-esteem is reported to be connected to emotional stability, (Sonstrom 1997) life satisfaction (Diener and Diener 1995) and overall healthy behaviour (Torres and Fernandez 1995). Low self-esteem on the other hand is reported to be connected to overweight/obesity (Strauss 2000, Rasmussen et al 2004) depression and anxiety (Baumeister 1993).

Level of self-esteem has been identified as an important factor in predicting reactions to feedback, motivation and behaviour (Kernis et al 1993). Several motivational theories exist. Two of these are used to explain children’s motivation (Whitehead and Corbin 1997), the competence motivation theory (Harter 1978) and the self-determination theory (Deci and Ryan 1985).

Harter (1978) implies that demonstrating competence in a domain is important, especially in those domains deemed significant to the individual. For instance, individuals with high self-perception in their physical ability will be more likely to take part in physical activity (Harter 1985).

Self-determination theory focuses on how activities initially uninteresting and boring will be internalised and perceived as rewarding and interesting. The motivation changes gradually from amotivation over four steps of external motivation over to intrinsic motivation. Motivation is reported fundamental in learning situations as well as in behavioural changes, and events that promote perception of competence will increase a person’s intrinsic motivation (Deci and Ryan 1985). In the process of health promotion by lifestyle changes “motivation and self-esteem are inextricably interlinked” (Whitehead and Corbin 1997 p 176).

Physical Self-esteem assessment

Based on research of a multidimensional self-esteem (Shavelson et al 1976), Harter (1985) presented a hierarchal model for self-esteem suggesting that the global self-esteem (GSE) is composed of different aspects, such as social, physical and cognitive.

In an attempt to provide insights to the mechanism of self-esteem change through exercise Fox and Corbin (1989) presented a questionnaire “the Physical Self-Perception Profile” (PSPP) demonstrating that physical self-worth (PSW) is one domain which affects the GSE of an individual. Individuals PSW is built up by four different sub-domains: Sport Competence (SC), Body Attractiveness

(BA), Physical Strength (PS) and Physical Condition (PC). From the PSPP, Whitehead (1995) created a scale for children and youth, the Children and Youth Physical Self-Perception Profile (CY-PSPP), see Figure 1.

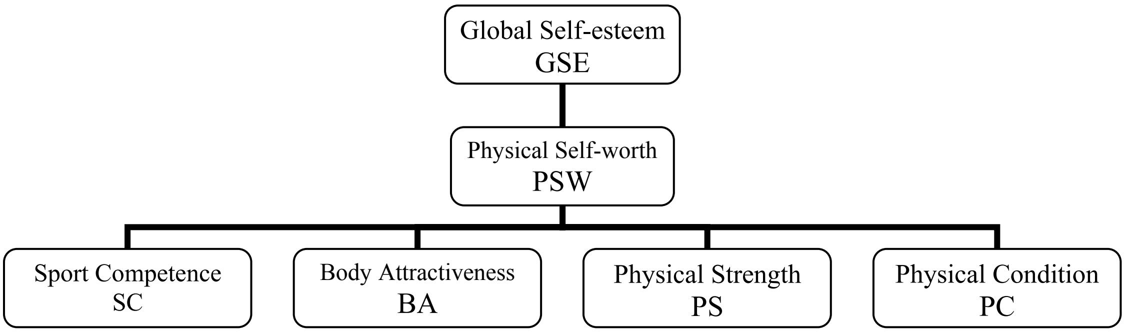

Figure 1 *Hierarchal model of Children and Youth Physical Self-Perception Profile (CY-PSPP) (Whitehead 1995). An individuals Physical Self-worth is built up by four different sub-domains: Sport Competence, Body Attractiveness, Physical Strength and Physical Condition.*

Validity and reliability have been confirmed by later studies (Eklund et al 1997, Hagger et al 1998). CY-PSPP has been found valid and reliable for children as young as nine years of age (Welk et al 1997).

An alternative instrument for assessing physical self-esteem on individuals from the age of 12 is the PSDQ (Physical Self-Description Questionnaire) (Marsh and Redmayne 1994). The PSDQ includes 11 aspects of self-esteem: strength, body fat, endurance/fitness, co-ordination, health, appearance, flexibility, sport competence, general self-concept and self-esteem.

Another instrument, the Perceived Physical Competence Scale for adolescent boys and girls, has been used in Finland and showed that stability and change of self-perceptions over a four-year period varied considerably depending on the specific domain, gender and activity level (Lintunen 1995).

The connection between exercise and self-esteem has been reported in a meta-analysis of 37 randomised controlled studies of all ages and concluded exercise as a valuable tool for increasing and maintaining physical self-worth and other physical self-perceptions (Fox 2000). The effect was greatest in children and middle-aged adults and was shown in males as well as females. However, a positive effect on global self-esteem was only reported in half of the studies (Fox 2000).

A gender difference in physical self-perception has also been reported with females rating lower on all sub-domains compared to males (Eccles and Harold 1991). The sub-domain Physical Condition has been reported the single greatest contributing factor separating exercisers from non-exercisers (Fox and Corbin 1989). Physical Condition and Sport Competence were significantly correlated to physical activity in 10-14 year old Canadian school-boys (Crocker et al. 2000).

In Sweden, a controlled six month exercise intervention study on adolescent girls 13-20 years of age, using the adult PSPP scale, showed that perceived Physical Condition and perceived Body Attractiveness increased significantly (Lindwall 2004).

Increased knowledge of physical activity levels in children and adolescents and its relation to body composition and to individuals perceived physical self-esteem ought to be of interest for professionals working with physical activity and sciences dealing with human bodily movement. To find and follow individuals that may be at risk for future diseases related to physical inactivity and identify predictors for a healthy life style can help prioritising and individualise programs. If we can identify the levels that indicates an “at risk” individual, understandable recommendations can be given to school children and adolescents, parents, teachers and supportive actions can be formed to influence healthy habits.

AIMS

The aims of this thesis were:

- to classify and describe levels of physical activity, body composition (7-18 years of age) and physical self-esteem (10-17 years of age) among children and adolescents

- to compare levels of activity and body composition in children 6-12 years of age in Sweden, United States and Australia

- to identify criterion-referenced pedometer determined recommendations for children 6-12 years of age

- to evaluate eventual predictors for a healthy lifestyle in a three year follow-up group

Scientific questions

- Which level of physical activity, measured with pedometers, and which body mass index (BMI) have children and adolescents in south-eastern Sweden? *(Study I,V)*

- Are there any differences and/or correlations between different age groups of boys and girls level of physical activity and BMI? *(Study I,V)*

- Are the Swedish translations of the Children and Youth Physical Self-Perception Profile (CY-PSPP) valid and reliable? *(Study II)*

- How do school children and adolescents in south-eastern Sweden perceive their physical self-esteem? Are there any differences between boys and girls? *(Study II, V)*

- Are there any correlations between perceived physical self-esteem and physical activity and BMI in boys and girls, respectively? *(Study II, V)*

- Are there any differences between level of physical activity and BMI in children from Sweden, United States and Australia? *(Study III)*

- Which are the preliminary referenced standards for physical activity as steps per day related to BMI in children? *(Study IV)*

- Is there any correlation between BMI and Bioelectrical Impedance measured body fat in adolescents? *(Study V)*

- Which are the most important predictors for a healthy lifestyle i.e. highly physically active, normal BMI and a high physical self-esteem? *(Study V)*

MATERIAL AND METHODS

Participants 2000

During autumn 2000, data was collected on boys and girls 6-14 years of age in Kalmar, Oskarshamn and Mörbylånga, all middle class communities (Sweden statistics 2002). Nine schools in these communities were categorized as countryside schools, suburban schools and city schools. From the three communities a sample of participants was taken from each of the three types of schools. A letter was sent to all children's´ parents requesting parental permission allowing their child to participate. In every age group, at least two of the three types of schools were represented, except for age group 13, where the data were collected in city schools only.

From a sample of 1072 children, 941 (88%) were included and 901 children (84%) completed the gathering of physical activity data. Reasons for non-participation were lack of parental permission, missing the first day of the study, illness and choosing not participate. Children six-years old were excluded from statistical analysis due to the small number of subjects. Thus the total number of participants included in **Study I** was 892 (457 boys), see Figure 2. Analyses concerning BMI were only available in 871 due to missing values.

From the 892 children in Study I, children 7-9 years of age were excluded as well as the children that denied participation or had difficulties in completing the scale, thus in **Study II** 501 children participated. From these children (248 boys and 253 girls) data of physical self-perception were collected. Study II also included a validation part were 48 children (21 boys) participated, see Figure 2.

From the 892 participants in Study I children 13 and 14 years old were excluded in the international comparison study **(Study III)** as well as in the criterion-referenced study **(Study IV).** In those studies the contribution from the Swedish sample was 680 children aged 7-12 years (356 boys). Analyses concerning BMI were only available in 661 due to missing values. The sample in United States, 711 children (325 boys) was from an urban community in the South West with mixture of ethnicity. The Australian sample, 593 children (278 boys) was from a large urban city with predominantly white participants.

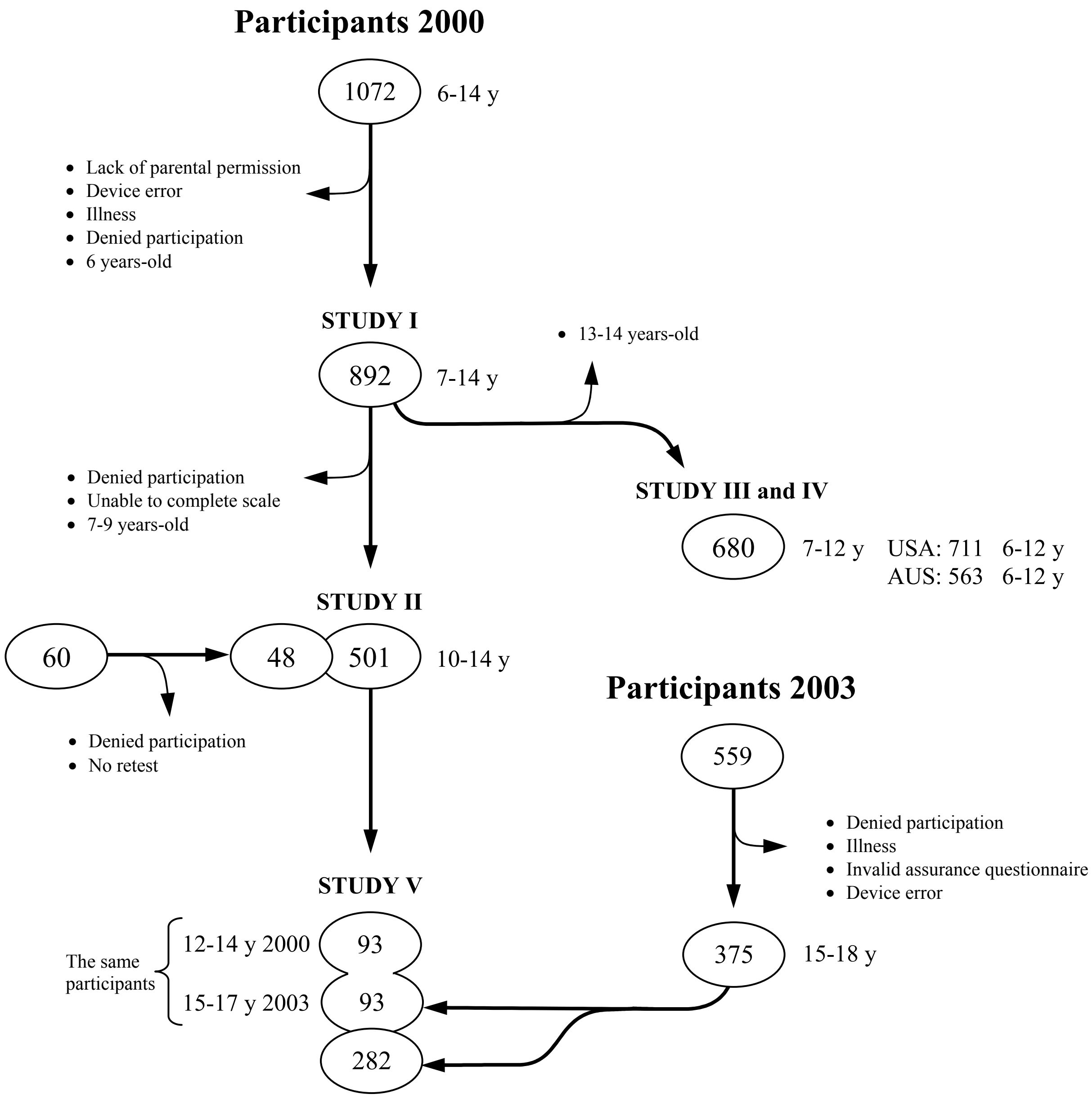

Figure 2 *Number and age of participants in the different studies. Study I, II and the Swedish part of Study III and IV with the exception for the validation sample are from the same origin sample 2000.*

Participants 2003

In 2003, 559 adolescents aged 15-18 years old were asked to participate in **Study V**. Out of these 559 adolescents, 184 were excluded due to missing the first day of the study, instrument error and insufficient assurance questionnaire or not willing to participate. Out of the remaining 375 adolescents (176 boys), 93 (47 boys) were measured already 2000 (Study II). Those 93 formed the follow-up group (FUG) while the remaining 282 adolescents (129 boys) formed the comparing group, see Figure 2.

Physical Activity
To measure physical activity participants carried a cable tie sealed pedometer, the Yamax Digiwalker SW-200, MLS 2000 (Tokyo, Japan). The pedometer was attached on the belt or waistband and placed in line with the midpoint of the right knee. Five Physical Education Teachers and twenty-two students in the Physical Education Teacher Training Program at the University of Kalmar were trained to collect the data. Participants were instructed to carry the sealed pedometers during the entire day until bedtime and put it on after dressing in the morning. The number of daily steps was measured over four consecutive days. This is recommended in order to assure reliable results and avoid reactivity (Vincent and Pangrazi 2002). Each day, during first hour of school, the researcher collected the pedometers, recorded the number of steps, resealed the pedometers and returned them to the participants. A questionnaire was completed to assure that the pedometer was carried according to given instructions during the entire day and to register after school activities. More than one hour of non-measuring time excluded the data of from analysis.

Body Composition
Body mass index (BMI)
The week before the test, participants were allowed to become familiar with the pedometers during a lesson in physical education. At this time, height was measured on a tape attached to a wall (Friedrich Richter; Kirchenlaibach, Germany) and rounded down to nearest centimetre. Weight was measured on a step-up scale (EKS International Wittiesheim, France) in 2000 and (HEFA Digital AB Halmstad, Sweden) in 2003 and rounded up to nearest kilogram. Cut off points according to Cole et al. (2000), were used to define the prevalence of overweight and obesity.

Bioelectrical Impedance Analysis (BIA)
Body fat was analysed with the bioelectrical impedance method. An Omron BF 306 Body Fat Monitor (Omron Matsusaka Co.LDT, Japan) was used. BIA is considered a reliable and valid method to measure resistance in biological tissue (Deurenberg et al 2001, Sun et al 2003, Gibson et al 2000, Loy et al 1998, Kyle et al 2004). In BIA, a weak electric current is transmitted between two electrodes placed on different parts of the body, and measures the level of resistance in different segments of the body. The fat free mass of the body contains the major part of the water and electrolytes, which results in low levels of resistance, while fat mass acts as an isolator with high level of resistance.

Adolescent's bioelectrical impedance was measured during a school-lesson at least two hours after breakfast or lunchtime. Based on height, weight, age and sex, upper body resistance were measured with the adolescent standing upright with out-stretched arms parallel to the floor and the hands gripped for contact to the instruments measuring area (Deurenberg et al 1989, Kyle et al 2004). Relative body fat in percent was calculated using the manufacturer's equation and was showed digital and recorded by the researcher. For adolescents aged 15-17, the fat free mass (FFM) was recalculated to compensate for the age-related change in body water (Siri 1961, Lohman 1992). This was carried out according to the following equation: FFM = (weight in kg – body fat in % * weight in kg / 100) and subtracted with 0.045 and 0.084 for girls and boys, respectively, for each year they were younger than 18 years of age as recommended by P. Deurenberg, one of the developer of the method.

Perceived Physical Self-esteem

The CY-PSPP consists of 36 items about youth physical self-perception. The items represent six domains: Global Self-esteem, Physical Self-worth, Sport Competence, Body Attractiveness, Physical Strength and Physical Condition. Each item consists of two statements and a four point structured alternative format. First, the participants must decide which of the two statements that best describes them and then mark with (X) weather the statement is kind of true or really true for them.

The assistant carefully described the procedure and read both statements for each item. In the sample of 2003 with adolescents the assistant did not pre-read the items. Every item gives a score from one to four, where scoring four means highest self-perception on that item. Maximum score of the six items of a sub-domain is 24 points and minimum is six points, consequently maximum and minimum score on CY-PSPP is 144 points and 36 points.

Statistical Analysis
A survey of the statistical methods used is presented in Table I
Data were analyzed using SPSS 10.1 for Windows. SPSS software package were used for all statistics. Significant level was set at $p \leq 0.05$.

Table I *Survey of statistical methods used in Study I-V.*

	Study I	**Study II**	**Study III**	**Study IV**	**Study V**
Descriptive statistics					
Frequency	X	X	X	X	X
Mean, SD	X		X	X	X
Median, range		X			X
Tertiles			X		
Analytical statistics					
Students dependent t-test					X
Students independent t-test				X	X
Pearson's product moment correlation	X		X		X
Multivariate ANOVA			X		
One way ANOVA	X				
Contrasting group's method				X	
Multiple regression analysis		X			
Wilcoxon´s Signed Rank		X			X
Mann-Whitney U-test		X			X
Spearman's rank correlation		X			X
Chi ^{2} analysis			X		
Weighted Kappa		X			
Logistic regression analysis					X

The strength of the correlation and kappa values were evaluated according to Altman (1991), see Table II.

Table II *Strength of the Kappa coefficients (κ) according to Altman (1991).*

Coefficient	**Strength**
< 0.20	Poor
0.21-0.40	Fair
0.41-0.60	Moderate
0.61-0.80	Good
0.80-1.00	Very good

RESULTS

Physical Activity levels and BMI among Swedish school children (Study I)

Step counts were significantly higher in boys than in girls, showed stability over age and large in-group differences, see Table III. Only four significant differences between age groups were found in each sex and those differences were mainly related to the high step count for 10 year old boys and girls.

Table III *Numbers of participants (n), daily mean step counts and standard deviation (SD) for boys and girls, presented in age groups.*

	Boys			Girls		
Age	**n**	**Mean**	**SD**	**n**	**Mean**	**SD**
7	42	15 672	3148	29	14 025	2684
8	74	15 776	2787	60	13 041	2402
9	74	16 405	3282	73	14 577	3162
10	50	18 346	3746	60	14 825	2804
11	54	16 752	3729	52	13 370	3454
12	62	15 975	4621	50	12 238	2930
13	47	16 011	3960	65	13 188	2606
14	54	14 911	3912	46	12 851	3107
Total	457			435		

Body mass index was calculated for 446 boys and 425 girls and compared to the International BMI cut points to examine the prevalence of overweight and obesity. The prevalence of overweight was 13.2% and 14.6% for boys and girls respectively. Among both boys and girls 4.5% were obese.

Translation and validation of the questionnaire Children and Youth Physical Self-Perception Profile (CY-PSPP) and levels of perceived Physical Self-esteem in Swedish school children (Study II)

Translation and validation

In the translated version good concurrent and content validity was found. The test-retest reliability over a two week period was acceptable as the weighted κ coefficient resulted in eight items with good agreement, 20 with moderate agreement, seven with fair agreement and one item with poor agreement.

Physical Self-esteem in children

In children 10-14 years the total score on CY-PSPP ranged from 51-144 in boys and 54-140 in girls (see Table IV). There was a significant gender difference in all sub-domains as well as in the total score on CY-PSPP ($p<0.001$).

Table IV *Median and range for the Children and Youth Physical Self-Perception Profile (CY-PSPP) and sub-domains in children 10-14 years of age (n=501).*

	Boys n=248		Girls n=253		Total n=501	
	Median	Range	Median	Range	Median	Range
Global Self-esteem	20	(9-24)	19	(6-24)	19	(6-24)
Physical Self-worth	18	(6-24)	17	(6-24)	17	(6-24)
Sport Competence	17	(7-24)	16	(6-24)	16	(6-24)
Body Attractiveness	17	(8-24)	16	(6-24)	16	(6-24)
Physical Strength	17	(7-24)	16	(6-24)	16	(6-24)
Physical Condition	17	(7-24)	16	(6-24)	16	(6-24)
Total CY-PSPP	104	(51-144)	96	(54-140)	100	(51-144)

CY-PSPP, sub-domains and Physical Activity in children

In boys there was a fair correlation both between total CY-PSPP score and mean step counts ($r_s=0.37$) as well as between sub-domains and mean step counts. In girls there was a poor correlation ($r_s=0.18$). In boys Body Attractiveness ($r_s=0.69$) and Physical Condition ($r_s=0.65$) and in girls Body Attractiveness ($r_s=0.64$) and Sport Competence ($r_s=0.58$) showed the strongest correlation to PSW.

CY-PSPP, sub-domains and BMI in children

In both sexes, there was a fair negative correlation as well between the total CY-PSPP score and BMI level (boys $r_s=-0.23$) (girls $r_s=-0.40$) as between sub-domains and BMI except for Physical Strength where the correlation was poor. There was a stronger negative correlation between PSW and BMI in girls ($r_s=-0.35$) than in boys ($r_s=-0.19$). In both sexes, Body Attractiveness (boys $r_s=-0.28$) (girls $r_s=-0.40$) and Sport Competence (boys $r_s=-0.21$) (girls $r_s=-0.40$) were the sub-domains most negatively correlated to BMI.

Comparing Physical Activity level and BMI in children from Sweden, United States and Australia (Study III)

In general, the Swedish children were significantly more active than the Australian and American children. For boys, the mean step counts ranged from 15 672-18 346 for Sweden, 13 864-15 023 for Australia and 12 554-13 872 for America. For girls the mean step counts ranged from 12 238-14 825 for Sweden, 11 221-12 322 for Australia and 10 661-11 383 for America.

The American children were significantly heavier than the Australian and Swedish children. The rate of increase in BMI with age was greater in the American children than in Swedish or Australian children. The percent of American, Swedish and Australian boys classified as overweight/obese was 33.5, 17 and 15.8, respectively. The percent of American, Swedish and Australian girls classified as overweight/obese was 35.6, 17.8 and 14.4, respectively. Correlation analysis found few significant negative relationships between daily step counts and BMI.

Step per day recommendations for girls and boys aged 6-12 years (Study IV)

Based on optimal criterion-referenced cut points indicated for each sex and age group, the median cut point for steps per day for children 6-12 years of age was for girls 12 000 steps and for boys 15 000 steps. Children who failed to meet these recommendations were more likely to be classified as overweight/obese compared to those who met these recommendations.

Levels of Physical Activity and BMI and perceived Physical Self-esteem in adolescents in Sweden and predictors for healthy lifestyle variables (Study V)

Levels of Physical Activity and BMI in adolescents

The daily mean step in boys was 11 892 (6 072-21 797) and in girls 12 271 (5 606-21 683), see Table V. No significant difference was found between boys and girls. Almost 17% of the boys and girls were considered overweight or obese.

Table V *Numbers of participants (n), daily mean step counts and standard deviation (SD) for boys and girls, presented in age groups.*

	Boys			Girls		
Age	**n**	**Mean**	**SD**	**n**	**Mean**	**SD**
15	81	11 556	2570	70	11 887	2969
16	39	11 968	2910	39	12 744	2246
17	28	13 315	3189	40	12 875	3818
18	28	11 336	3611	50	11 957	2426
Total	176			199		

There was no significant correlation between daily steps and BMI in any age group of boys and girls. The correlation between BI analysed body fat and BMI was moderate in boys aged 15 and very good in boys aged 18 and girls age 17. In all other age groups the correlations were good.

Follow-up group
Data from 2003 was compared to data three years earlier in the follow-up group and a significant ($p \leq 0.001$) increase in BMI in boys and girls were found as well as a significant ($p \leq 0.001$) decrease in daily steps in boys. There were no significant changes regarding perceived physical self-esteem neither in boys ($p = 0.175$) nor in girls ($p = 0.105$).

Levels of Physical Self-esteem in adolescents
In adolescent 15-17 years of age (Table VI) the total score of CY-PSPP ranged from 75-140 in boys and 72-136 in girls. Significant gender differences were found in global self-esteem and total score of CY-PSPP.

Table VI *Median, range and gender differences for the Children and Youth Physical Self-Perception Profile (CY-PSPP) and sub-domains in adolescents 15-17 years of age (n=93).*

	Boys n=47		Girls n=46		Total n=93		Gender diff P
	Median	Range	Median	Range	Median	Range	
Global Self-esteem	22	(14-24)	19	(9-24)	20	(9-24)	0.01
Physical Self-worth	18	(11-24)	17	(11-24)	18	(11-24)	0.21
Sport Competence	18	(8-24)	17	(9-24)	18	(8-24)	0.13
Body Attractiveness	18	(9-24)	17	(8-23)	17	(8-24)	0.07
Physical Strength	17	(10-24)	16	(6-24)	16	(6-24)	0.34
Physical Condition	19	(7-24)	17	(8-24)	18	(11-24)	0.34
Total CY-PSPP	109	(75-140)	102	(72-136)	105	(72-140)	0.03

No significant correlation between total CY-PSPP score and daily steps was found in the adolescent group (boys $r_s = 0.16$, girls $r_s = -0.11$). There was no significant correlation between total CY-PSPP score and BMI neither in boys nor in girls. In both boys ($r_s = 0.91$, $p = < 0.001$) and girls ($r_s = 0.80$, $p < 0.000$) Sport Competence was most important for perceived physical self-esteem.

Predictors for healthy lifestyle variables
Level of daily mean step was the strongest predictor for being highly active three years later for both boys [exp(B) 1.164] and girls [exp(B) 1.129]. BMI was the strongest predictor to maintain normal weight in boys ([exp(B) 0.267] and in girls [exp(B) 0.432]). The strongest predictor regarding perceived physical self-esteem was BMI in boys [exp(B) 0.820] and physical self-esteem in girls [exp(B) 1.798]. The strongest predictor for being highly physically active, maintain a normal BMI and a high physical self-esteem three years later, i.e. to have a healthy lifestyle, was for boys a decreased BMI [exp(B) 0.753] and for girls increased physical self-esteem [exp(B) 1.835].

GENERAL DISCUSSION

Study design and sample

Data from all three countries, Sweden, Australia and United States was obtained from a convenience sample, narrow from a national point of view. Therefore it is important to be cautious when generalizing. Data of physical activity level was obtained during weekdays only, however, weekend and weekday data differ significantly (Tudor-Locke et al 2004), therefore including weekday and weekend data when monitoring is preferable (Trost et al 2000). Factors, such as genetic heritage and quality and quantity of energy intake, are not accounted for in this study although they all influence body composition (Hill and Peters 1998).

In Sweden in an attempt to compensate the lack of randomisation, we categorized the schools in three categories: countryside, suburb and city schools. A post-test analysis of the socio-economics of the schools revealed an overall medium socio-economic profile of the inhabitants in those school areas.

Physical Activity

Children seven to 14 years of age in south-eastern Sweden were highly physically active when measured as mean steps per day and compared to children in United States and Australia. Some explanations of the differences between activity levels in the three countries could be environmental as community design, socio-economic differences, school recess time and after school sport activities. Comparable pedometer determined results from Northern Wales (Rowlands et al 1997) and Belgium (Cardon and de Bourdeaudhuij 2004) are in line with the levels in south-eastern Sweden. Physical activity measured as mean steps per day and reported for cross sectional age groups, decreased as the children matured. However, the decline tends to stop earlier in girls.

When we compare the daily mean step for Swedish adolescents age 15-17 with those reported in United States (Wilde et al 2004), all from the similar geographical area as in the child sample, a gap between Sweden and United States seems to remain. Previously, a gender difference in physical activity has been reported (Rowland 1990, Sallis 2000, Ekelund et al 2000). This corresponds to the results in age group seven to 14 but not in age group 15-18. A wide variation in activity levels of youth in any age group and sex was found. Some participants accumulated about 7 000 step counts per day while others accumulated over three times as many steps per day. Cutbacks in mandatory physical education programs contribute to overall physical activity decline (Hill and Peters 1998). Relatively, this decline might be larger in the least active children and adolescents.

When the follow-up groups of 2000 and 2003 were compared a large and statistically significant drop in daily mean step was observed in boys. An average of 15 700 steps in 2000 is down on 11 200 three years later. This finding, of greatest decline in boys at age 12-16, corresponds to Finnish (Telema and Yang 2000) and Dutch (van Mechlen et al 2000) longitudinal recall studies. In girls no significant differences between levels of step per day over the three years were found. This was not in line with a longitudinal study by Kimm et al (2000) reporting a 21 percent drop in objectively measured physical activity in girls. An explanation for the large drop seen in boys might be that activity during recess time is reduced in secondary school, further that after school sport participation seems to decrease during age 12-15 in Swedish children and adolescents (Engström 2004).

Earlier research has mainly focused on physical fitness, i.e. capacity. A study that compared youth aged 16 1974 with 16 years old 1995 reveal a change in physical capacity. An increase of weight and lower extremity strength and a decrease in aerobic capacity and upper extremity strength was found (Westerståhl et al 2003). A decrease in aerobic capacity in boys but not in girls between 1987 and 2001 was reported (Ekblom et al 2004b). The results might indicate a tendency of decrease in physical activity. However, the relationship between physical activity and physical fitness is not clear. In a review of 20 studies, Morrow and Freedson (1994) reported a small to moderate relationship between physical activity and aerobic fitness in children and adolescents.

Using the definition of physical activity and objectively measure every day activity, few studies on children and adolescents in Sweden are available and none based on pedometer steps per day. Ekelund et al (2000) used a combination of accelerometers and heart rate registrations to compare the activities of youth aged nine and 15 with the recommendations of physical activity. Most of the children were physically active more than 30 minutes per day. If the demand should increase to recommended 60 minutes moderate to vigorous activity 85 percent and 65 percent of the children aged nine met the recommendation but in the 15 year old group only 60 percent of the boys and 45 percent of the girls met the recommendations.

A direct comparison of these results with the results from the present study can not be done since pedometers used in this study do not give information of intensity. However, studies by Wilde et al (2004) on adolescents and Cardon and de Bourdeaudhuij (2004) on children report that the participants meeting the recommendations for moderate and vigorous activity were those accumulating the most steps. Further, Tudor-Locke et al (2002a) in adult, report that approximately 8 000 pedometer steps per day were associated with a mean of 33 accumulated minutes of moderate-intensity activity as determined by accelerometer. In the present study, this level is exceeded by most children and adolescents.

The new perspective on health benefits of physical activity, the guidelines emphasising accumulated activity (USDHHS 1996) and the importance of goal setting and self-monitoring in behavioural change (Hall and Kerr 2001) all support pedometers as a research device. The low cost of the devices and the easiness to understand the outcome of the pedometer make it a bridge between research and practice, thus useful in tracking sedentary physical activity behaviour (Tudor-Locke and Myers 2001b).

When using pedometers for goal setting there are two main possible opportunities. The first is to measure a baseline and increase the daily step individually on a weekly basis for instance by 10 percent until a self-chosen comfortable and sustainable level has been reached (Pangrazi et al 2003). An adult is considered “highly active” if accumulating more than 12 500 daily steps, “active” between 10 000-12 499 steps and “somewhat active” between 7 500-9 999 steps (Tudor-Locke and Bassett 2004).

The other possibility is to give general recommendations. Recommended levels of steps per day should emerge from data related to important health outcomes. In Study IV, BMI was used, as an accepted indicator of relative obesity (WHO 1998). By using the contrasting group’s method (Safrit 1986) we were able to, preliminary, establish criterion-referenced standards. In age group seven to 12 years old, 62 percent of the boys and 72 percent of the girls met the pedometer determined BMI referenced standards of 15 000 and 12 000 steps respectively.

To correct interpret the activity levels we must consider the incapability of pedometers to detect common youth activities such as bicycling and swimming. Furthermore, we have to note the decrease in accuracy for pedometer at very slow walking, less than one mile per hour (Melanson et al 2004).

Body Composition

The prevalence of overweight/obese in children aged seven to 14 year (17.7% in boys and 19% in girls) and in adolescents 15-18 year (16.9% in boys and 16.6% in girls) in this study are in line with other studies in Sweden (Ekblom et al 2004a, Mårild et al 2004, Rasmussen et al 1999). In age group six to 12 more than 33 percent of the children in United States were classified as overweight/obese almost double the prevalence compared to Sweden and Australia.

The concern about the rapid increase in the percentage overweight and obese children and adolescents was an important factor for starting this multi-center study. Body mass index was used in this field setting research however, classifying body composition and comparing it in different ethnic groups raises questions since the prevalence of overweight and obesity differ among different ethnic groups (Deurenberg et al 1998).

By using Cole's scale, where BMI cut off points in six large nationally representative cross sectional growth studies were extrapolated to provide standards for overweight and obese children and adolescents two to 18 years of age, comparing BMI levels between countries was possible. However, the cut off points established by Cole et al (2000) have been criticised for over representing wealthy countries and for its selection of adult age at 18 years of age (Neovius et al 2004).

With regard to health risks, questions have been raised if BMI is an adequate method of measure body fat, the main cause of many health problems (SBU 2002, Viikari 2004, Deurenberg et al 2001). In the sample from 2003, a bioelectrical impedance analysis (BIA) was added to examine the relationship between BMI and body fat. A limitation of the BIA is the need to recalculate the free fat mass to get proper body fat data on 15-17 years old, further the need to follow special restrictions while gathering the data. In this study, BMI correlated good or very good to body fat in adolescents 15-18 years of age, except for 15 year old boys, maybe because some still are pre-pubertal. This might support BMI as a method in survey field studies.

Exact standards for allowable fat percentages have not been established (Wilmore and Costill 2004 p 666). However, Williams et al. (1992) have developed standards of body fat percent in children and adolescents aged eight to 18 suggesting that body fatness of 25 percent in boys and 32 percent in girls are associated with increased cardiovascular risk factors. Among the adolescents in Study V, 11 percent of the boys and 35 percent of the girls exceeded those recommendations. Using these body fat criteria provides lower levels of "at risk" boys than using cut off points by Cole et al (2000) however for girls, it will double "at risk" individuals. So while the BMI and BI analysed body fat levels show satisfying correlations in this study, the BMI cut points and the body fat cut points do not detect adolescents "at risk" equally.

Perceived Physical Self-esteem
In children there was a significant gender difference in total CY-PSPP score as well in all the sub-domains. The results are in line with what has previous been reported (Eccles and Harold 1991). This difference remains in the adolescent group regarding total CY-PSPP score and GSE. Stability over time in total CY-PSPP score as well as in the sub-domains was identified. The longitudinal design made it possible to follow 93 students over three years. The stability remained. This stability over time in both genders was in line with previous reported findings (Raudsepp et al 2004). In contrast, Lintunen (1995) found a gender difference in stability. An explanation might be that the followed students in the present study were older. Still the range of the total score revealed the existence of students with a low perceived physical self-esteem. To identify these individuals is a necessity for individualizing activity programs that might support an increase of perceived physical self-esteem.

In girls 10-14 years old, Body Attractiveness and Sport Competence and in 15-17 years old Sport Competence and Physical Condition showed the strongest correlation to PSW and to the total score. In boys 10-14 years old, Body Attractiveness and Physical Condition and in 15-17 years old Sport Competence showed the strongest correlation both to PSW and to total score. This finding suggests that when approaching adulthood competence in the physical domain, i.e. motor skills, is important for our perceived physical self-esteem.

Many factors are important for the individual level of daily physical activity for a healthy lifestyle such as cultural, social and personal factors (Engström 1999, Sallis et al 2000). By adding physical self-esteem, a personal factor formed by the social interactions between individuals, was included. The need for a scale validated for a wide age span and similar in the three countries, Sweden, Australia and United States, was the underlying motive to choose the CY-PSPP scale. By translating the questionnaire and test it for validity and reliability in Sweden we provided an instrument that could measure perceived physical self-esteem in Swedish children and adolescents.

When analysing the sub-domains of perceived physical self-esteem, a correlation against both total score on the CY-PSPP and to the PSW (level of hierarchal profile) was calculated. There was a small relative difference between the total score and PSW, which can depend on the fact that the six questions of the GSE, do not specifically relate to physical self-esteem, i.e. are higher in the hierarchy, see Figure 1.

Variable interactions

Physical Activity – Body Composition

The relation between physical activity levels and body composition was analysed in several ways. In Study I, III and V, when dividing in age groups and sex no correlation between BMI and steps per day was found.

In Study III, when the sample was divided in physical activity tertiles a trend towards that the number of youngsters classified as obese or overweight increased as activity level, by tertile group, decreased. In the United States and Sweden, the frequency of overweight/obese children significantly differed from the expected frequency. A significantly greater number of overweight/obese was found in the least active tertile. Boys and girls in the most active tertile group showed much smaller BMI differences between youngest and oldest age group when compared to the least active. In Study IV, analysis between overweight/obese and normal weighted in different age groups six to 12 showed a significant difference in steps per day.

The findings in Study I, III and V of no correlation between physical activity and BMI were not in line with previous research with pedometers (Rowlands et al 1999). Normally, a comparison is performed between activity levels of high BMI and normal BMI groups and argues can be raised that it makes no sense in studying the correlation between normal weighted. Further, using pedometers that are unable to show intensity of the activity might not be able to detect normal weighted, vigorously active children with low level of step per day. Using accelerometers, Ekelund et al (2002) reported that obese adolescents spent less time in moderate to vigorous activity than normal weighted controls. Ekblom et al (2004a) emphasise the strong increase in BMI levels of the upper quartile when explaining the BMI increase in Sweden over the past 14 years.

While physical activity is important in preventing weight gain, physical activity alone does not seem to result in weight reduction (Welk and Blair 2000, Wing 1999). Physical activity is only one factor in the complex picture of weight management. Diet, genetic heritage and behavioural factors all have an influence on body composition. On the other hand, physical activity offers metabolic adaptations that benefit health even without a measurable decrease in weight (USDHHS 1996).

Focusing on an increase in physical activity rather than a decrease in body weight might be a more constructive approach for children and adolescents. It avoids the stigma placed on these youngsters when weight alone is the central point. Adding increased activity to sedentary individuals can have a strong impact on their health status. Identifying at-risk individuals early in life offers an opportunity to change lifestyle patterns during this malleable time of life.

The large drop in physical activity in boys during these important years might be a reason of concern itself. However, they might still have a "buffer" to levels critical for weight control. Still there are no body constitution referenced standards for recommended pedometer determined steps for adolescents.

In Study IV, the first health related criterion-referenced standards for children, more than 12 000 steps per day for girls and more than 15 000 steps per day for boys, were set. Although some may argue that it is socially irresponsible to advocate separate recommendations based on sex, sex-related differences in objectively monitored physical activity have been consistently reported (Rowlands, et al 1999, Vincent and Pangrazi 2002) and therefore cannot be ignored. One weakness in making this recommendation is that physical activity is not the only contributor to weight status. It is reasonable that boys must take additional steps per day to accommodate sex-related differences in energy intake (Crespo et al 2001).

Physical Self-esteem – Physical Activity

The correlation between physical activity, measured as daily mean steps and perceived physical self-esteem, was poor to fair in Study III (10-14 years of age) as well as in Study V (15-17 years of age). These results were further supported by the multiple regression analysis as in 10-14 year old boys self-perceptions predicted just 20 percent of the variance in physical activity and only 4 percent in girls.

A higher correlation was seen between physical self-esteem and performance related fitness, tested as shuttle run (Raudsepp et al 2002) than between accumulated steps per day and physical self-esteem in the present study. To accumulate daily steps may be regarded as a process related physical activity, which does not seem to be strongly dependent on our physical self-esteem. These are important findings when it comes to promote alternative physical activity to individuals with low self-esteem.

To help individuals at risk, i.e. individuals with low physical self-esteem, obtain health benefits of physical activity there might be two possible ways. One way may be to present physical activity programs that apparently do not require high physical self-esteem. The other alternative may be to provide activity programs that help increasing the level of physical self-esteem. Lindwall (2004) showed increasing levels of perceived physical self-esteem after a six month intervention program in adolescent girls. In that program, twice a week a self-chosen 45 minutes exercise session was followed by 15 minutes healthy life style discussions.

Cornerstones in activity programs for supporting and increasing physical self-esteem are, according to Whitehead and Corbin (1997 p 183), programs" that unconditionally support task mastery and minimize external control and ego involvement, i.e. comparison with the ability of the peer, they are likely to lead to the development of a healthy sense of self and to encourage the most desirable types of motivation".

Perceived Physical Self-esteem – Body Composition

For both sexes aged 10-14 years and for girls aged 15-17 years there were a fair negative correlation between total CY-PSPP score and BMI. In boys 15-17 years of age, there was a poor negative correlation. Both in the child and the adolescent sample there was an obvious gender difference with a stronger negative correlation between as well PSW score and BMI as total score and BMI in girls. In the 10-14 year group, self-perceptions predict seven percent of the variance in BMI in boys but 26 percent in girls. These findings are in line with gender difference (Eccles and Harold 1991) and lower self-esteem in obese adolescents (Strauss 2000, Rasmussen et al 2004).

In boys in 10-14 years old, Body Attractiveness and Sport Competence and in these 15-17 years old Physical Condition showed the strongest negative correlation to BMI. In girls Body Attractiveness and Sport Competence were the sub-domains most negatively correlated to BMI in both 10-14 and 15-18 years of age. Interestingly, Physical Strength was not negatively correlated to BMI level in 15-18 years old. In those years adding strength training to activity programs might attract individuals with high BMI and low physical self-esteem.

Predictors
To evaluate the most important predictor for healthy life style variables logistic regression analysis of the independent variables, daily mean step in intervals of 1000, BMI in integers and total physical self-esteem scores in tens was performed.

Since the adolescents are approaching adulthood, the 12 500 adult cut point (Tudor-Locke and Bassett 2004) was chosen to identify health related physical activity (dependent category). The interval used was 1 000 step which is approximately 10 minutes of activity (Tudor-Locke 2002). The strongest predictor for reaching the 12 500 step per day goal was the level of daily mean steps measured three years earlier.

A decrease in BMI level was the strongest predictor to stay normal weighted (dependent category) three years later. This supports the connection between high levels of BMI and future overweight. Guo and Chumlea (1999) showed that overweight at 35 years old could be predicted from BMI excellently at age 18, well at aged 13 but only moderately at ages below 13 years of age.

When analysing perceived physical self-esteem using the Swedish translation of the CY-PSPP scale, a 10 points change was chosen to have the possibility to detect a difference outside the limits of the error of measurement of the scale which was set to 4.23 points. "To belong to the upper half" regarding physical self-esteem was assumed to be a healthy physical self-esteem level (dependent category) and in girls the strongest predictor for this goal was perceived physical self-esteem. For boys, however a decrease in BMI was the strongest predictor to have a healthy physical self-esteem three years later.

Finally, those indicators for a healthy lifestyle were combined (dependent category) and the strongest predictor for adolescents to be highly physically active, normal weighted and with a healthy perceived physical self-esteem three years later were for girls increased physical self-esteem and for boys decrease in BMI.

Further research
It is important to continue studies with focus on children, adolescents and adults in a larger randomised national sample. That will help to survey changes in activity levels and body composition that might influence health status. The study design allows continued longitudinal research. To establish criterion-referenced pedometer standards for other health criterion such as blood pressure, glucose tolerance and blood lipid may be reachable.

Concluding remarks

Putting together these findings, an increase of daily step to expect a high level of physical activity and the decrease in BMI to predict later normal weight we asked the question what can be done? First, to promote an increase of physical activity is crucial since this itself predicts high physical activity and is an important factor for weight control. Secondly, to support weight control program for school adolescents with “at risk” BMI levels is important. On the other hand, physical activity offers metabolic adaptations that benefit health even without a measurable decrease in weight (USDHHS 1996). Focusing on an increase in physical activity rather than a decrease in body weight might be a much more constructive approach for children. It avoids the stigma placed on these youngsters when weight alone is the focal point. Criterion-referenced recommendations might help in goal setting for professionals, such as physiotherapist and physical educators, working with children and adolescents at risk for obesity.

Further, perceived physical self-esteem is an important predictor and recent research indicates the possibility to increase its level in adolescent girls with physical activity intervention program (Lindwall 2004). For professionals, working with physical activity it must be a goal to construct physical activity program that promote the perceived physical self-esteem. Since perceived physical self-esteem contains both perceptions of abilities in physical fitness and strength, sense of body attractiveness and sport competence this model ought to be built up to promote broad variety of motor skills combined with moderate to vigorous intense in physical strength and physical fitness. This must be carried out throughout the school years but when approaching adulthood sport competence should be emphasized to increase physical self-esteem and thereby increase the motivation to be and stay physically active.

“Do not always follow the common way.
Take a different path and leave footprints”
Unknown

CONCLUSIONS

- In children seven to 14 years of age, boys had a mean BMI between 16-20 kg/m^2 and averaged 14 911-18 346 daily steps and girls had a mean BMI between 16-21 kg/m^2 and averaged 12 238-14 825 daily steps.
  In adolescents 15-18 years of age, boys had a mean BMI between 20-23 kg/m^2 and averaged 11 336-13 315 daily steps and girls had a mean BMI between 21-22 kg/m^2 and averaged 11 887-12 875 daily steps.

- In children, boys were significantly more active than girls in all age groups. Few significant correlations were found between the age groups. In adolescents, no significant gender differences were found. No significant differences were found between the age groups. No significant correlation was found between physical activity and BMI in any age group and sex in children and adolescent.

- The Swedish translation of the Children and Youth Physical Self-Perception Profile had an acceptable reliability as well as concurrent and content validity.

- In children, boys and girls physical self-esteem score ranged from 51-144 (median 96) and 54-140 (median 96), respectively. Boys scored significantly higher totally as well as in all sub-domains of the scale. In adolescents, boys and girls physical self-esteem score ranged from 75-140 (median 109) and 72-136 (median 102), respectively. Boys scored significantly higher totally and in sub-domain global self-esteem.

- In children and adolescents there was a fair to poor correlation between physical activity and physical self-esteem. Between physical self-esteem and BMI there was a fair to poor negative correlation.

- Swedish children accumulated the most daily steps compared to Australian and American children. Swedish and Australian children maintained a healthier weight throughout their pre-pubescent years than did American children.

- BMI criterion-referenced cut points indicated for each sex and age group, the optimal median cut point for steps per day for six to 12 year olds to be 12 000 steps per day for girls and 15 000 steps per day for boys.

- The correlation between BI analysed body fat and BMI was moderate in boys aged 15 and very good in boys aged 18 and girls age 17. In all other age groups, the correlation was good.

- The strongest predictor to be highly physically active, maintain a normal BMI and a high physical self-esteem three years later, was for girls increased physical self-esteem and for boys a decreased BMI.

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