DIPLOMARBEIT

Titel der Diplomarbeit

Comparison of Motor Abilities and Anthropometric Data of School-Aged Children with and without a Background in Competitive Sports

Verfasser

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Foreword

An erster Stelle möchte ich herzlichst meinem Betreuer Harald Tschan für die Unterstützung und seinen Beitrag zum Gelingen dieser Diplomarbeit danken.

Da diese Arbeit im Rahmen eines Projektes des Bundesministeriums für Wissenschaft und Forschung entstanden ist, möchte ich allen Beteiligten, in besonderem Barbara Wessner für ihre Hilfestellung, meinen Dank aussprechen.

Ich könnte jedoch heute nicht das Vorwort zu genau dieser Diplomarbeit schreiben, hätte mich mein Studienfreund Christian „Pezi“ Polt nicht vor knapp einem Jahr davon in Kenntnis gesetzt, dass ein Diplomand für das Projekt „Körperliche Aktivität macht Schule“ gesucht wird.

Und all jenen, denen mein Abschluss Freude bereitet ein herzliches

DANKE

Abstract

Background: Overweight, obesity and their relation to inactivity has been intensively studied during the last decade. Many studies show an alarming increase of children and adolescents with overweight and obesity as well as health problems and chronic diseases. Reduced physical activity and an increase in sedentary habits of children and adolescents are only two out of a few reasons which may result in the effects mentioned above.
Exercise performance in motor ability tests and skill tasks have also shown to decrease since children and adolescents reduce the amount of physical activity and prefer inactive leisure and recreational activities. Consequences are reduced physical performances and an increase of overweight and obesity in children and adolescents.

Purpose of the study: The study aims to compare school children attending a regular high school with those attending a specific school-type for elite sports concerning their performance in motor ability tests and concerning their anthropometric parameters as well as health parameters.

Methods: Motor abilities of more than 300 children aged 10-18 years were tested within the project “Körperliche Aktivität macht Schule” using a modified version of the EUROFIT Test (20m-shuttle run, cycle ergometer test, 20m sprint, sit and reach test, single leg balance test, MFT S 3-Balance Check, standing broad jump, vertical jump test, handgrip strength, medicine ball throw). In addition anthropometric tests were performed using calliper method, infrared, circumference measurement, body mass and height. Statistical comparisons were performed between school types and age-groups.

Results: Children and adolescents attending an elite sports school demonstrate higher performance throughout all motor ability tests. Statistical significant differences vary between the age groups but are very strong in girls between the ages from 14 to 16 yrs and in boys below the age of 12 yrs and above the age of 16 yrs. Children and adolescents with greater amounts of sports activities perform better in motor tests and the prevalence of overweight and obesity in children within the elite sports school is lower than in the regular school. For further studies it would be recommended to have a more representative sample.

Abstract (in German)

Problemstellung: Übergewicht, Adipositas und ihre Beziehung zu einer verminderten körperlichen Aktivität sind während des letzten Jahrzehnts intensiv untersucht worden. Viele Studien zeigen eine beunruhigende Zunahme von Kindern und Jugendlichen mit Übergewicht und Adipositas sowie eiern Zunahme von Gesundheitsproblemen und chronischen Krankheiten. Reduzierte körperliche Aktivität und eine Zunahme von sitzendem Verhalten bei Kindern und Jugendlichen sind nur zwei von vielen Gründen, welche auf die zu den oben erwähnten Effekten führen können.
Erbrachte Leistungen in sportmotorischen Tests sind zurückgegangen, da Kinder und Jugendliche in ihrer Freizeit lieber weniger körperliche und weniger anstrengende Aktivitäten bevorzugen. Die Folgen sind eine reduzierte körperliche Leistungsfähigkeit sowie eine Zunahme von übergewichtigen und fettleibigen Kindern und Jugendlichen.

Ziel der Studie: Die Studie vergleicht die körperliche Leistungsfähigkeit in sportmotorischen Tests sowie anthropometrische als auch gesundheitliche Parameter von Schulkindern, welche einerseits in ein normales Gymnasium und andererseits in ein Gymnasium für Kinder mit leistungssportlichem Hintergrund gehen.

Methodik: Motorische Fähigkeiten von mehr als 300 Kindern im Alter von 10-18 Jahren wurden innerhalb des Projektes "Körperliche Aktivität macht Schule" mittels eines modifizierten EUROFIT-Tests geprüft (20m-shuttle run, Rad Ergometrie, 20-m Sprint, Sit&Reach Test, Einbeinstand, MFT S 3-Gleichgewichts-Check, Standweitsprung, vertikaler Sprung-Test, Handynamometrie, Medizin-Ball-Wurf). Außerdem wurden anthropometrische Tests durchgeführt wie Hautfaltenmessungen, Infrarotfettmessung, Bauch- und Hüftumfang, Gewicht und Größe. Statistische Vergleiche wurden zwischen Schultypen und Altersgruppen durchgeführt.

Ergebnis: Kinder und Jugendliche, welche eine Schule für Leistungssportler besuchen haben Vorteile in allen sportmotorischen Tests. Statistische Unterschiede variieren in den einzelnen Altersgruppen, allerdings sind sie am stärksten bei den Mädchen im Alter von 14 bis 16 und bei den Jungen unter 12 sowie über 16 Jahren. Kinder und Jugendliche welche sich häufiger sportlich betätigen schneiden besser bei sportmotorischen Tests ab und das Vorherrschen von übergewichtigen und fettleibigen Kindern innerhalb dieses Schultyps ist niedriger als im regulären Gymnasium. Für weitere Studien wäre es empfehlenswert, eine repräsentativere Stichprobe zu wählen.

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1. Introduction

Recent studies have demonstrated that overweight and obesity are strongly related with inactivity, sedentariness and the environmental habits of children and adolescents (Trost et al., 2003). The risk for overweight and obesity in children is high and directly tracks into overweight and obesity in adults with an increase of chronicle diseases and health problems (Sallis et.al., 1992; Malina, 1996).

But not only those who face these circumstances are affected, the whole social economy, the government, all other people have to deal with higher cost for the public health service.

Therefore we should try to make children and adolescents aware of the risks of inactivity as well as how a healthy lifestyle should look like (Wright et al., 2008). In return, healthy grownups will influence the lifestyles of their own children, which may save a lot of money for the governments' health treatments.

Looking at the timetables of Austrian school children these days, it seems that the importance and power of physical activity and a healthy lifestyle has not been realized in our society. Physical education (PE) lessons were decreased years ago to save money within the Austrian school system (RH, Bund 2009/1)

It is important to convince people who make decisions of the sustainability of the long term effect of increasing the amount of PE lessons again, and even if not the PE lessons then at least the opportunities for children and adolescents to be more physically active (Jannsen, I., 2007).

In Austria the demand for schools with a sport background has risen since parents have realised the importance of their children's sports habits. But until now, there are still few sports schools, and often it is quite expensive to attend those. Some of the schools are special made for elite sports athletes which may raise a question about the sense and necessity of sending 10 year olds to those. Is elite sport in that very young age period still healthy one might ask.

Another argument could be that many young elite athletes drop out early and are fed up with the sport for the rest of their lives (Smoll & Smith, 1990).

No matter how, a very important task is to offer children and adolescents a wide range of physical activities, while making them aware how important it is to live a healthy live not only for themselves as well as for the whole community.

The present pilot study was assessed within the project "Körperliche Aktivität macht Schule" which is one out of 67 projects funded by the Austrian Federal Ministry of Science and Research. Under the name "Sparkling Science" more than 7000 pupils from all over

Austria are involved in these projects, as the main interest of the ministry was to link schools with research departments. Children and adolescents from 10 to 19 years of age can experience how research in certain fields is done and hopefully their enthusiasm for a later scientific study at a university will rise.

In the current study, 7 pupils from the selected school were included to support our team in data collection, analysing as well as for presenting results at a book fair.

“Körperliche Aktivität macht Schule” aims to assess an anthropometric, immunological and physiological profile of the pupils, which in return may give information about physical activity habits, health parameters and possible correlations between physical efficiency and health status.

After the first testing session, an intervention class at school will be established, where pupils will be more physically active during education. It is planned to install fixed cycle ergometers, where pupils can cycle during lessons at a comfortable intensity. After one year of that intervention, another testing session is due to assess possible improvements in performance and health benefits.

This master thesis will concentrate on the first testing session. It will determine the status quo of a selected sample size of the school of either school type analyzed, regular and elite sports school respectively. In the first part, the introduction, background knowledge will be described such as how physical activity is defined and why it is important to be physically active. Metabolic risk factors shall point out the necessity of a healthy lifestyle, starting with interventions as early as possible in young children’s lives. Recommendations of PA for children and adolescents will be discussed followed by an outline of PA habits and health status of Austrian school-aged children. The Austrian school system will be described and the question, how many sports schools in Austria exist at the moment and how many active lessons Austrian pupils on average have at school will be explained.

In the second part of the thesis, the setting of the study will be described. Sample school, sample size and methods of tests will be introduced and the research questions will be formulated. Descriptive statistics followed by a comprehensive representation of the results will lead to the discussion of the given findings.

2. Theoretical Background

Physical activity (PA) in clearly defined contexts such as active transport, school physical education, and organised sports is declining in many countries (Dollman et al., 2005). Even though many people know that regular exercise helps to stay healthy, nevertheless most of them have a largely sedentary lifestyle. This resulting lack of exercise increases the risk of chronic disease such as obesity, high blood pressure, type II diabetes, coronary heart disease to name only a few (Fogelholm, M., 2008). A survey made in Austria shows that more than two thirds of the Austrian population aged 15 years and older spend less than 3 times on physical exercises per week. Whilst the difference between sex is very high in the age from 15 to 29 years (42.1% active men vs. 25.5% active women), the difference aligns in ages from 30 to 74 years and increases again from 75 years and older. In general, there is a steadily decrease in activity in both men and women (Statistics Austria, 2007).

This trend of a decrease of PA and an increase of sedentariness is also seen especially in children and adolescents where activity habits have been changed due to a changed lifestyle (Matton et al., 2007). With all the disadvantages of being less physically active as mentioned above, the performance in motor ability tests might also be lower for children and adolescents with a lower physical activity level, a question which this present study is trying to answer.

2.1 Physical Activity – Definitions

PA is a very clear defined term nowadays. It is not only about physical movement, like walking, jumping, running etc. PA is also related with factors relevant for health, as the following definition describes.

On the website of the WHO (World Health Organisation, 2009), PA is defined as

“Any bodily movement produced by skeletal muscles that requires energy expenditure.” (Bouchard et al, 1990, p.6)

Furthermore, a lack of physical activity, called physical inactivity, is an independent risk factor for chronic diseases, and overall is estimated to cause 1.9 million deaths globally. (WHO, 2009)

Physical activity

- is a key determinant of energy expenditure which is fundamental for energy balance and weight control
- reduces the risk of coronary heart disease and stroke
- reduces the risk of Type II diabetes
- reduces the risk for colon cancer and breast cancer among women (WHO, 2009)

Many studies ask for an increase of PA (Steele et al., 2008; Zahner et al., 2006; Biddle et al., 2004), especially at an early age, as active or sedentary habits are formed already in childhood and risk factors mentioned above might track into adulthood (Hurtig-Wennlöf et al., 2007; Kristensen et al.,2006).

PA does not equal PA. PA differs in terms of complexity, precision of execution, power and speed of motion. On the basis of human energy expenditure, PA is divided into light intensity, moderate intensity and vigorous intensity activities. A commonly used concept is called MET (Metabolic Equivalent of Task), where human activities are expressed in energy cost as multiples of resting metabolic rate. The resting metabolic rate is set at 1 MET which equals an oxygen uptake of approximately 3.5ml O_2 per kg and per minute and is comparable to a person quietly sitting. As written above, PA is classified into following grades (Ainsworth et al, 1993):

- light intensity PA: <3 MET like sleeping, watching TV, writing, walking slowly
- moderate intensity PA: 3 – 6 MET like bicycling slowly, moderate gymnastics, hiking
- vigorous intensity PA: >6 MET like track and field, alpine skiing, elite sports

In summary, everything we do in our life, even if we are active or not active, is a subject to energy expenditure. Intensity of activity is therefore a reliable indicator whether the action is supporting our health or not.

2.2 The Metabolic Syndrome

Maybe the most important argument to support and ask for more PA of children and adolescents, even adults, is the fact that being not physically active, highly increases the risk of getting serious diseases (Steele et al., 2008; Rizzo et al., 2008).

Development of cardiovascular disease and diabetes affects one out of five people and increases with age according to Statistics Austria in 2007. There are some different interpretations of what risk factors the metabolic syndrome consists of, but a very common one used is the one from the National Cholesterol Education Program (NCEP) which is an expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). Following risk factors and defining levels are relevant:

- waist circumference (abdominal obesity): women > 88cm, men>102cm
- elevated triglycerides: ≥150mg/dl
- decreased HDL cholesterol: women <50mg/dl, men <40mg/dl
- high blood pressure: ≥130/≥85 mm Hg
- fasting glucose: ≥110mg/dl

A very important factor is missing here. The amount and intensity of PA should be included in these guidelines because PA is probably the key to prevent all these risk factors with all possible diseases.

Opper et al. (2005) wrote that this risk factor “lack of exercise” is closely associated with motor performance and fitness of children and adolescents. Moreover they assume that being inactive might lead to

- deficits in endurance, strength and coordination performance
- postural deformity due to lower motor ability
- increase of accidents at home or in leisure activities
- increase in under- and overweight children and adolescents
- increased malnutrition
- delay in language development, behavioural disorders and stress.

Sedentary children and adolescents, as well as adults, face a lot of risks for their health. Many studies and intervention programmes try to solve the problem and try to increase the amount of PA of children and adolescents, which is obviously a very important task in terms of children´s and adolescents´ health.

An often used measurement to define and compare children´s and adolescents´ body composition is the so called body mass index (BMI). BMI is a simple index of weight-for-height that is commonly used to classify underweight, overweight and obesity in adults. It is defined as the weight in kilograms divided by the square of the height in meters [kg/m²] (WHO). BMI is a well accepted measurement for body fat mass with high correlations between BMI and skinfold thickness of children, adolescents and adults. (Micozzi et al., 1986; Spyckerelle et al., 1988).

Table 1 shows BMI values with common cut-off points for adults.

Table 1: The International Classification of adult underweight, overweight and obesity according to BMI

Classification	BMI (kg/m²)	
	Principal cut-off points	Additional cut-off points
Underweight	<18.50	<18.50
Severe thinness	<16.00	<16.00
Moderate thinness	16.00 - 16.99	16.00 - 16.99
Mild thinness	17.00 - 18.49	17.00 - 18.49
Normal range	18.50 - 24.99	18.50 - 22.99
		23.00 - 24.99
Overweight	≥25.00	≥25.00
Pre-obese	25.00 - 29.99	25.00 - 27.49
		27.50 - 29.99
Obese	≥30.00	≥30.00
Obese class I	30.00 - 34-99	30.00 - 32.49
		32.50 - 34.99
Obese class II	35.00 - 39.99	35.00 - 37.49
		37.50 - 39.99
Obese class III	≥40.00	≥40.00

Source: Adapted from WHO, 1995, WHO, 2000 and WHO 2004.

As body composition of children and adolescents changes with age, cut off points for children and adolescents need to be adapted. Kromeyer-Hauschild et al. (2001) recommend the use of percentiles as reference to asses under- and overweight (obesity) in German children and adolescents. In the guidelines of the “Arbeitsgruppe Adipositas im Kindes- und Jugendalter”(AGA) the 90th and 97th BMI percentiles as calculated in their reference population are proposed as cut-off points for the definition of overweight and obesity in German children and adolescents. Analogical to the overweight and obesity percentiles, the 3rd and 10th percentiles are recommended to be used as cut-off points for severe underweight and underweight. In figure 1 and figure 2 determined BMI percentiles are presented by sex and age. These figures explain that a normal BMI calculation would not be adequate for children and adolescents. For children and adolescents it is important to consider gender-specific and age-relevant changes for BMI calculation and further definition of underweight, overweight and obesity.

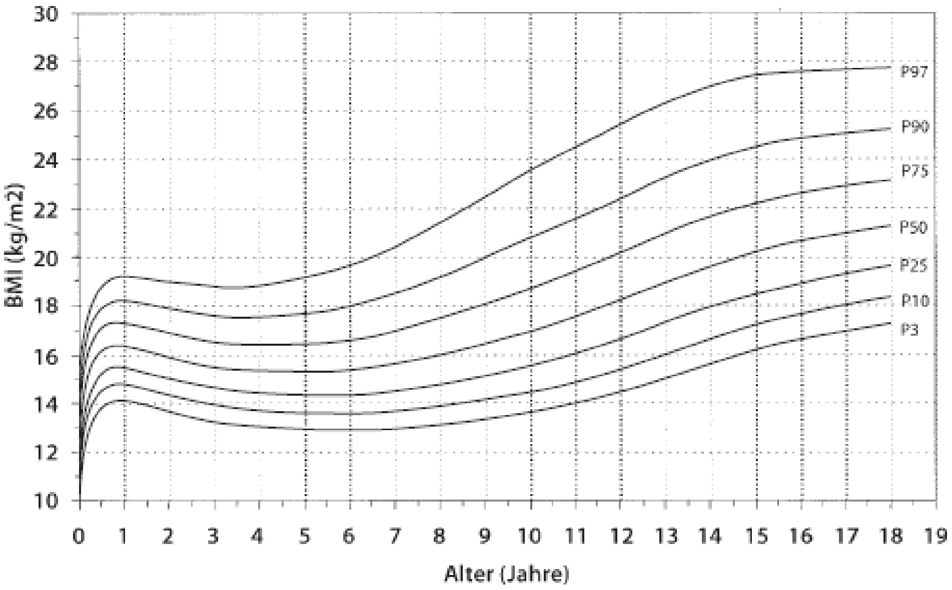


Figure 1: Percentiles for BMI of girls aged between 0-18 years (Krohmeyer-Hauschild, 2001)

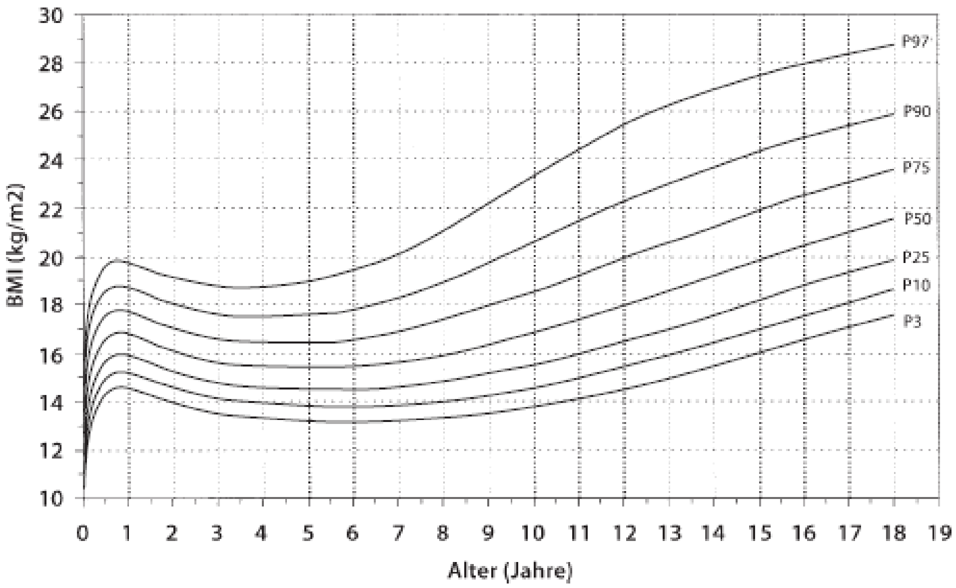


Figure 2: Percentiles for BMI of boys aged between 0-18 years (Krohmeyer-Hauschild, 2001)

Percentiles indicate how many % of children of same age and sex have lower BMI´s. For example the 90th percentile for 10 year old boys is at a BMI of nearly 21 which means that 90% of children have a lower BMI while 10% have a higher BMI than 21. Those children above the 90th percentile are supposed to be overweight. All other percentiles work following the same procedure.

2.3 Recommendations for PA

In the following chapter, some recommendations of amounts of PA for children and adolescents will be discussed. How much sport, or more exactly how much PA at which intensity is necessary for children and adolescents.

Strong et al. (2005) concluded that school aged youth should participate 60 minutes or more of moderate to vigorous physical activity that is developmentally appropriate, enjoyable, and involves a variety of activities. Many interventional studies indicate specific amounts of physical activity necessary for beneficial changes in the skeletal health, aerobic fitness, and muscular strength and endurance of youth, and in adiposity in youth who are overweight. They talk of 30-45 min of continuous moderate to vigorous PA for 3 to 5 days a week, which according to Strong et al is not enough.

A more recent study from Denmark came to the result, that common recommendations of at least 1 hour of moderate to vigorous activity is not enough to prevent children and adolescents from risk factors like high blood pressure, diabetes or adiposity. A cross-sectional study of 1732 randomly selected 9-year-old and 15-year-old school children from Denmark, Estonia, and Portugal, called “The European Youth Heart Study” revealed that 90 minutes of daily activity might be necessary for children to prevent insulin resistance, which seems to be the central feature for clustering of cardiovascular disease risk factors (Andersen et al., 2006).

The U.S. department of health and human services 2008 stated more detailed how the amount of PA for children and adolescents should be composed. They also refer to the quantity of at least 1 hour or more of daily PA (Strong et al., 2005). For aerobic purposes, most of the 60 or more minutes a day should be either of moderate or of vigorous intensity aerobic PA, and should include vigorous intensity PA at least 3 days a week. Furthermore, muscle strength exercise should be a part of these 60 or more minutes of daily PA. Children and adolescents should include muscle strengthening PA on at least 3 days a week. Last but not least, bone strengthening PA should be included on at least 3 days of the week as well as part of their 60 or more minutes of daily PA.
A very important factor is to encourage young people to participate in physical activities that are appropriate for their age, that are enjoyable and that offer variety, the department of health and human service recommended as well.

2.4 Positive Effects of PA in Children and Adolescents

Many positive effects of PA have been described in the recent years. For children and adolescents it is an essential piece of a puzzle for a healthy and ideal growing up and maturation phase.

2.4.1 Diabetes

Occurrence of type II diabetes has risen in the last decades (Yach et al., 2004). Adiposity is meant to be a major factor or the trigger for that increase. But there is also strong evidence that a sedentary lifestyle with the effect of inactivity is responsible for the numerous cases of additional type II diabetics (Hu et al., 2004; Zimmet et al., 2001).
Studies show that active people have a lower risk of 30 to 50 percent to develop diabetes compared to their sedentary counterparts (LaMonte et al., 2005). PA is a possibility to slow down or even better to prevent people with glucose intolerance to develop diabetes. Even those already facing diabetes have been shown to have health benefits from increased PA as well. Studies revealed a small, but significant improvement of blood glucose values of diabetics who were at least physically active 3 times a week for more than 30 to 40 minutes by biking or walking (Kavookjian et al., 2007).

2.4.2 Cancer

To be physically active seems to reduce the risk for developing cancer as well, whereby moderate to vigorous intense activities offer the best protection. An example states that physically active people reduce the risk for developing large intestine or rectal cancer by 40 to 50% (Lund Nielsen et al., 2001). PA may have a positive influence on other cancer types as well, evidence is being collected at the moment.

2.4.3 Musculoskeletal Health

Dysfunctions or diseases which affect muscles or bones like inflammations of bones and joints, back pain or osteoporosis can have therapeutic advantages through periodical PA. PA enhances building stronger muscles, tendons and ligaments and denser, which means stronger bones. Especially for children and adolescents PA is an important factor to increase bone density and bone size (Boot et al., 1997). For adults, PA is substantial to uphold bone density and to slow down the decrease during aging. PA can help to prevent osteoporosis or delay the breakout, but not degenerate once developed osteoporosis (Vuori, 2001).

2.4.4 Mental well-being

Scores of studies document that PA reduces the risk of clinical depressions and can be as effective as traditional treatment such as psychotherapy (Fox, 1999). Regular PA over a period of years can decrease the risk of recurring depressions as well (Dunn et al., 2001). PA also improves the mental well-being in persons who suffer from emotional disturbance. Positive effects of PA on subjective well-being, mood and emotion as well as self perception have been shown in many studies (Biddle, Fox & Boutcher, 2000).
Further, moderate and vigorous intensity activities and training reduce anxiety, improve reactions on stress along with an improvement of quality and length of dormancy. It also has been shown that PA improves aspects of brain function like planning, short term memory and decision making, which is of big importance not only in children and adolescents (Kramer et al., 1999).

Summarized, the effects of PA are shown in table 2.

Table 2: Effects of PA

Lifespan	ΔΔΔ
Risk for cardiovascular diseases	∇∇∇
High blood pressure	∇∇
Risk to develop cancer	∇∇
Risk to develop type II diabetes	∇∇∇
Arthrosis	∇
Bone density in children and adolescents	ΔΔ
Weight control	Δ
Anxiety and depression	∇
General well-being and quality of life	ΔΔ

Source: US Department of Health and Human Services (1996)

Δ: weak evidence, that PA increases this variable

ΔΔ: moderate evidence, that PA increases this variable

ΔΔΔ: strong evidence, that PA increases this variable

∇: weak evidence, that PA decreases this variable

∇∇: moderate evidence, that PA decreases this variable

∇∇∇: strong evidence, that PA decreases this variable

PA has a wide range of positive effects on the physiological and psychological side of children and adolescents as explained before. Which possibilities are there to make them move? It seems obvious that the role of the school is very important here. Other options would be to increase the offer for sport facilities and playgrounds for children or to bring them to sports clubs or to motivate them to other forms of extracurricular sports where children and adolescents have the chance to be physically active during the week. But do these efforts have an effect on children´s habits? Are children who participate in school or leisure programs healthier? Do they perform better in motor tests? The following chapter will give some answers to these questions by presenting some studies of extracurricular and leisure physical activities.

2.5 Physical Education and Extracurricular Sports Activities

There has been a lot of discussion about extracurricular sports activities to promote PA. A common opinion is to increase the amount of physical education (PE) lessons in schools. Klaes et al. (2003) stated that in every motor test of their movement check up, pupils having only 2 hours of PE per week performed significantly worse than pupils having 3 or more PE lessons per week. In the female group the results were strongly influenced by the amount of PE lessons, the more the better. In the male group, however the correlation was only weak. As explained before, children and adolescents should be active for at least 60 minutes or more at a moderate to vigorous intensity, schools would offer a perfect setting in this respect. Unfortunately additional PE lessons have not been added so far to the curriculum.

Another alternative, which was researched by Boyle-Holmes et al. (2009) was to develop a new PE curriculum. Fourth and fifth grade students were exposed to the so called Michigan Exemplary Physical Education Curriculum (EPEC). The question was, if those students who were taught according to the new curriculum would demonstrate stronger motor skill-specific self efficacy and perceptions of PA competence, PA levels, motor skills and physical fitness than students exposed to the common PE curricula. Compared to students receiving standard PE, students exposed to EPEC showed significantly better results in motor skills but not in fitness outcomes. Generally EPEC was significantly more effective than standard PE curricula at improving motor skill performance in both grades and at increasing self-reported motor skill-specific self efficacy and PA levels in the fourth grade.

As some other studies, this one demonstrated that a school-based PE curriculum can improve motor skill proficiency without loss of PA. But the students did not become more physically fit than other students during the 2 years study period, which might only be possible by offering additional PE lessons or extracurricular sports activities.

This has been demonstrated in an intervention study from Carrel et al. (2009). The aim of this study was to determine whether a school-based fitness program improves body composition, cardiovascular fitness (CVF) and blood markers. 35 non-obese children aged approximately 12 years were enrolled in a fitness oriented gym class. The frequency of these special PE lessons was five times every 2 weeks for a 45 minute period. They also modified the curriculum to encourage student participation by de-emphasizing competitive games and replacing them with lifestyle focused activities such as walking or cycling. Very important was to break up the class into small groups to promote more movement and less “watching the others” time. After 9 months of gym classes, a post-treatment assessment of all study outcomes was obtained. The results were that school-based fitness oriented curriculum improved body composition and insulin sensitivity, increased CVF and decreased inflammation in non-obese children. The study demonstrated that both obese and non-obese children can benefit from school-based fitness curricula. Even this small change in the amount of PA showed beneficial effects and brought the evidence, that PA is very important for health of children and adolescents.

In another study, an increase of the amount of PA by implementing PA in existing lessons (Donnelly et al., 2009) was described. The primary aim was to increase PA sufficiently to reduce gains in BMI. Secondary aims were to assess changes in metabolic fitness, aerobic capacity, skinfolds, circumferences, daily PA, diet intake and academic achievement in children who received PAAC. Physical activity across the curriculum (PAAC) promoted 90 minutes per week of moderate to vigorous physically active lessons delivered intermittently throughout the school day. Special trained teachers got support from research assistants in the design and delivery of PAAC. After 3 years of intervention, there was no significant difference in BMI assessed. However, change of BMI was significantly influenced by exposure to PAAC. Schools with more than 75 minutes of PAAC per week showed significantly less increase in BMI after 3 years compared to schools that had less than 75 minutes of PAAC per week. Additionally some secondary aims like daily PA or academic achievement demonstrated significant improvements in the PAAC classes compared to control schools. This study shows that it is not only about PA of children and adolescents and the relation to health, but also about psychological factors and cognitive skills.

Further substantial contribution for public health and fitness provide the numerous sports clubs all over the place. They play a big role in children´s and adolescents PA habits and therefore directly influence health of our society. Sports club participation of children and adolescents is often related to socioeconomic status of parents (Brockman et al., 2009).

Family support is very important to encourage children to be physically active, but families from different socioeconomic status support their children in different ways. Lower socioeconomic status equals lower support and therefore children and adolescents have less PA which might easily lead into the explained risk factors like overweight, cardiovascular diseases or high blood pressure.

In 2003, “Check Your LimitZ”, an Austrian project was established. Main aim was to assess motor performance and motor skills of Austrian school aged children and adolescents from 6 to 20 years (Juran, 2007). This study is still ongoing – currently about 60,000 pupils have been tested. Results from Juran are based on a sample size assessed in the first 3 years where approximately 13.000 pupils were tested in 8 different motor ability tests. 20m sprint, standing broad jump, reaction, sit and reach, medicine ball throw, single leg balance, agility running test and 2000m run along with anthropometric and personal data like height, body mass, preferred sports, school type and sports club participation were determined. One hypothesis to answer was if children and adolescents participating in sports clubs would perform significantly better in motor tests compared to their counterparts. This hypothesis could be accepted except for results in reaction timing of female and male adolescents older than 15.5 years, medicine ball throw of girls younger than 10.5 years, single leg balance performance of girls younger than 10.5 and older than 15.5 years and 2000m running time of boys older than 15.5 years being not significant. Therefore, to be active in a sports club has been demonstrated to have a great impact on the motor ability of children and adolescents. Additionally the question to answer was, if children and adolescents attending a sports school would perform better in motor tests. In every age group and in every motor test, children and adolescents attending sports schools performed significantly better in this respect.

Sandmayr (2004) analyzing the project “Klug und Fit” came to the same conclusion that pupils in Austria attending a sports school have a higher motor competence than pupils from normal schools.

Children and adolescents who participate in sports clubs in their leisure time or attend a sports school are fitter and demonstrate better performance in motor tests, but is there also evidence, that those children and adolescents are healthier than others? A very commonly used index in this respect is the body mass index (BMI) to express under-, normal- and overweight as well as obesity. Juran (2007) described that there was no significant difference in BMI found between children and adolescents being or not being members of sports clubs. Comparing normal school pupils with sports school pupils however, a significant difference emerged. Children and adolescents attending a sports school had significant lower BMI´s than others with a normal PE curriculum.

A wide range of PA infrastructure is necessary to reach PA recommendations for our children and adolescents. The positive effects are evident. Children and adolescents benefit from a higher motor performance with all advantages in health outcomes explained earlier. How to reach this goal is secondary, either with additional PE lessons, a changed and advanced curriculum, more sports elective courses in schools, special sports schools or more sports clubs. The task is to make them move!

2.6 PA and Health Status of Austrian School Aged Children

In 2006, the international "Health Behaviour in School-aged Children" (HBSC) survey, which is under the patronage of the WHO, was carried out again. This project was first conducted in Austria in 1983 and is still being assessed in intervals of 4 years until now. The study surveys health status and health behaviour of 11, 13 and 15 year old pupils as well as the influence of family, school and peer group.
More than 4000 pupils replied the self fill in questionnaire. Complete sample size and sex distributions are shown in table 3.

Table 3: Sample of Austrian HBSC-survey 2005/2006

Geschlecht		Altergruppen			Gesamt
		11	13	15	
Burschen	n	**728**	**726**	**585**	**2.039**
	%	17,8	17,7	14,3	49,8
Mädchen	n	**693**	**710**	**654**	**2.057**
	%	16,9	17,3	16,0	50,2
Gesamt	n	**1421**	**1436**	**1239**	**4.096**
	%	34,7	35,1	30,2	100,0

Source: WHO-HBSC Report 2007

2.6.1 PA of Austrian School Aged Children

The best and golden standard for determining children´s and adolescents PA would be to use accelerometers which should be worn for at least 4 to 5 days throughout the whole day. Any movement would be recognised by the gadget and would allow serious conclusions about the wearers´ PA habits. As this method is very time consuming and looking at the sample size of the HBSC survey, it appeared to be easier to use a questionnaire.

PA of 11, 13 and 15 year olds was assessed with following 3 questions:

- How often in the last 7 days were you physically active for 60 minutes or more?
- How often in your leisure time in a normal week are you as physically active so that you are short of breath or start sweating?
- How many hours in a normal week in your leisure time are you as physically active so that you are short of breath or start sweating?

After evaluating the filled in questionnaires, Dür & Giebler (2007) assessed that on average the Austrian pupils in that certain age group are physically active for at least 60 minutes on 4.2 days per week. Boys move a little bit more frequently (4.4 days) compared to girls (3.9 days). For both gender PA decreases with age, whereby the highest change is between 13 and 15 years of age and a little bit more pronounced in girls compared to boys. Mean values of PA for at least 60 minutes per day by sex and age are presented in figure 3.

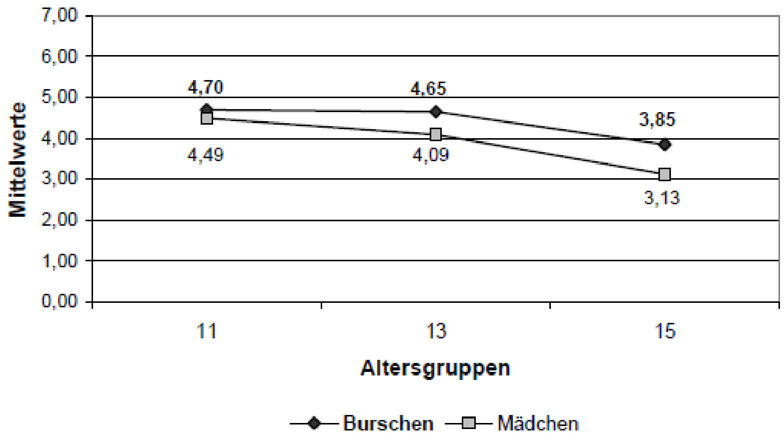


Figure 3: Days per week, where 11, 13 and 15 year olds are physically active for at least 60min, by age and gender (Dür&Giebler, 2007)

Following recent recommendations only every fourth 11 year old child (24.7%) in Austria reaches 60 minutes of PA per day. Within the 13 years olds only every fifth child (21%) and in the 15 years old children even only every tenth child (11%) moves more than 60 minutes per day at an intensity so that they get out of breath or start to sweat.

Overall, only one in five (20.5%) Austrian pupils aged between 11 and 15 years is physically active outside school every day. More boys (25.6%) are active than girls (15.6%) in their leisure time every day. Apparently more than half (58.8%) of the pupils are physically active only on maximum 3 days per week, more girls (67%) than boys

(50%). Figure 4 shows very clear, that girls PA habits differ adverse from boys habits. Age of pupils is also very strongly related to PA, as one can see in figure 4 as well.

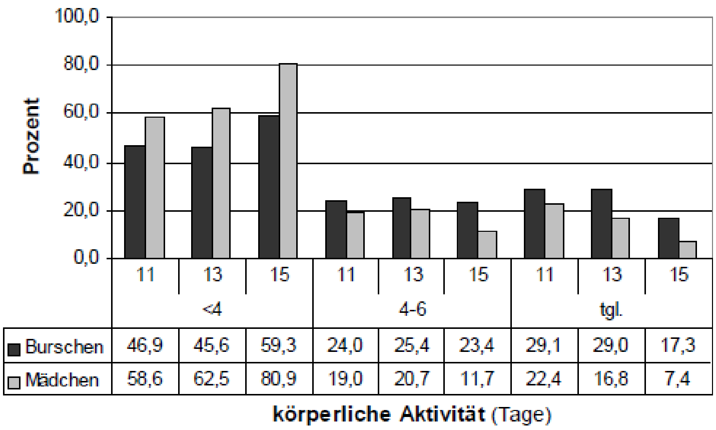


Figure 4: Days per week, where 11, 13 and 15 year olds are as physically active in their leisure time that they are short of breath or start sweating, by age and gender (Dür&Giebler, 2007)

Very alarming is the fact, that more than half (51.1%) of the pupils in Austria aged between 11 and 15 years are physically active only for less than 2 hours per week (girls: 58.8%, boys: 43.4%). Approximately 78 % of girls and boys from 11 to 15 years spend at most 3 hours of sports or PA per week. More girls (84.6%) than boys (71.8%) move less than 3 hours per week. Figure 5 clearly expresses that approximately only 1 in 20 girls is physically active for at least 60 minutes per day, compared to the boys where nearly 1 out of 7 boys performs 60 minutes of PA per day. As the days, where pupils are physically active, decrease with age there is no clear relation found regarding spent hours of PA per week.

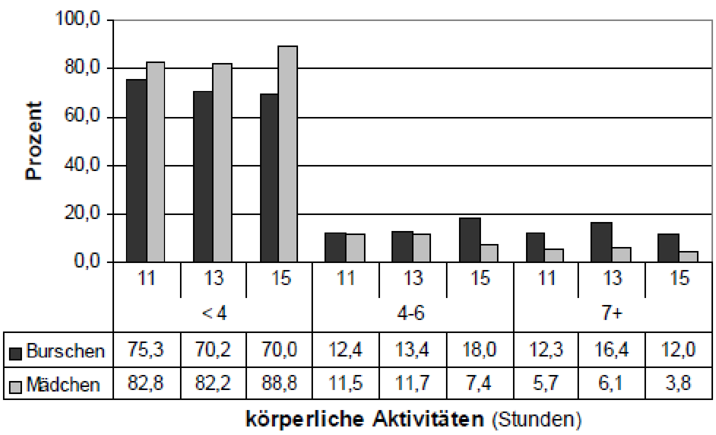


Figure 5: Hours per week, where 11, 13 and 15 year olds are as physically active in their leisure time that they are short of breath or start sweating, split by age and sex (Dür&Giebler, 2007)

Summarizing, the situation of PA of Austrian school aged children is really depressing. Austrian children are far away from reaching common PA recommendations. Only a small part is physically active every day. Being inactive has a strong influence on health status, as shown before, in which way will be demonstrated in the following chapter.

2.6.2 Health Status of Austrian School Aged Children

Health status of children was presented by BMI. As this was assessed using a self report as part of the HBSC survey 2006, the data are only limited reliable. Nevertheless BMI represents a quick and easy possibility to give an overview of weight distribution in a certain cohort. Cut-off points for prevalence of overweight, underweight and obesity were taken from Cole et al. (2000) as shown in table 4. These cut-off points rival the ones from Krohmeyer-Hauschild, which are often used in German and Austrian publications. As Krohmeyer-Hauschild use slightly adapted cut-offs for German youth, they however do not allow international comparison.

Table 4: Cut-off points for overweight and obesity, Cole et al. (2000, p.4)

	Body mass index 25 kg/m^2		Body mass index 30 kg/m^2	
Age (years)	Males	Females	Males	Females
2	18.41	18.02	20.09	19.81
2.5	18.13	17.76	19.80	19.55
3	17.89	17.56	19.57	19.36
3.5	17.69	17.40	19.39	19.23
4	17.55	17.28	19.29	19.15
4.5	17.47	17.19	19.26	19.12
5	17.42	17.15	19.30	19.17
5.5	17.45	17.20	19.47	19.34
6	17.55	17.34	19.78	19.65
6.5	17.71	17.53	20.23	20.08
7	17.92	17.75	20.63	20.51
7.5	18.16	18.03	21.09	21.01
8	18.44	18.35	21.60	21.57
8.5	18.76	18.69	22.17	22.18
9	19.10	19.07	22.77	22.81
9.5	19.46	19.45	23.39	23.46
10	19.84	19.86	24.00	24.11
10.5	20.20	20.29	24.57	24.77
11	20.55	20.74	25.10	25.42
11.5	20.89	21.20	25.58	26.05
12	21.22	21.68	26.02	26.67
12.5	21.56	22.14	26.43	27.24
13	21.91	22.58	26.84	27.76
13.5	22.27	22.98	27.25	28.20
14	22.62	23.34	27.63	28.57
14.5	22.96	23.66	27.98	28.87
15	23.29	23.94	28.30	29.11
15.5	23.60	24.17	28.60	29.29
16	23.90	24.37	28.88	29.43
16.5	24.19	24.54	29.14	29.56
17	24.46	24.70	29.41	29.69
17.5	24.73	24.85	29.70	29.84
18	25	25	30	30

According to the data of the children, 87.6% of them are normal weight. Slightly more girls (91.7%) than boys (83.4%) have lower BMI´s than the 90th percentile, which equals a BMI of 25 at the age of 19 and marks the cut-off point between under- and overweight. On the other hand it means that 1 out of 8 pupils in Austria (12.4%) has a raised BMI, whereas 3.1% can be called obese. There is a stable quantity of pupils who are overweight or obese over the age range except a slight increase within the boys between 13 and 15 years of age as described in figure 6. Generally more boys (16.6%) have higher BMI´s than girls (8.3%) and boys are more likely to be obese (7.2%) than girls (1.1%).
Main problem of self fill in forms is often an underestimation of children. They intend to be slightly taller and lighter than they are in real which might increase the prevalence of overweight and obese children up to 20% (Dür & Giebler, 2007).

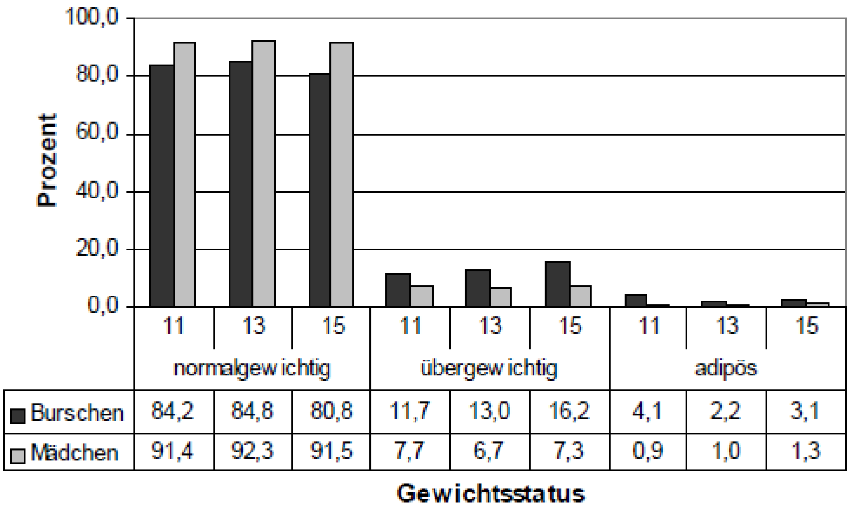


Figure 6: Overweight and obesity of 11, 13 and 15 year old pupils, by sex and age (2006)

To clarify health status of children and adolescents more precisely would request for additional measurements like blood samples, skinfold measurements or blood pressure values. BMI is only one small and easy opportunity which allows a rough determination of body composition. Anyway, it is still a good determinant to tell children, adolescents and adults whether they are at risk of being overweight or obese or not.

2.7 Health Benefits, Motor Competence and Physical Fitness

High and low motor competence have a great influence on physical fitness and consequently on health of children and adolescents as well. Haga (2008) researched the relationship between physical fitness and motor competence of children. She had a sample of 67 children who first participated at a the Movement Assessment Battery for Children to assess their general motor competence followed by a Physical Fitness Test containing nine different tasks including jumping, throwing, running and climbing to assess general fitness levels of the subjects. The results revealed a strong and significant correlation between motor competence and physical fitness which indicates very clear that the work of maintaining and developing both sufficient physical fitness and motor competence in children is very important as these parameters are relevant contributors to their health and well-being (Haga, 2008).

Improvement of one of the variables is presumed to positively influence and develop the second variable as well. However, children and adolescents should be enabled and encouraged to develop a high motor competence as this will influence their physical fitness and health as well.

Another study from Cantell et al. (2008) approves similar findings. Children with low motor competence had less optimal levels of overall health and fitness indices than those from children with high motor competence. Musculoskeletal fitness was significantly compromised for the low motor competence group and BMI´s of that group were significantly higher as the ones from the high motor competence group as well. Also exercise intensity differed between children from the group with high and low motor competence. The findings of the study show that children with a low motor competence have a lower health-related fitness than children with high motor competence.

Motor ability tests consist of a multitude of different tasks which are more or less good predictors for fitness and health. For instance there is strong evidence indicating that the 20m shuttle run test is a valid test to estimate cardio respiratory fitness; handgrip strength test is a valid measure of musculoskeletal fitness; skinfold thickness and body mass index are good estimates of body composition and waist circumference is a valid measure to estimate central body fat (Castro- Piñero et al., 2009).

The maximal rate of oxygen uptake (VO_2max) is considered as a gold standard for measurement of cardiorespiratory fitness. Cardiorespiratory fitness is a direct marker of physiological status and reflects the overall capacity of the cardiovascular and respiratory systems and the ability to carry out prolonged exercise.

High-cardiorespiratory fitness during childhood and adolescence has been associated with a favorable plasma lipid profile in both overweight and non-overweight adolescents with total and central body fat, features of the metabolic syndrome, blood pressure, novel cardiovascular disease risk factors, and with arterial compliance in young people. (Castro-Piñero et al., 2009)

These findings support the concept that cardiorespiratory fitness may exert a protective effect on the cardiovascular system from an early age.

2.8 School System and Distribution in Austria

The Austrian school system is very sophisticated. Austrian pupils and their parents can choose from a wide range of school types after 4 years of primary school. Another 4 years of new secondary, lower secondary or academic secondary (grammar) school with different focuses are followed by at least 1 additional school year to get a graduation from school and to start working. If one aims to continue school education for another 4 to 5 years in an academic secondary school or a higher technical and vocational college, a general qualification for university entrance at the end will be given. As indicated in figure 7 there are many different options to run through the Austrian educational system.

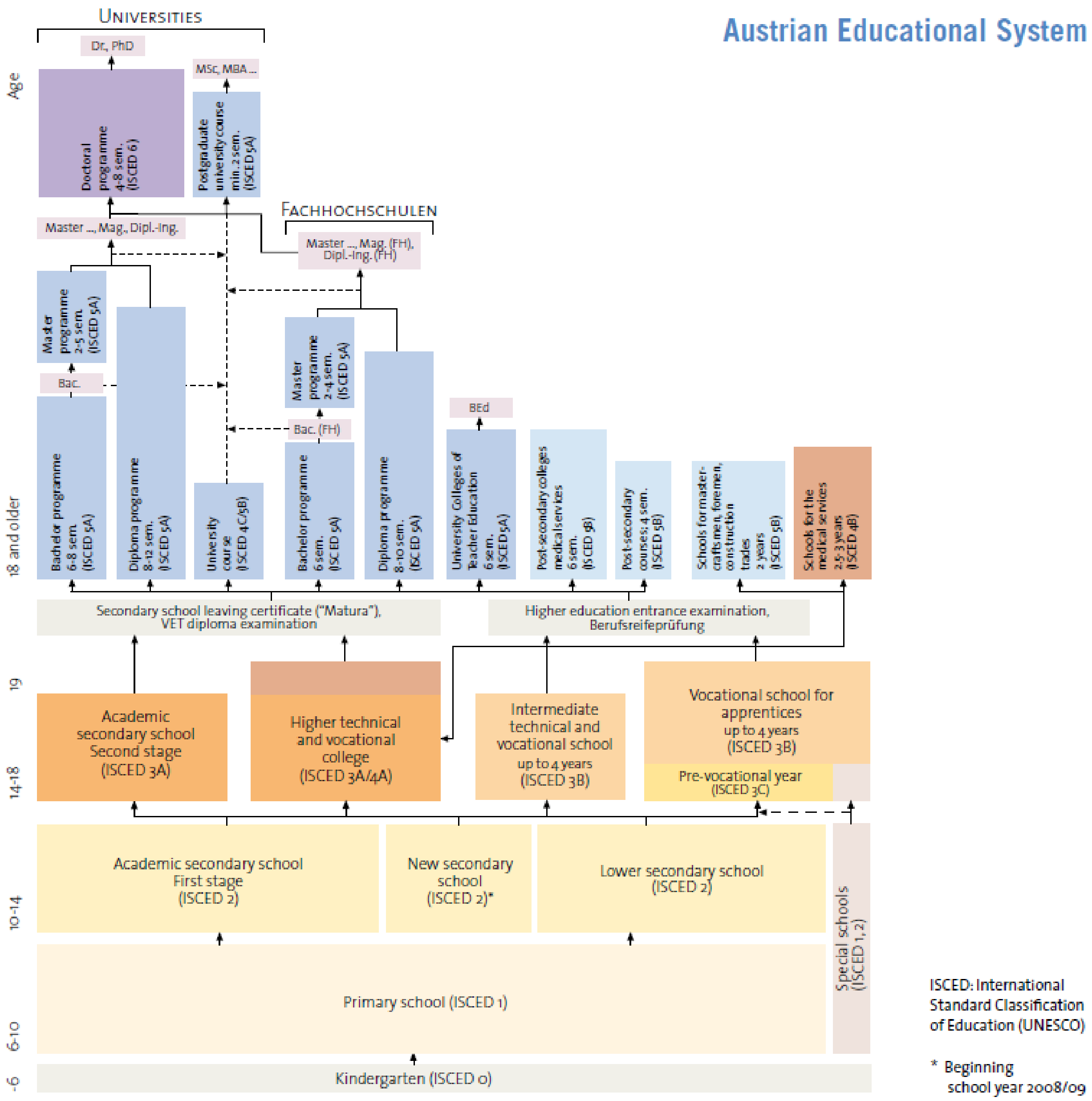


Figure 7: Austrian Educational System (BMUKK, 2008)

In this huge mixture of schools there are technical, social, arts or economical focused schools as well as schools with the main objective to offer special sports abilities and infrastructure.

Starting in 1962, such schools have been established in Austria for specific development of physically gifted children and adolescents. In these schools, particular attention has been paid that teachers have an additional sports-oriented education beyond their required teaching diploma. Pupils are required to demonstrate their physical suitability in a motor performance test and to undergo medical examination before entering the classes.

Since school autonomy in Austria has empowered schools to issue autonomously their own curricular regulations, which means that certain points of emphasis may be chosen within a given framework and schools can develop their own specific profiles, many schools decided to focus on PE and projects around sports activities. In 1994, the 14th Amendment of the School Organization Act offered those opportunities (BMUKK, 2008).

2.8.1 Sports-oriented Schools

Presently there are many different types of sports schools in Austria. The precise number of schools in each category was assessed by contacting the state education authority of each province in Austria or by internet research where possible. An outline of those shall give a good overview. (cp. www.bewegung.ac.at)

2.8.1.1 Lower Secondary Sports Schools with Focus on General Sports (116)

In Austria, there are presently 116 secondary schools which offer sports interested and gifted children good opportunities with additional 3 to 4 PE lessons per week to develop good general motor competence. In addition there are voluntary training sessions, increased participation in school competitions and a greater number of school events like summer or winter sports weeks. One goal of those schools is to develop talented pupils and to introduce them to competitive sports. Another very important aim is to create an ideal foundation for health promotion and lifelong sports habits.

2.8.1.2 Lower Secondary Sports Schools with Focus on Winter Sports (alpine, nordic) (11)

As Austria is a rich country of mountains, winter sports, especially skiing, ski jumping and cross-country skiing etc., have a great value for the Austrian population and the Austrian Skiing Federation (ÖSV). Young talents support and development of competitive athletes are very important additionally to a qualified school education. Those 11 schools offer perfect settings for young athletes and even if not all of them reach competitive top level, the Austrian society needs many skilled people in those fields of sports like trainers and ski instructors. Skiing is a complex sport and impact on body structure is very high which requires a targeted development of motor skills. This will be achieved by 12 hours of PE lessons per week in all 4 stages of this type of school including special fitness and ski training.

2.8.1.3 Middle and Higher Sports Schools with Focus on Winter Sports (alpine, nordic) (7)

Austrians are often described as a skiing nation. Skiing is the only sports in Austria where special school forms are especially established for. State-certificated trainers are responsible for developing motor and high performance skiing skills while special classes provide pupils with all necessary school education to pass exams after competition season ends. School classes are coordinated with training sessions and competitions with exclusive learning hours for pupils in the evenings.

Those schools cooperate with the ÖSV and make it possible for pupils to participate in competitions as their curriculums are aligned with competition period.

Even though only a small chosen ones reach top level, their education and graduation offer many good prospects for later jobs of the others and ski retirees.

2.8.1.4 Academic Secondary and Sports Schools with Focus on General Sports (25)

A broad practical training combined with a special subject called sports science form the basement of this school type. Children and adolescents experience a multisided instruction in different sports together with theoretical background in training theory and sports physiology. 7-8 hours of PE per week are therefore scheduled for practical work as well as 2 hours per week for theoretical inputs. Before entering such a school a general motor performance test needs to be passed together with a medicinal checkup. Pupils will be instructed to participate at youth competitions or competitions from sports federations. In addition an increased opportunity for voluntary sports activities is a component of this education. The rise of quality within this sports education was enabled by making sports science a compulsory subject at the final exams.

2.8.1.5 Sports Schools with Focus on Competitive Sports (22)

In 1985 the first school has been established regarding the special needs for young elite athletes. Since then, more than 20 sports schools for elite athletes offer perfect settings for adolescents for their sports and educational development. Main objective was to give young elite athletes an opportunity to finish school with a certificate for university entrance beyond their sports career.

An extra year in their curriculum is necessary to allow young elite athletes participation in trainings and competitions with their sports associations. Schools coordinate their timetables according to pupils´ training sessions as good as possible. The subject sports science is a compulsory part of the final exam as well.
Admission standards for these special sports schools are sports qualification (national elite level, motor performance tests), academic requirements (good school reports) and a medical pre-test.

In total there are 181 (3.1%) schools with focus on general or specific sports in Austria in 2008/2009 according to research results. This number is only an actual snapshot of sports schools in Austria as the request for more sports schools is still very high. In 2008, 5820 schools were counted in Austria with 1,163.978 pupils according to Statistics Austria. Actual data of pupils attending a sports school are not available unfortunately.

2.8.2 Comparison of PE Lessons at Sample School

The school in Maroltingergasse 69-71 located in the 16th district of Vienna offers several focuses for educating pupils. Basically there are 4 lower stages or secondary levels and 4 higher stages. In both stages, children and adolescents can choose between linguistic, music and arts, natural science and mathematics or sports focused education. A timetable of the secondary level from the sample school is shown in table 5.

Table 5: Timetable of secondary level (10-14 years), focus on language skills

	1st	2 nd	3rd	4th	Sum
Religious Instruction	2	2	2	2	8
German	4	4	4	4	16
English	4	4	3	3	14
French / Latin			4	4	8
History		2	2	2	6
Geography	2	1	2	2	7
Mathematics	4	4	3	3	14
Biology	2	2		3	7
Chemistry				2	2
Physics		2	3		5
Music	2	2	1	2	7
Art	2	2	2	2	8
Crafts and Textiles	2	2			4
Physical Education	4	4	3	3	14
Total hours	28	31	29	32	120

In regular classes without focus on sports activities in Austria, PE lessons are distributed as indicated above which allow a total amount of 14 hours of PE in 4 years. Compared to regular school timetables, table 6 shows distribution of lessons in the secondary level of the sample school with focus on competitive sports.

Table 6: Timetable of secondary level (10-14 years), focus on competitive sports

	1st	2 nd	3rd	4th	Sum
Religious Instruction	2	2	2	2	8
German	4	4	4	3	15
Foreign Language	4	4	3	3	14
History	-	2	2	2	6
Geography	2	1	2	2	7
Mathematics	4	4	4	3	15
Geometry	-	-	-	2	2
Biology	2	2	2	2	8
Chemistry	-	-	-	2	2
Physics	-	2	1	2	5
Music	2	2	1	1	6
Art	2	2	2	1	7
Crafts and Textiles	2	2	2	1	7
Physical Education	6	6	3	3	18
Social Skills	1	1	1	1	4
Total hours	31	34	29	30	124

Pupils attending this elite sports school participate in 4 hours more (28.6%) of PE during secondary level compared to regular secondary classes. Moreover they also have regular training sessions during the week in their specific sports clubs at least twice a week. That does not mean that pupils from regular classes do not attend sports clubs in their leisure time, but the percentage in regular classes is possibly lower.

Looking at timetables from higher levels aged between 14 and 19 years in Austrian grammar schools, there are 9 hours of PE reserved in total over 4 years for sports activities as shown in table 7 below.

Table 7: Timetable of higher level (10-18 years), focus on language skills

	5th	6th	7th	8th	Sum
Religious Instruction	2	2	2	2	8
German	3	3	3	3	12
English	3	3	3	3	12
French / Latin	3	3	3	3	12
Latin/French/Greek	4	3	3	3	13
History	1	2	2	2	7
Geography	2	2	1	2	7
Mathematics	3	3	3	3	12
Biology	2	2		2	6
Chemistry			2	2	4
Physics		2	2	2	6
Psychology / Philosophy			2	2	4
Informatics	2				2
Music	2	1	2	2	3+4
Art	2	1			3+4
Physical Education	3	2	2	2	9
Optional Subjects		Total of 6 hours			6
Total hours	32	28	31	33	124

The very special situation about the elite sports school is, in our present study the school in Maroltingergasse, that young elite sports athletes attending the school have less PE lessons compared to their counterparts in regular classes as indicated in table 8.

Table 8: Timetable of higher level (10-19 years), focus on competitive sports

	5th	6th	7th	8th	9th	Sum
Religious Instruction	2	2	2	2	2	10
German	3	3	3	3	3	15
English	3	3	3	2	3	14
French	4	3	3	3	3	16
History	2	2	2	1	0	7
Geography	2	2	2	1	0	7
Mathematics	3	3	3	3	3	15
Biology	2	2	1	1	0	6
Chemistry	0	0	0	2	2	4
Physics	0	1	2	2	2	7
Psychology/Philosophy	0	0	2	2	0	4
Music	1	2	2	0	0	5
Art	1	2	2	0	0	5
Informatics	2	0	0	0	0	2
Sport Science	0	2	2	2	2	8
Compensational Sports	1	1	1	1	1	5
Total hours	26	26	26	25	23	126

Young elite sports athletes do not have PE lessons any more, instead they have 1 hour of compensational sports activities per week every year. In addition they have 8 hours of sport studies where they get taught important principals about training and human physiology exercise distributed over 5 years. That´s another main difference compared to regular classes which graduate after 4 years. Elite sports classes have to stay one year longer at school as they have fewer hours per week on average. Of course they also need to reach given total hours whereby a fifth year is necessary.

Main advantage for pupils attending the elite sports school is that they are enabled to train possibly twice a day. As school starts about 10am they have a training session in the morning and one after school ends at about 4pm.

Even if those young elite athletes do not have more PE lessons in school, it can be speculated that they are probably a lot more physically active than pupils attending a regular school. Regarding normal sports schools which offer more PE hours and therefore a better comprehensive motor development those pupils might also be fitter in motor tests compared to regular school pupils.

3. Empirical Elaboration

This chapter represents the heart of this thesis. Scientific questions will be hypothesized followed by an explanation of the setting of the study. All motor and medical tests will be described precisely as well as the assessed results.

3.1 Aims and Hypothesis

This study aims to compare school children attending a regular school with those attending a specific school type for elite sports concerning their performance in motor ability tests and concerning their anthropometric parameters as well as health parameters.

The first question to answer is if young elite athletes have a higher level of fitness and a better motor performance in certain motor ability tests. Secondly the question raised is if young elite athletes are on the other hand healthier than non athlete children in respect of a higher level of fitness and motor competence. Regarding those two main questions the following hypothesises are proposed:

H1: Children attending the elite sports school have better fitness parameters and motor competence than children attending the regular school.

H2: Children attending the elite sports school have better health parameters than children attending the regular school.

H3: Children with better motor performances have better health parameters.

Hypothesis 2 and 3 are proposals for the overall project “Körperliche Aktivität macht Schule” which will not be analyzed in this current thesis but in the final report after this project will be finished.

3.2 Study Design, Test Battery and Sample Population

3.2.1 Study Design

Data were collected within the project “Körperliche Aktivität macht Schule”, which was funded by the Austrian Ministry for Science and Research. Within this pilot study we aimed to describe fitness levels and health status of children with and without a background in elite sports. The sample population was recruited within one single school (GRG Maroltingergasse, Vienna, Austria), where regular pupils and elite athlete pupils aged 10 to 19 years attend the same school. They only differ in the amount spent for sports activities as explained earlier. This unique situation allows the comparison of fitness and health parameters in one single environment (same school, same teachers, same facilities, etc).

The regular school type consists of 8 grades. The amount of PE lessons account for 3-4 hours per week in the first four years and for 2-3 hours in the second four years. In comparison the elite sports school consists of 9 grades, whereby the amount of PE lessons account for 6 hours per week in the first two years and for 3 hours per week in the third and fourth year. Thereafter, they only have 1 PE lesson (compensational sports activities) per week in school but they need to train within their sports specific training sessions (up to 2 training sessions per day) as mentioned above. Generally children and adolescents attending the elite sports school type need to pass a fitness test before entering the first and fifth grade. Additionally, they need to have a letter of recommendation from their specific national sport association, e.g. soccer, handball, basketball, gymnastics, skiing or others to be qualified to enter the school as an elite athlete.

3.2.2 Participants

In general 1,139 pupils have attended the school in 2008/2009, where 610 children were in 4 secondary levels from 10 to 14 years of age and 529 adolescents in 4 to 5 higher levels from 15 to 19 years of age. Out of these pupils 238 attended the elite sports school. Every 9th child (11.3%) in the secondary level was in the elite sports school compared to every 3rd adolescent (31.9%) in the higher levels. For each grade we have arbitrarily chosen 1 regular and 1 elite sports class and asked the pupils to take part in the study. Written informed consent was obtained from children´s parents or legal guardian after they were given a detailed written explanation of the aims of the study, its´ possible hazards, discomfort and inconvenience, and the option to participate voluntarily on the tests explained. Finally, 344 out of 433 (79.4 %) participated. The distribution between school types and gender is shown in figure 8. As the cases per age group were very low we decided to form 4 age groups (U12, U14, U16, and U19) for statistical analyses within this pilot study.

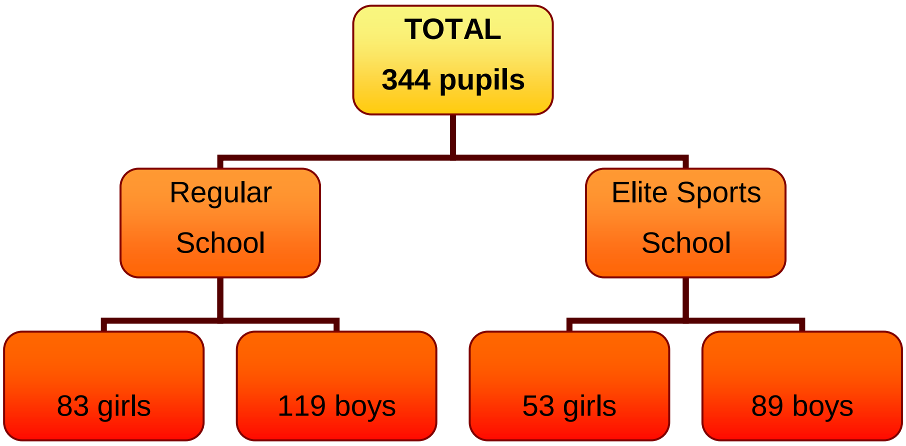


Figure 8: Distribution of participants by schooltype and gender

3.3 Measurements

Two different test settings were executed. The motor test battery was carried out directly at school between November 2008 and February 2009, whereas the sports medical test battery was assessed parallel at the ÖISM (Austrian Institute for Sport Medicine) from December 2008 until March 2009.

The motor test battery performed at school included the measurements of:

- medicine ball throw
- maximum hand grip test
- standing broad jump
- vertical jump
- maximum running speed 10m and 20m
- 20m aerobic fitness /endurance shuttle run
- sit and reach
- single leg balance test

Anthropometric parameters like height and body mass were measured additionally with the motor test battery at school.

Before the test battery started, a short 10 minute warm-up session was instructed by myself. This was important to prevent injuries and to have the same level of warming-up for all children.

Warming up included slow running with exercises at low intensity, slight stretching. After warming up, the children got split into their groups to carry out the tests as follows.

3.3.1 Medicine Ball Throw

This test measures the maximum explosive and speed strength of the arm and upper body muscles (figure 9).

Material

- 2kg medicine balls
- Measuring tape
- Adhesive tape to fix measuring tape
- Mattresses at the throw off zone
- Gym hall with hard and antislip surface

Figure 9: Medicine Ball Throw

Number of trials

3 trials in a row

Procedure

From a kneeing position (see picture) with one knee on the mattress and the other one in a right angle behind the throw off line, the children take the medicine ball double handed over head. They throw the ball as far as possible without lifting the knee from the floor or falling forward over the line.

Scoring

The distance from the throw off line to the impact of the medicine ball is measured in centimetres to the nearest of 5cm. The best trial is evaluated.

Comments

It is important that children throw the ball with both hands over head and do not draw aside with their upper body or throw single handed.

It might be good to give some advice about how to throw a ball as far as possible (trajectory parabola).

3.3.2 Maximum Hand Grip Test

This test measures the maximum power (isometric strength) of the forearms and hands on both sides.

The dynamometer works on the hydraulic principle where the force on the grip is transferred into pressure of the oil and indicated on a display in kilogram and pounds.

Material

- Hydraulic hand grip dynamometer *Saehan SH5001* with adjustable size for the children´s hands (figure 10)
- Chair
- Fill out form

Figure 10: Hydraulic hand grip dynamometer

Number of trials

2 trials per hand, after each trial a short break

Procedure

The subject sits down in an upright position on the chair, taking the individual size adjusted hand grip dynamometer. The tested arm in a right angle with the elbow on the side of the body. Now the subject squeezes the dynamometer as strong as possible with maximum isometric power for at least 3 seconds. After the second hand measured, the subject has a short break while others are going to be tested.

Scoring

Values are measured in kg. The best result of each side is evaluated. Additional information about the dominant and non-dominant side is recorded as well.

Comments

It is important that the subjects have the exact same arm positions while being tested to have reliable results. The accuracy of the adjustment for the hand size is also very crucial in terms of validity and reliability.

3.3.3 Standing Broad Jump

This test measures the maximum explosive and speed strength of the lower limbs (figure 11).

Material

- Measuring tape
- Adhesive tape to fix mattresses and measuring tape
- Mattresses for safety
- Gym hall with hard and antislip surface

Figure 11: Standing broad jump

Number of trials

2 trials, break between the trials for recovery

Procedure

From a hip width standing position behind the jump off line, the children flex their knees and swing their arms for maximum drive. They jump double feeted as far as possible with a double feeted landing. Stepping back, falling back or walking is not allowed.

Scoring

The distance from the jump off line to the heel of the children, without falling or stepping back, is measured in centimetres. The best trial is evaluated.

Comments

It is important that the children jump off and land with both legs equally. Trials where children cross the jump off line, step or fall back after the landing are invalid.

3.3.4 Vertical Jump

This test measures the maximum explosive and reactive strength of the legs, especially of the calf muscles (figure 12).

Material

- Contact mattress with online system (laptop) and *Fitronic* software

Number of trials

1 trial per child; only when a trial is invalid, a second trial is possible.

Figure 12: Vertical jump test

Procedure

The hands are positioned at the hips looking straight forward. On the command “go” the pupils perform vertical jumps for 10 seconds. The task is to jump as high as possible, without bended knees, and to have the shortest contact time possible. Jumps should mainly be performed out of the ankles.

Scoring

Contact time and flight time are measured to the nearest of 1/1000 of a second. Only the 3 best values get evaluated via an online system calculating a muscle-stiffness-index, which can be compared to other jumping parameters. Muscle-stiffness-index is calculated as follows:

Muscle-stiffness-index [cm/s] = jump height [cm] / contact time [s]

Comments

The correct execution of the task is very important. Therefore the children get the chance to try the movement before jumping on the mattress. While the test runs, it is advantageous to have a person next to the contact mattress supporting the children as they jump not to get off the mattress.

For a better understanding of the task the children got told to imagine if they were jumping on a hot plate with shortest contact time possible, and as high as possible at the same time.

3.3.5 *Maximum Running Speed, 10m and 20m*

This test measures the maximum running speed, respectively the speed strength and power strength of the lower limbs (figure 13).

Material

- 3 pairs of light barriers (starting line, 10m, 20m) including radio controlled timing system (*Brower timing system*)
- 20 m running track
- Measuring tape
- Adhesive tape for starting, intermediate and finish line
- Safety mattress after the finish line to protect children running against the wall
- Gym hall with hard and antislip surface

Figure 13: Sprint 20m

Number of trials

2 trials, break between the trials for recovery

Procedure

From a high start position 50cm in front of the first timing gate (see sketch) the pupils start to run as fast as possible through the 20m distance. Acceleration with maximum intensity is requested. Pupils shall start to slow down right after the finish line (20m).

Scoring

Timing of the children starts when they reach the first light barrier at the starting line and stops after 20m at the finish line. An intermediate time is measured after 10m. Time is rounded to 1/100 of a second. The best time of each section is evaluated.

Comments

To prevent injuries during the test, an adequate warming-up phase is recommended, as the children run at maximum intensity.

3.3.6 20m Endurance Shuttle Run

This test measures the aerobic fitness ability. After all other tests had been carried out, this test was the last one during testing phase to have all pupils at the same exhaustion level (figure 14).

Material

- Measuring tape
- Adhesive tape or cones to mark 20m lines
- CD-Player
- Gym hall with hard and antislip surface
- Test protocol

Figure 14: Shuttle run test

Number of trials

1 run per child

Procedure

Approximately 10 children are being tested at the same time, depending of the size of the gym hall. They stand behind the starting line, listening to the CD-Player. When the acoustic start signal sounds, the children start to run to the opposite line, which is 20m away. They shall reach that line until they hear the next “beep” from the CD-Player. So every “beep” they shall touch a line. The “beeps” appear faster every minute, starting with 8km/h at the first stage, 9km/h at the second stage and then an increase of 0.5km/h every other stage. The numbers of shuttles are recorded as long as the children can follow the pace.

Scoring

Only the number of full run shuttles per person are counted and evaluated.

Comments

Children sometimes do have problems to find the correct speed at the beginning, therefore it is suggested that an adult gives the pace for the first few stages until the children find their own rhythm.

It is also very important to have enough persons for counting the shuttles, at least 1 person per 2 children. As this test is a maximum exhaustion test, the children should be verbally encouraged to give maximum effort.

3.3.7 *Sit and Reach*

This test measures flexibility and extensibility of the lower back and hamstring muscles (figure 15).

Figure 15: Sit and Reach test

Material

- Special wooden equipment box
- mattress

Number of trials

1 trial per child

Procedure

The children sit down on the mattress with stretched legs without wearing shoes. Soles should be pressed flat against the wall of the wooden box. Both knees are extended and pressed down onto the mattress. Now the task is to slowly move the upper body towards the toes with extended arms. With extended fingertips a wooden bar, which is located on the box, is pushed as far as possible towards the toes and even further. The farthest possible move of the bar should kept hold at least for 2 seconds.

Scoring

The wooden box includes a measuring system to the nearest of 1cm. It is scaled that the toes are at zero centimetres while every centimetre further down from the toes are counted as “+” and every centimetres not reaching the toes are counted as “-“ .

Comments

To avoid flexion of the knees, it is suggested that the tester holds the knees down during the test. Stretching before the test is not permitted as this would influence the outcome of the test.

3.3.8 Single Leg Balance Test

This test measures the ability to balance successfully on one leg (figure 16).

Material

- wooden balance beam (50cm x 2,5cm x 2,5cm)
- adhesive tape to fix the beam
- stop watch

Number of trials

2 trials per child with each leg, short break between the trials

Figure 16: Single Leg Balance test

Procedure

Without wearing shoes the children stand with one foot at the centre of the wooden beam and the other foot on the floor, keeping their hands at their hips. When the second foot releases the floor and the tested person starts to balance, time starts to count.
The task is to balance as long as possible on the beam, without touching the floor or the beam with the second leg or moving the hands off the hips.

Scoring

Time is measured to the nearest of 1 second as long as the tested person can uphold the position (one leg, hands at hips). When 45 seconds are reached, the test is stopped. The best value of each leg is evaluated.

Comments

It is important that tested children do not get influenced by other people surrounding them. The best setup would be that they face a wall and fix a point with their eyes while being tested.

In addition to these motor ability tests, height and body mass were measured as well.
Height of the pupils was measured without shoes using a transportable stadiometer to the nearest of 0.5 cm. *Body mass* was measured in light clothing to the nearest of 0.1 kg using a calibrated electronically scale.

The medical tests at the ÖISM included:

- waist/hip circumference
- skinfolds
- resting electrocardiogram
- body mass
- height
- maximum watt test on a cycle ergometer
- skeletal muscle function tests
- balance test (MFT S3 Check)

Only cycle ergometer test and waist circumferences are part of the evaluation of this present thesis. For the sake of completeness all other tests executed during the medical tests at the ÖISM are described as well.

3.3.9 Waist/Hip Circumference

This test assesses the rough shape of a person, either more apple- or pear-shaped.
It is used as an indicator for health and part of the metabolic syndrome.

Material

- Measuring tape

Procedure

Waist circumference was measured with a level tape measure midway between the bottom of the rib cage and the top of the hip bone, the iliac crest, to the nearest of 0.1 cm. Hip circumference was measured with a tape measure around the maximum

3.3.10 Skinfolds (not evaluated within this thesis)

This test is used for estimation of body fat and fat distribution (body composition).

Material

- Harpenden skinfold caliper
- Dial Graduation: 0.20 mm
- Measuring Range: 0 mm to 80 mm
- Measuring Pressure: 10 g/mm2 (constant over range)
- Accuracy: 99.00%
- Repeatability: 0.20 mm

Procedure

Skinfold thickness was measured at biceps, triceps, subscapular, suprailiac and abdominal sites. The tester pinches the skin at the appropriate site, which is marked with a pen, to raise a double layer of skin and the underlying adipose tissue, but not the muscle. The calipers are then applied 1 cm below and at right angles to the pinch, and a reading in millimeters (mm) taken two seconds later.

Scoring

Each site was measured 3 times to the nearest of 0.2mm. The average is evaluated.

Comments

It is important to have one tester throughout the whole testing session as results may vary between different testers.

3.3.11 Resting Electrocardiogram

To make sure that the pupils have no heart rhythm failure for the later maximum watt test, a resting electrocardiogram was assessed by a doctor.

3.3.12 Body Mass and Height

Body mass was measured in light clothing to the nearest of 0.1 kg using a calibrated electronically scale. Height of the pupils was measured without shoes using a stadiometer to the nearest of 0.5 cm.

3.3.13 Maximum Watt Test

Aerobic fitness was assessed as a maximal power output in a cycle ergometer test with progressively increasing workload of 20 Watts per minute (figure 17).

Figure 17: Cycle Ergometer test

Material

- Cycle ergometer LODE Excalibur, type 911905
- Online system for electrocardiogram

Procedure

The subject gets wired with the online cardio ECG-system. Additionally the cycle needs to be fit to the person's anthropometry, e.g. saddle position. The test starts with 20

watts and increases every minute with an additional workload of 20 watt. As this is a maximum power output test, the subjects need to be encouraged to give maximum effort until they cannot uphold the rotary speed of approximately 60 to 80 rpm.
The online electrocardiogram was observed by a medical doctor throughout the whole testing phase.

Scoring

Aerobic fitness was expressed as maximal power output relative to body mass in Watts/kg.

Comments

As this was a maximum power test, children had to be verbally encouraged to give maximum effort.

3.3.14 Skeletal Muscle Function Tests (not evaluated within this thesis)

These tests were performed after Janda (2004). He established 3 different weakening and 3 different contraction levels which were used within this test.

Weakening levels:

- 3 the subject is able to execute the movement against gravity, equates approximately 50% of normal muscle strength
- 4 the subject is able to execute the movement against a submaximal additional load (tester presses 2 fingers against the moved muscle), equates approximately 75% of normal muscle strength
- 5 the subject is able to execute the movement against a maximum additional load (tester presses with palm against the moved muscle), equates normal muscle strength

Contraction levels:

- 0 no contraction of the tested muscle
- 1 moderate contraction of the tested muscle
- 2 strong contraction of the tested muscle

As these tests are quite subjective and therefore differ from tester to tester, it is very important that the procedures of the tests are very similar. Janda (2004) made a note list which is elementary for getting comparable results.

The whole motion needs to be observed, not just the beginning or the end of the movement

- the testing movement must be slow and constant, no pushing allowed
- fixation should be as strong as possible
- during fixation, the muscle tendon nor the muscle bulge must be flattened
- resistance is given through the whole motion and always against the direction of the motion
- resistance has to be equal throughout the whole motion with the same force
- resistance shall not affect 2 joints at the same time, if possible
- firstly the tested person executes the asked motion alone, how it is common. After analysing the motion the tested person receives corrections or practise support of the tester.

Procedure

Skeletal muscle function tests were performed in light clothing with musculus iliopsoas, m. rectus femoris, mm. ischiocrurales, mm. adductors, m pectoralis major, m. gluteus medius, m. gluteus maximus, m. erctor spinae thoracis, scapula muscles and mm. abdominales as follows.

❖ musculus iliopsoas (contraction)

Strongest hip flexor, very important for standing, walking and running

- ➢ Initial position: in a dorsal position the pelvis is at the edge of the table, both legs are flexed and pressed to the chest by the subjects´ hands to prevent pre-stretching of the iliopsoas.
- ➢ Testing: the tested person releases one leg and lets it smoothly hang down, drawn only by gravity, while the non tested leg is still kept at the chest.
- ➢ Fixation: by pushing the non tested leg to the chest of the subject
- ➢ Evaluation:
  - 0: no contraction, the thigh is lower or at a horizontal position
  - 1: moderate contraction, the thigh is slightly above the horizontal line, pressing down the thigh gently enables to reach the horizontal line
  - 2: strong contraction, the thigh is clearly above the horizontal line, even soft pressing down onto the thigh does not enable to reach the horizontal position.

- musculus rectus femoris (contraction)
  Hip flexor and knee extensor
  - Initial position: in a ventral position the forehead rests on the back of the hands, lying flat on the couch
  - Testing: the tester now takes one leg, flexes it in the knee joint and presses it towards the buttocks
  - Fixation: by pressing the hip down the couch
  - Evaluation:
    - 0: no contraction, distance from the heel to the buttocks is less than 5cm
    - 1: moderate contraction, distance from the heel to the buttocks is between 5cm and 15cm
    - 2: strong contraction, distance from the heel to the buttocks is more than 15cm

- musculus ischiocrurales (contraction)
  Hip extensor and knee flexor
  - Initial position: in a dorsal position both legs are flexed in the knee joints 90° and rest upright on the couch. Arms are beside the body and relaxed.
  - Testing: the tester takes one extended leg and makes a flexion in the hip.
  - Fixation: by pressing the hip down the couch, additionally a indicator for the tester when the hip starts to move off the couch
  - Evaluation:
    - 0: no contraction, flexion of at least 90° is possible
    - 1: moderate contraction, flexion is only possible from about 80° - 90°
    - 2: strong contraction, flexion is only possible less than 80°

- musculus adductores (contraction)
  Adductors of the thigh
  - Initial position: in a dorsal position the subject lies flat on the couch. Non tested leg is 15° - 20° abducted.
  - Testing: the tester takes one extended leg and abducts it parallel to the surface of the couch as far as possible
  - Fixation: abduction of the non tested leg fixes the hips, additionally the tester touches the underside of the hip to control if the hip starts to move.
  - Evaluation:
    - 0: no contraction, abduction of 40°and more from the sagittal-median plane

- 1: moderate contraction, abduction between 30°- 40° from the sagittal-median plane
- 2: strong contraction, abduction less than 30° from the sagittal-median plane

❖ musculus pectoralis major (contraction)

Adducts the arm

- Initial position: in a dorsal position at the side edge of the couch, knees flexed an sole pressed against the couch with arms beside the body
- Testing: the tester moves the extended arm from a diagonal position starting over the stomach ending over head beside the ears. The tested arm is still extended and relaxed hanging down.
- Fixation: by pulling the shoulder joint diagonal towards the sternum against the movement of the tested arm
- Evaluation:
  - 0: no contraction, the arm is lower or at a horizontal position
  - 1: moderate contraction, the arm is slightly above the horizontal line, pressing down the arm gently enables to reach the horizontal line
  - 2: strong contraction, the arm is clearly above the horizontal line, even soft pressing down on the arm does not enable to reach the horizontal position.

❖ musculus gluteus medius (weakening)

Abducts the leg

- Initial position: in a lateral position with the head resting on the arm, non tested leg is flexed in the hip and knee joints, tested leg is extended with the heel as highest point
- Testing: while the tester presses down the leg with the palm approximately at the lower third of the thigh, the subject tries to abduct the leg as strong as possible against the resistance.
- Fixation: the tester presses down the iliac bone of the hip and simultaneously fells the trochanter major for controlling the movement.
- Evaluation:
  - 3: strongly weak, the leg can be abducted only against gravity
  - 4: moderate weak, the leg can be abducted against a submaximal pressure of the tester with two fingers
  - 5: not weak, the leg can be abducted against a maximal pressure of the tester with the hand

- musculus gluteus maximus (weakening)
  Strong extensor in the hip
  - Initial position: in a ventral position with the head resting on the backside of the hands, one leg extended, the tested leg is flexed in the knee joint for 90°
  - Testing: while the tester presses down the leg with the palm just before the knee joint, the subject tries to push the sole as strong as possible towards the ceiling.
  - Fixation: the tester presses down the hip
  - Evaluation:
    - 3: strongly weak, the leg can be pushed up only against gravity
    - 4: moderate weak, the leg can be pushed up against a submaximal pressure of the tester with two fingers
    - 5: not weak, the leg can be pushed up against a maximal pressure of the tester with the hand

- erector spinae thoracis (weakening)
  Extend the vertebral column
  - Initial position: in a ventral position the end of the rib cage is at the edge of the couch, now the subject lets the upper body hang down the couch
  - Testing: the task is to move the upper body back up again against gravity with different arm positions for approximately 30°over the horizontal line
  - Fixation: the tester fixes the subject at the hip and the legs
  - Evaluation:
    - 3: strongly weak, the upper body can be moved up against gravity with the arms crossed at the chest
    - 4: moderate weak, the upper body can be moved up against gravity with the fingers at the ears
    - 5: not weak, the upper body can be moved up against gravity with the arms extended over head and thumbs pointing upwards

- scapula muscles (weakening)
  Lifting and lowering the scapula
  - Initial position: without wearing a t-shirt in push-up position with knees on the couch, fingers pointing together, head in extension of the spine
  - Testing: the task is to make slow push-ups while the tester observes the position of the scapula

- Evaluation:
  - 3: strongly weak, scapulas lift off the rib cage
  - 4: moderate weak, scapulas stay at the rib cage, but move close together
  - 5: not weak, scapulas stay at the rib cage without moving together

❖ musculus abdominales (weakening)

For movements of the upper body, erection of the hip

- Initial position: in a dorsal position the subject lies flat on the couch with slightly flexed knee joints. A foam coil is located beneath the knees,
- Testing: the task is to make slow motion sit-ups without additional drive and different arm positions
- Evaluation:
  - 3: strongly weak, a sit-up with arms beside the body and moving them forward is possible
  - 4: moderate weak, a sit-up with crossed arms on the chest is possible
  - 5: not weak, a sit-up with elbows in line with the head and fingers at the ears is possible

3.3.15 Balance Test (MFT S3-check) (not evaluated within this thesis)

This test measures the balance ability via an online system. The wooden MFT plate has a diameter of 53cm and is fixed on a base plate through a flexible axis. Therefore the plate is tilt able and depending on how the subject stands on the plate it is either moving from right to left or from heels to toes. In our test, the plate was agile right to left (figure 18)

Material

- MFT S3 plate
- Laptop or PC with software
- Measuring tape
- Adhesive stickers

Number of trials

1 trial procedure per child

Figure 18: MFT Balance Test

Procedure

Without wearing shoes the subject stands in an upright position, with slightly flexed knees and a hip wide stance, hands touching the hips, at the plate. The marks on the plate help to have the exact position from the centre of the plate. The plate is 140cm away from the wall, at the wall, there are 3 white stickers at heights 140cm, 154cm and 170cm from the floor. During the test, the subject has to concentrate on one of the stickers which is comfortable to ones body height. When the subject is set in the correct position, the automated software procedure is started by the tester. The tester only gives advice what the subject has to do as follows:

- 15 seconds warm up on the plate (trying to get a feeling for the shaky plate)
- 10 seconds break with the plate down on one side
- 5 seconds for finding the balance again
- 30 seconds test phase (trying to keep the plate in balance as good as possible)
- 10 seconds break with the plate down on one side
- 5 seconds for finding the balance again
- 30 seconds second test phase (trying to keep the plate in balance as good as possible)

Scoring

The best trial is evaluated by the software. The parameters are stability, sensomotor ability and symmetry of the balance. Reference values are based on the subjects´ age.

Comments

It is important that the tester makes precise instructions as the test program cannot be stopped during the test. The correct position, especially of the feet, hands and the head needs to be observed and corrected at all time to have reliable results.

3.4 Statistical Analysis

For all analyses, SPSS 17 was used. All parameters are presented by indicating the median followed by minimum and maximum. Statistical comparisons were performed between the two school types using t-test for independent samples, whereby the study population was separated by age groups and gender. A p-value below 0.05 was considered statistically significant and marked with a "*". P-values below 0.01 were considered statistically very significant and marked with "**". P-values below 0.001 were considered statistically highly significant and marked with "***" throughout the whole thesis.

4. Presentation and Interpretation of the Results

In the following chapter the sample will be described and results will be presented in figures and tables to explain all found correlations.

4.1 Description of the Sample

The total sample of this pilot study consists of 344 pupils aged 10 to 19 years whereas 329 pupils participated at the whole motor test battery. 286 pupils delivered complete data of the medical tests at the ÖISM. The sample is described as follows.

4.1.1 Age Groups and Age Distribution

For analysing this pilot study, the sample was divided into 4 age groups to increase the statistical power of the results. Following age groups were formed (table 9).

Table 9: Sample size within each age group and test battery

Age group	Age	Sample size motor tests	Sample size medical tests
U12	<12 years	92	73
U14	12 -13,99 years	81	67
U16	14 - 15,99 years	65	59
U19	>16 years	91	87

4.1.2 Gender Distribution

The following figure 19 shows the distribution of girls and boys within each age group of the motor test battery.

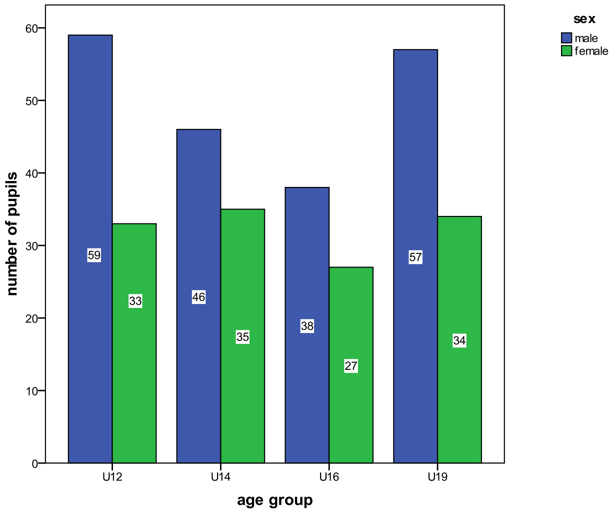


Figure 19: Distribution of female and male pupils within each age group

As shown above, there is a predominant majority of male participants throughout all age groups. In the groups of U12 and U19 nearly two thirds of the pupils are male, while in the groups of U14 and U16 the distribution is a little more balanced with roughly every second pupil being male.

4.1.3 Type of School

One main reason for this study is to show differences, if there are any differences, between regular and elite sports school-aged children and adolescents in terms of motor abilities, fitness levels and in health status.

The following figure 20 on the left shows the distribution of children attending the regular school or the elite sports school by sex and age group who participated at the motor test battery.

In both genders, the distribution of male and female participants' levels out as the pupils get older. But in general, more children from the regular school took part. This is not surprising as there are more regular classes than elite sports classes at the school and it was a bigger problem, if a pupil from a elite sports class did not want to participate than a pupil from the regular school as there were far more pupils anyway.

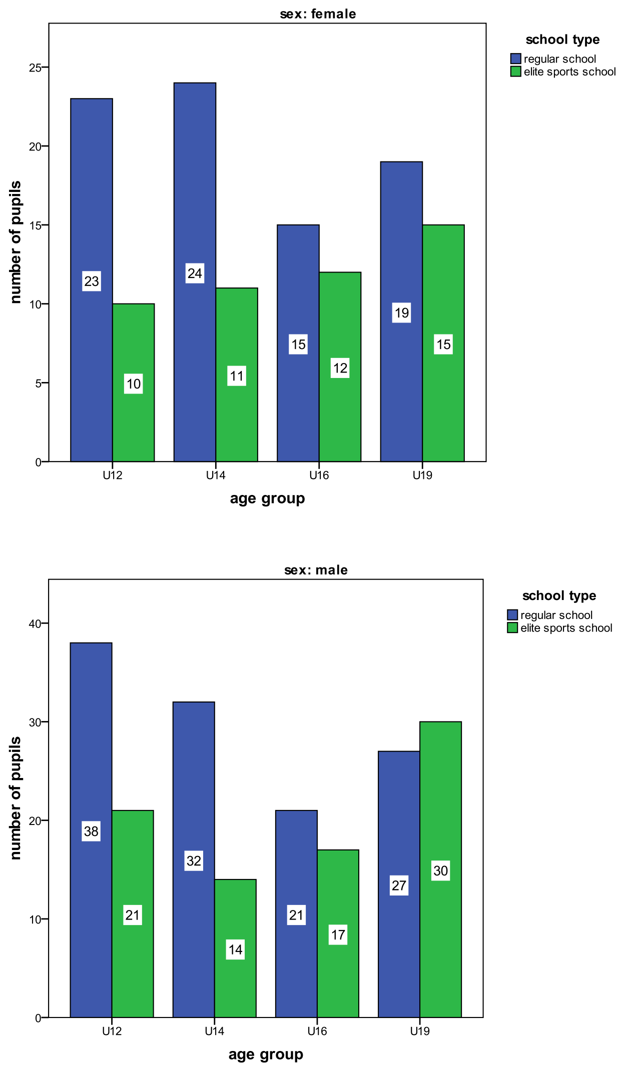


Figure 20: Distribution of female and male pupils within each age group and school type

4.2 Results of Anthropometry

Descriptive statistics of the girls and boys from both school types for four age groups are shown in tables 10 to 14. In the age group U12, boys from regular school had significantly (p=0.025) larger waist circumferences. In the age group U14 there were no differences found between girls and boys in both school types regarding their anthropometry. In the age group U16, girls from the elite sports school were significantly heavier (11%) and had significantly larger waist circumferences (7%). In the last age group, the U19, girls from the elite sports school were significantly taller (p=0.016), heavier (p=0.029) and had larger waist circumferences (p=0.024). That was the only group (U19) where boys from the elite sports school were significantly heavier (10%) than boys from the regular school.

Table 10: Anthropometric parameters for age group U12, by school type and gender

	Regular school				Elite sports school			
	Girls (N=23)		Boys (N=38)		Girls (N=10)		Boys (N=21)	
U12	Median	(Min, Max)	Median	(Min, Max)	Median	(Min, Max)	Median	(Min, Max)
age (years)	11.15	(10.23, 11.99)	10.97	(10.18, 11.86)	11.41	(10.32, 11.80)	11.32	(9.94, 11.98)
height (cm)	151.6	(139.0, 163.2)	146.5	(137.0, 164.0)	148.5	(138.0, 158.0)	148.0	(132.0, 164.0)
body mass (kg)	39.7	(27.8, 73.6)	37.4	(27.5, 61.2)	39.1	(33.2, 50.0)	36.9	(29.3, 48.5)
BMI (kg/m²)	17.4	(14.1, 28.1)	17.4	(14.1, 26.1)	17.9	(15.7, 20.5)	17.3	(15.4, 20.3)
	N=19		N=24		N=10		N=20	
waist circumf (cm)	60.4	(52.8, 71.0)	62.5*	(54.8, 75.2)	60.1	(57.1, 74.3)	59.6	(53.7, 66.8)

Table 11: Anthropometric parameters for age group U14, by school type and gender

	Regular school				Elite sports school			
	Girls (N=24)		Boys (N=32)		Girls (N=11)		Boys (N=14)	
U14	Median	(Min, Max)	Median	(Min, Max)	Median	(Min, Max)	Median	(Min, Max)
age (years)	12.86	(12.17, 13.99)	12.86	(12.16, 13.91)	13.33	(12.36, 13.86)	13.04	(12.06, 13.80)
height (cm)	159.3	(134.0, 174.5)	155.0	(134.0, 182.5)	160.0	(151.0, 191.5)	157.0	(139.0, 172.0)
body mass (kg)	48.2	(27.5, 71.1)	47.7	(27.8, 78.7)	55.7	(38.4, 76.0)	44.6	(31.4, 65.1)
BMI (kg/m²)	18.6	(14.5, 25.5)	19.0	(14.6, 28.9)	19.3	(16.8, 23.4)	18.3	(14.1, 22.3)
	N=15		N=20		N=11		N=14	
waist circumf (cm)	63.6	(54.1, 83.0)	64.5	(55.2, 88.0)	67.1	(58.6, 74.1)	64.5	(58.7, 74.5)

Table 12: Anthropometric parameters for age group U16, by school type and gender

	Regular school				Elite sports school			
	Girls (N=15)		Boys (N=21)		Girls (N=12)		Boys (N=17)	
U16	Median	(Min, Max)	Median	(Min, Max)	Median	(Min, Max)	Median	(Min, Max)
age (years)	14.43	(14.01, 15.63)	14.92	(14.08, 15.85)	14.84	(14.00, 15.98)	15.01	(14.31, 15.99)
height (cm)	165.0	(155.0, 177.7)	170.2	(150.2, 190.5)	167.1	(160.5, 174.9)	170.0	(155.0, 187.0)
body mass (kg)	51.5	(45.2, 81.0)	61.3	(36.0, 79.6)	57.7*	(55.6, 75.7)	61.9	(42.1, 78.2)
BMI (kg/m²)	19.4	(14.5, 33.7)	19.6	(15.9, 28.8)	20.8	(19.2, 26.4)	21.6	(16.6, 23.5)
	N=9		N=19		N=12		N=15	
waist circumf (cm)	63.2	(59.2, 84.2)	71.0	(65.8, 86.3)	68.2*	(62.7, 80.0)	73.5	(62.7, 83.3)

Table 13: Anthropometric parameters for age group U19, by school type and gender

	Regular school				Elite sports school			
	Girls (N=19)		Boys (N=27)		Girls (N=15)		Boys (N=30)	
U19	Median	(Min, Max)	Median	(Min, Max)	Median	(Min, Max)	Median	(Min, Max)
age (years)	16.74	(16.01, 18.20)	17.21	(16.03, 18.56)	17.21	(16.31, 18.12)	16.90	(16.01, 18.71)
height (cm)	164.0	(153.5, 175.0)	179.0	(160.0, 191.0)	169.9*	(159.6, 188.0)	178.7	(171.5, 203.5)
body mass (kg)	55.1	(40.0, 92.6)	66.7	(37.7, 89.1)	60.2*	(49.8, 89.3)	73.5*	(59.6, 91.7)
BMI (kg/m²)	20.2	(15.1, 30.2)	21.1	(14.7, 27.2)	20.6	(19.6, 31.3)	22,0	(19.1, 27.4)
	N=18		N=23		N=15		N=26	
waist circumf (cm)	64.9	(57.1, 86.6)	75.7	(60.3, 83.9)	67.7*	(62.5, 87.7)	77.2	(70.0, 89.2)

4.3 Comparison of Motor Performances

Results of motor performances are presented by gender at first. Within each gender a comparison between 4 age groups and 2 school types is indicated and a possible trend in terms of an increase or decrease of motor performance can be obvious.

After description of each motor performance test a summary of all statistical findings will give an overview in each age group and gender regarding the school type.

4.3.1 Medicine Ball Throw

To determine upper body strength and explosive power of the pupils, a medicine ball throw test was performed. Results are shown in figure 22 and table 14.

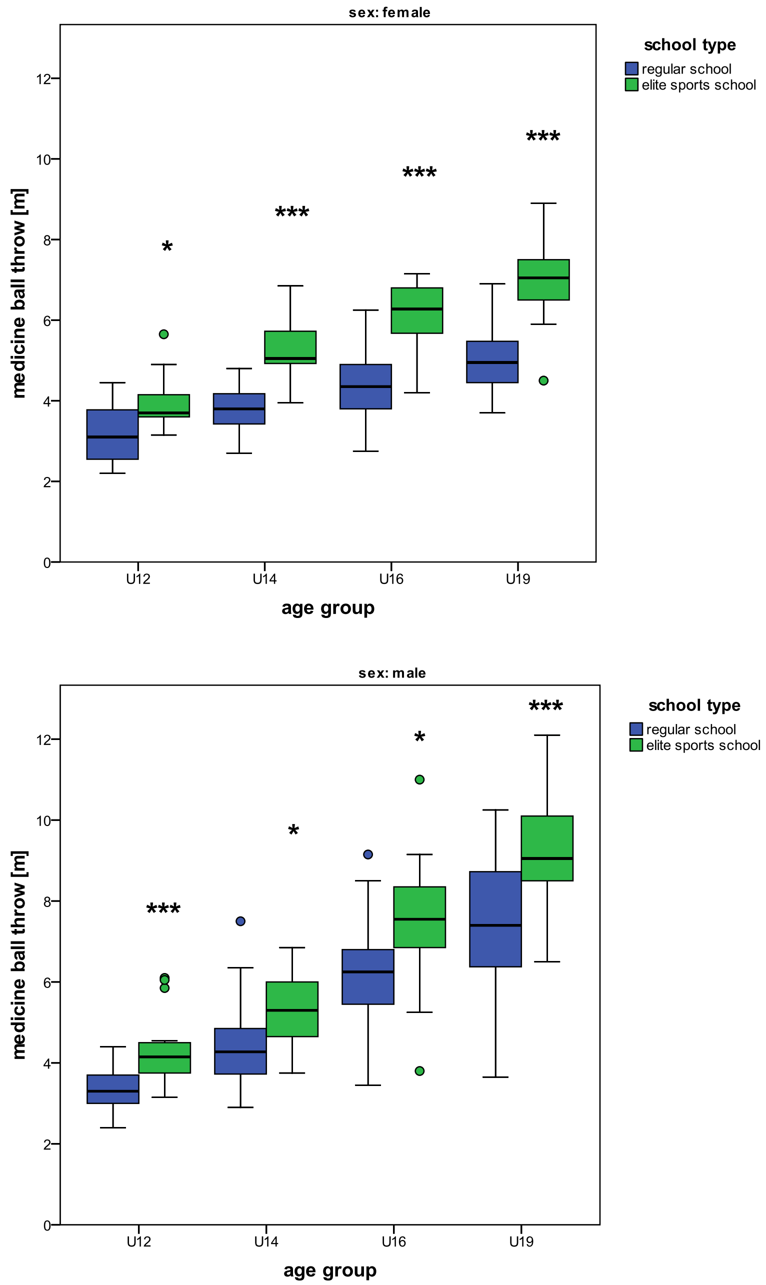


Figure 21: Influence of school type, age group and sex on medicine ball throw performance

Statistical comparisons were performed separately for girls and boys. A univariate factor analysis showed a significant influence of school type (p=0.000) and age group (p=0.000) regarding the girls´ medicine ball throw performance. Older girls are significantly better in the medicine ball throw compared to their younger colleagues (from U12 to U19: +60% in regular and +91% in elite sports school). In the male group school type and age group have significant influence (p=0.000 and p=0.000, respectively) on throwing performance as well. The performance increased within the male group from U12 to U19 by 124% in the regular school and by 118% in the elite sport school. Regarding differences due to school type, girls from the elite sports school performed significantly better in all 4 age groups (U12: +19%, p=0.011; U14: +33%, p=0.000; U16: +44%, p=0.000; U19: +42%, p=0.000). Boys from the elite sports school performed significantly better in every age group as well (U12: +26%, p=0.000; U14: +24%, p=0.012; U16: +21%, p=0.015; U19: +22%, p=0.000).

Table 14: Median, range and sample size of medicine ball throw performance [m]

	regular school						elite sports school					
	female			male			female			male		
	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)
U12	23	3.10	(2.20, 4.45)	38	3.30	(2.40, 4.40)	10	3.70	(3.15, 5.65)	21	4.15	(3.15, 6.10)
U14	24	3.80	(2.70, 4.80)	32	4.28	(2.90, 7.50)	11	5.05	(3.95, 6.85)	13	5.30	(3.75, 6.85)
U16	15	4.35	(2.75, 6.25)	21	6.25	(3.45, 9.15)	12	6.28	(4.20, 7.15)	17	7.55	(3.80, 11.00)
U19	19	4.95	(3.70, 6.90)	27	7.40	(3.65, 10.25)	13	7.05	(4.50, 8.90)	30	9.05	(6.50, 12.10)

4.3.2 Maximum Handgrip Test

To test the maximum isometric strength of the hand and forearm muscles a maximum handgrip test was performed. 120 girls were right handed and 9 girls had their dominant side on the left. From 200 boys to be tested, 181 were right handed and 19 left handed. The results are presented first for the dominant side followed by the non-dominant side.

1.1.1.1 Dominant Side

Results for the dominant side with the dominant hand are shown in figure 23 and table 15.

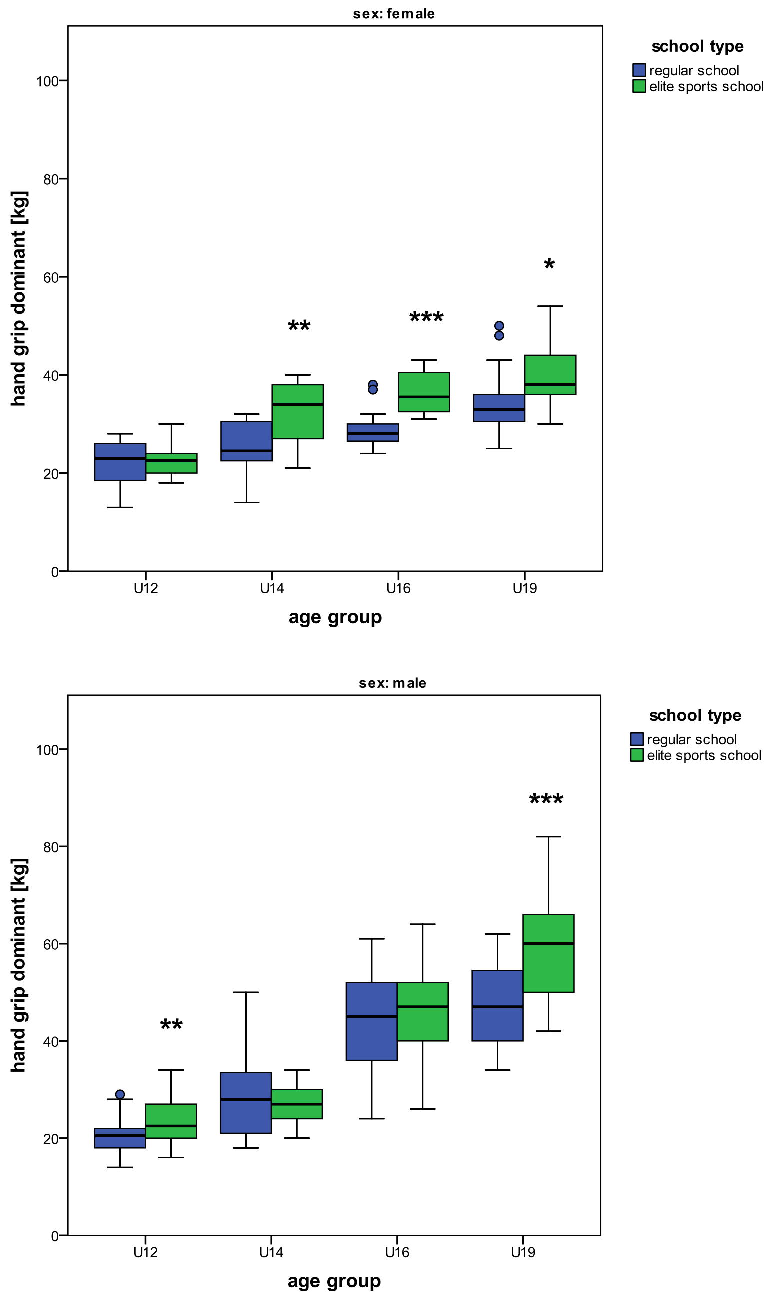


Figure 22: Influence of school type, age group and sex on handgrip performance

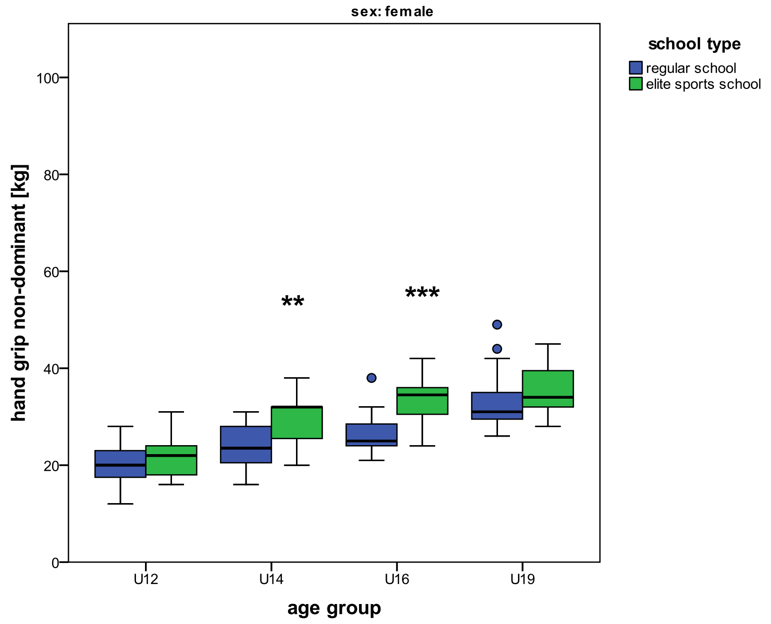
Statistical comparisons were performed separately for girls and boys. A univariate factor analysis revealed a significant influence of school type (p=0.000) and age group (p=0.000) regarding the girls´ dominant handgrip performance. Older girls perform significantly better in the maximum handgrip test with the dominant hand compared to their younger colleagues (from U12 to U19: +43% in regular and +69% in elite sports school). In the male group the fixed factors school type and age group show significant differences as well (p=0.001 and p=0.000, respectively) and therefore both influence the performance in maximum handgrip test with the dominant hand. The performance increased within the male group from U12 to U19 by 129% in the regular and by 167% in the elite sports school. Regarding differences due to the school type, girls from the elite sports school performed significantly better above the age of 12 years (U14: +39%, p=0.0013; U16: +27%, p=0.000; U19: +15%, p=0.045) while in the girls aged between 10 and 12 years no differences between the school types could be detected (p=0.699). Boys from the elite sports school performed better in age groups U12 (+10%, p=0.009) and U19 (+28%, p=0.000) while in the age groups of U14 (-4%, p=0.547) and U16 (+4%, p=0.470) no significant difference was found.

Table 15: Median, range and sample size of handgrip performance at the dominant side [kg]

	regular school						elite sports school					
	female			male			female			male		
	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)
U12	23	23.0	(13, 28)	38	20.5	(14, 29)	10	22.5	(18, 30)	20	22.5	(16, 34)
U14	24	24.5	(14, 32)	32	28.0	(18, 50)	11	34.0	(21, 40)	13	27.0	(20, 34)
U16	15	28.0	(24, 38)	21	45.0	(24, 61)	12	35.5	(31, 43)	17	47.0	(26, 64)
U19	19	33.0	(25, 50)	27	47.0	(34, 62)	14	38.0	(30, 54)	30	60.0	(42, 82)

1.1.1.2 Non-Dominant Side

Results for the maximum handgrip test with the non-dominant hand are shown in figure 24 and table 16.



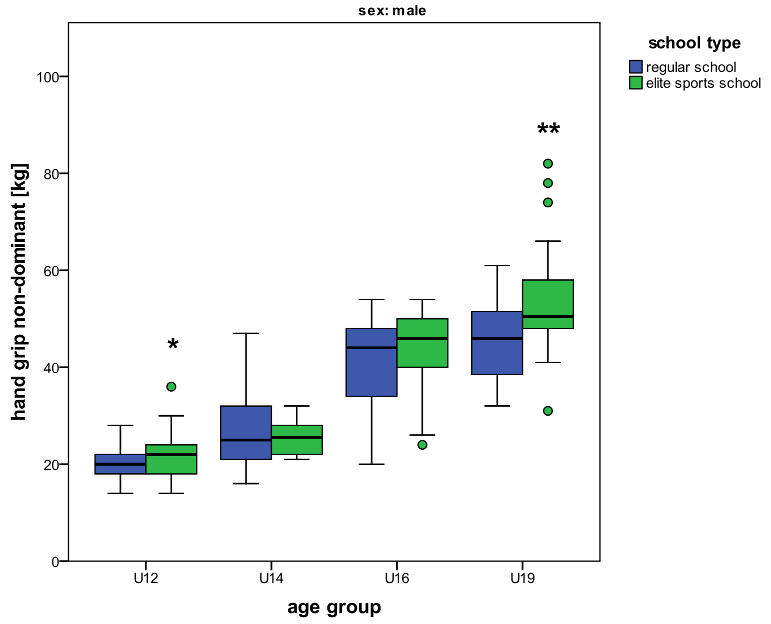


Figure 23: Influence of school type, age group and sex on handgrip performance

As before, statistical comparisons were performed separately for girls and boys. A univariate factor analysis indicated a significant influence of the school type (p=0.000) and the age group (p=0.000) regarding the girls´ non-dominant hand grip performance as well. Older girls significantly perform better in the maximum handgrip test with the non-dominant hand compared to their younger colleagues (from U12 to U19: +55% in regular and in elite sport school). In the male group school type and age group are found to be significant factors as well (p=0.004 and p=0.000) and therefore both influence the performance in maximum handgrip test with the non-dominant hand. The performance increased within the male group from U12 to U19 by 130% in both school types.

Regarding differences due to the school type, girls from the elite sports school performed significantly better in 2 age groups (U14: +36%, p=0.003; U16: +38%, p=0.0006) while below the age 12 years and above the age of 16 years the difference in performances did not reach statistical significance (U12: +10%, p=0.299; U19: +10%, p=0.270). Boys from the elite sports school performed better below the age of 12 years (+10%, p=0.029) and above 16 years (+10%, p=0.005) while in the age groups of U14 (+2%, p=0.888) and U16 (+5%, p=0.265) no significant difference could be detected.

Table 16: Median, range and sample size of handgrip performance at the non-dominant side [kg]

	regular school						elite sports school					
	female			male			female			male		
	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)
U12	23	20.0	(12, 28)	38	20.0	(14, 28)	9	22.0	(16, 31)	21	22.0	(14, 36)
U14	24	23.5	(16, 31)	32	25.0	(16, 47)	11	32.0	(20, 38)	14	25.5	(21, 32)
U16	15	25.0	(21, 38)	21	44.0	(20, 54)	12	34.5	(24, 42)	17	46.0	(24, 54)
U19	19	31.0	(26, 49)	27	46.0	(32, 61)	15	34.0	(28, 45)	30	50.5	(31, 82)

4.3.3 Standing Broad Jump

This test was used to assess the maximum explosive leg power of the children. Results for standing broad jump are presented in figure 25 and table 17.

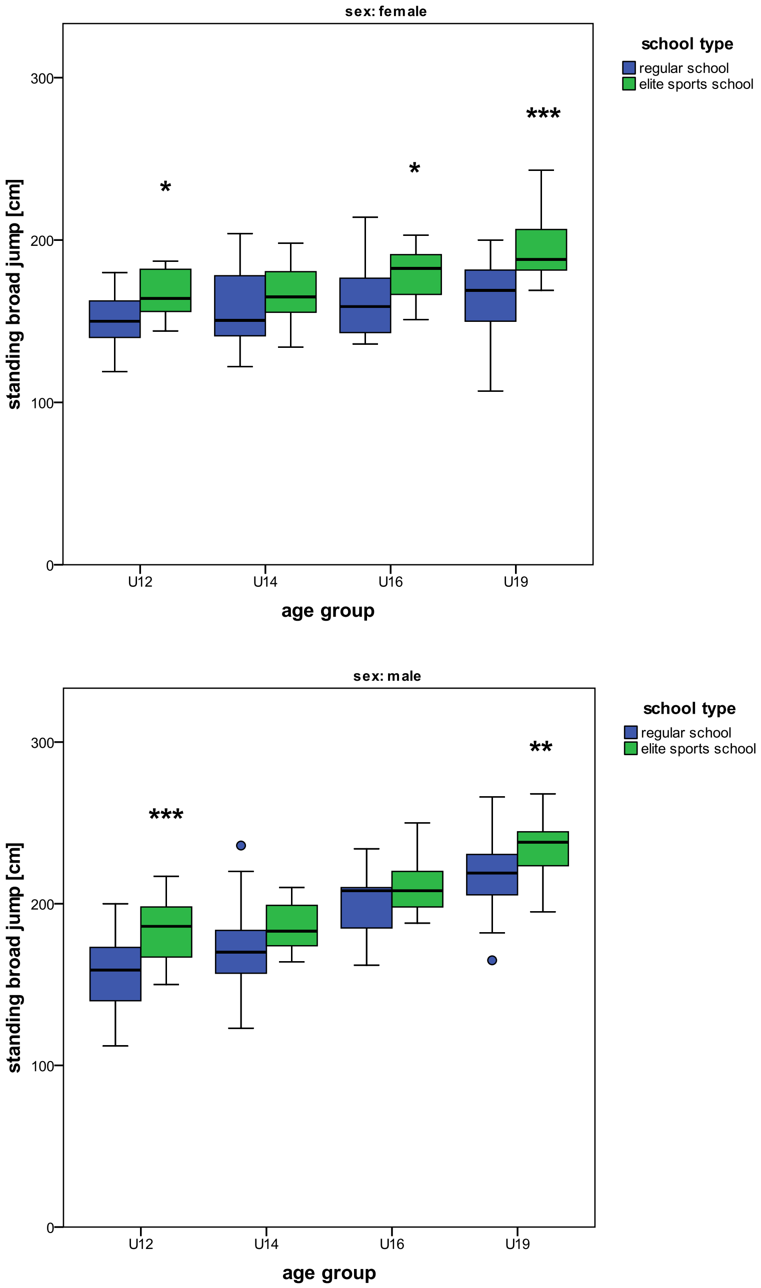


Figure 24: Influence of school type, age group and sex on standing broad jump performance

Statistical comparisons were performed separately for girls and boys. A univariate factor analysis revealed a significant influence of school type (p=0.000) and age group (0.001) regarding the girls´ standing broad jump performance. Older girls jump significantly longer compared to their younger colleagues (from U12 to U19: +13% in regular school, +15% in elite sports school). School type and age in the male group are significant as well (p=0.000 and p=0.000, respectively) and therefore both influence the performance in standing broad jump test. The performance increased within the male group from U12 to U19 by 38% in the regular and by 28% in the elite sports school. Regarding differences due to the school type, girls from the elite sports school performed significantly better in 3 age groups (U12: +9%, p=0.029; U16: +15%, p=0.040; U19: +11%, p=0.000) while in the age from 12 to 14 years not even a trend was found (p=0.252). Boys from the elite sports school performed significantly better below 12 (+17%, p=0.000) and above 16 years (+9%, p=0.002). In the age between 12 (U14: p=0.080) and 16 (U16: p=0.068) only trends were detectable which did not reach statistical significance.

Table 17: Median, range and sample size of standing broad jump performance [cm]

	regular school						elite sports school					
	female			male			female			male		
	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)
U12	23	150	(119, 180)	38	159	(112, 200)	10	164	(144, 187)	21	186	(150, 217)
U14	24	150.5	(122, 204)	31	170	(123, 236)	11	165	(134, 198)	13	183	(164, 210)
U16	15	159	(136, 214)	21	208	(162, 234)	12	182.5	(151, 203)	17	208	(188, 250)
U19	19	169	(107, 200)	27	219	(165, 266)	15	188	(169, 243)	28	238	(195, 268)

4.3.4 Vertical Jump Test - Muscle Stiffness Index

To test the reactive power of the lower limbs during the stretch shortening cycle and the ability of energy storage of muscles and tendons there, we performed a vertical jump test on a jumping plate. Results for vertical jump test are shown in figure 26 and table 18.

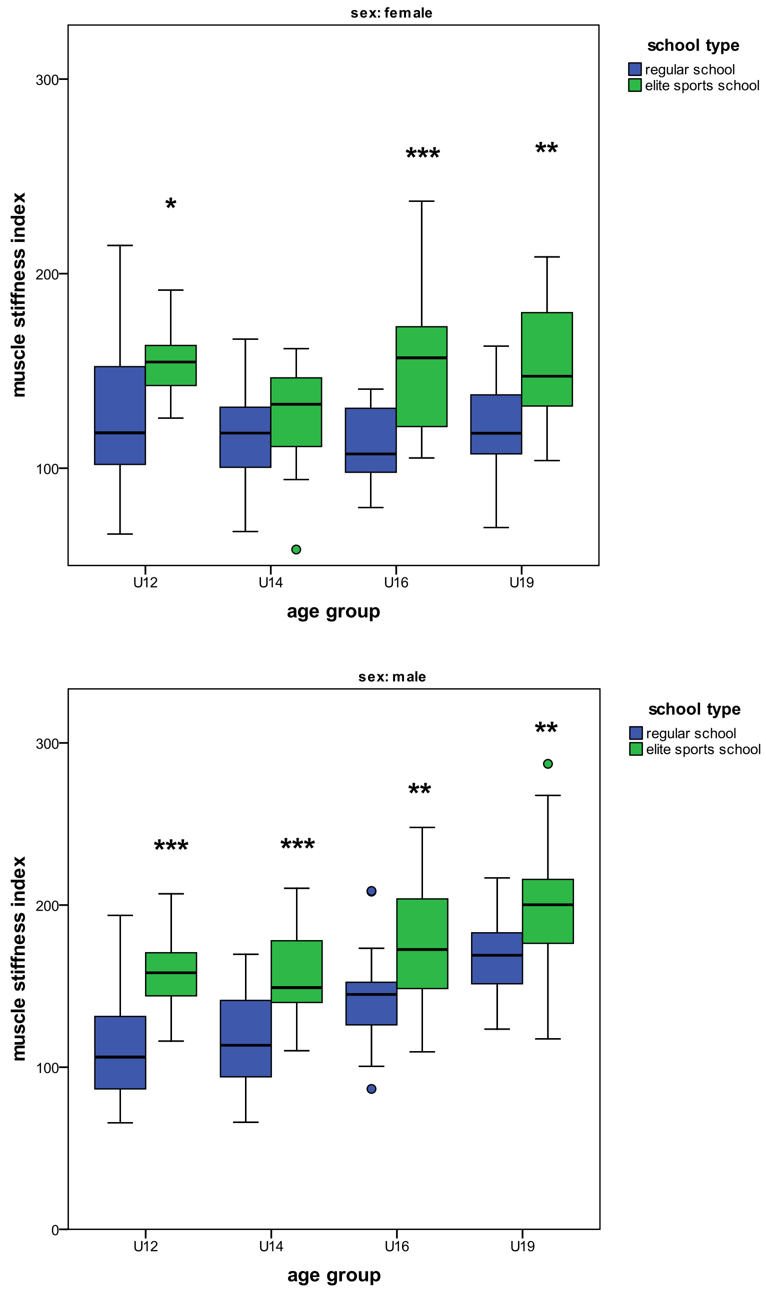


Figure 25: Influence of school type, age group and sex on vertical jump test performance

Statistical comparisons were performed separately for girls and boys. A univariate factor analysis revealed a difference in the girls´ vertical jump test performance which is only significantly (p=0.000) related to the school type, but not to the age group (p=0.157). Older girls do not perform significantly better in the vertical jump test compared to their younger colleagues (from U12 to U19: 0% in regular school, -5% in elite sports school). In the male group school type and age are highly significant (p=0.000 and p=0.000, respectively) and therefore both influence the performance in vertical jump test. The performance increased within the male age group from U12 to U19 by 59% in the regular and by 27% in the elite sports school. Regarding differences due to the school type, girls from the elite sports school performed significantly better in 3 age groups (U12: +31%, p=0.012; U16: +47%, p=0.0009; U19: +25%, p=0.002) while from 12 to 14 years we found no significant difference (+13%, p=0.382). Boys from the elite sports school performed significantly better in every age group (U12: +49%, p=0.000; U14: +31%, p=0.000; U16: +19%, p=0.003; U19: +18%, p=0.0014).

Table 18: Median, range and sample size of muscle stiffness index in the vertical jump test

	regular school						elite sports school					
	female			male			female			male		
	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)
U12	23	118	(66, 215)	38	106	(66, 194)	10	155	(126, 192)	21	158	(116, 207)
U14	24	118	(68, 166)	32	114	(66, 170)	11	133	(58, 161)	14	149	(110, 210)
U16	15	107	(80, 141)	21	145	(87, 209)	12	157	(105, 237)	17	173	(110, 248)
U19	19	118	(70, 163)	27	169	(124, 217)	15	147	(104, 209)	28	200	(117, 287)

4.3.5 Sprint 20m

The aim of this test is to determine maximum running speed and is also a reliable indicator for agility and quickness. Results are presented in figure 27 and table 19.

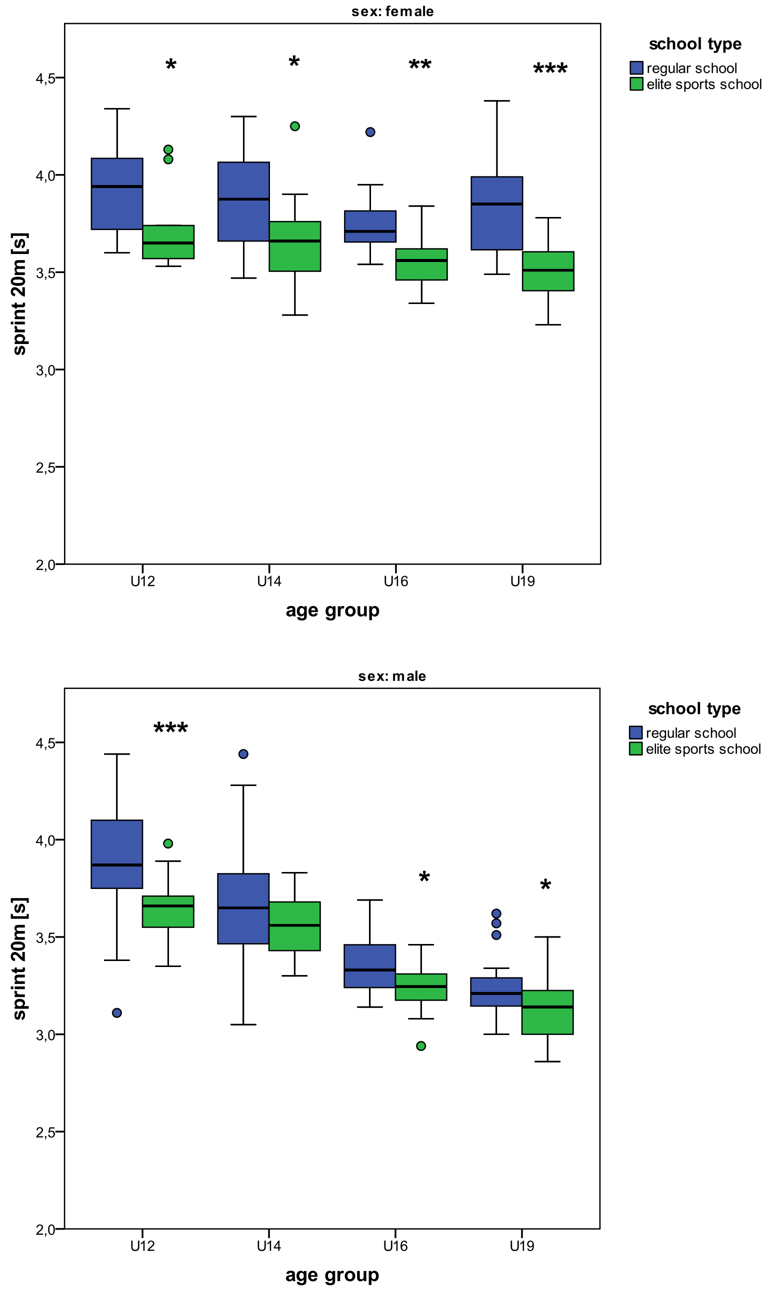


Figure 26: Influence of school type, age group and sex on sprint performance

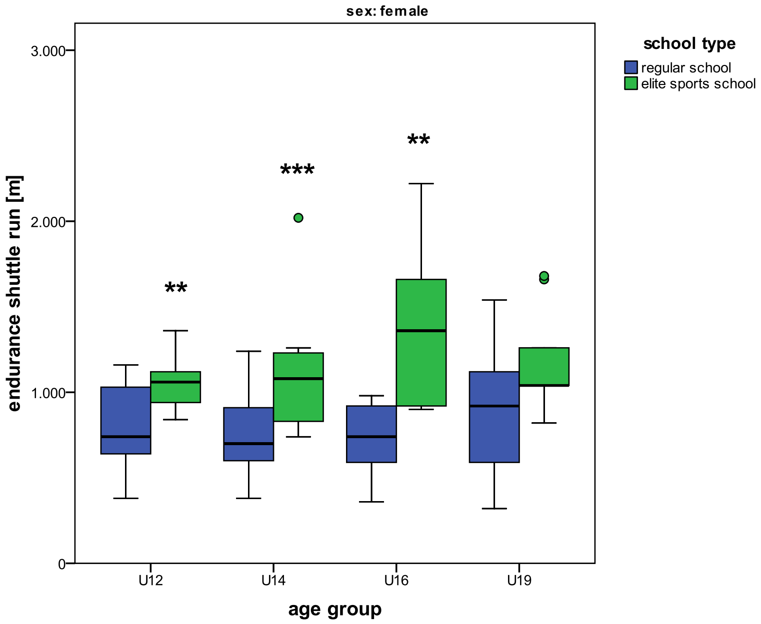
Statistical comparisons were executed separately for girls and boys. A univariate factor analysis revealed a significant influence of school type (p=0.000) and age (p=0.009) regarding the girls´ sprint performance. Older girls are significantly quicker compared to their younger colleagues (from U12 to U19: +2% in regular and +4% in elite sports school). In the male group school type and age show significant difference as well (p=0.000) and therefore both influence the performance in the 20m sprint test. The performance increased within the male group from U12 to U19 by 17% in the regular and by 14% in the elite sport school. Regarding differences due to the school type, girls from the elite sports school performed significantly better in every age group (U12: +7%, p=0.022; U14: +5%, p=0.037; U16: +4%, p=0.005; U19: +9%, p=0.000). On the other hand, boys from the elite sports school performed significantly better in 3 age groups (U12: +6%, p=0.000; U16: +2%, p=0.022; U19: +2%, p=0.026). Boys between the age from 12 to 14 did not perform differently in both school types (p=0.225).

Table 19: Median, range and sample size of sprint performance [s]

	regular school						elite sports school					
	female			male			female			male		
	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)
U12	23	3.94	(3.60, 4.34)	38	3.87	(3.11, 4.44)	10	3.65	(3.53, 4.13)	21	3.66	(3.35, 3.98)
U14	24	3.87	(3.47, 4.30)	32	3.65	(3.05, 4.44)	11	3.66	(3.28, 4.25)	14	3.56	(3.30, 3.83)
U16	15	3.71	(3.54, 4.22)	21	3.33	(3.14, 3.69)	11	3.56	(3.34, 3.84)	17	3.25	(2.94, 3.46)
U19	19	3.85	(3.49, 4.38)	27	3.21	(3.00, 3.62)	15	3.51	(3.23, 3.78)	27	3.14	(2.86, 3.50)

4.3.6 Endurance Shuttle Run

This running test was used to assess the maximal aerobic fitness of the children. Results for the endurance shuttle run are presented in figure 28 and table 20.



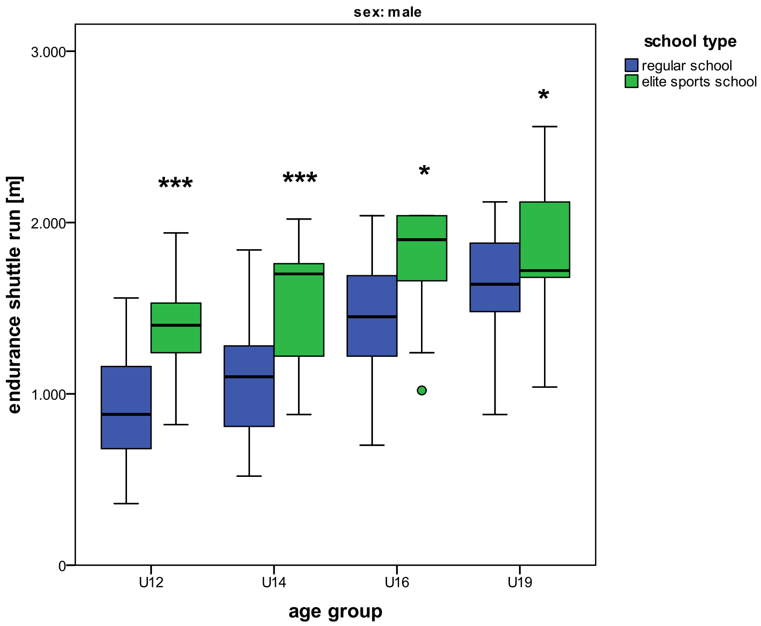


Figure 27: Influence of school type, age group and sex on shuttle run performance

Statistical comparisons were performed separately for girls and boys. A univariate factor analysis stated a significant difference in the girls´ endurance shuttle run performance which is only related to the school type (p=0.000), but not to the age group (p=0.227). Older girls are not significantly better in the shuttle run test compared to their younger colleagues (from U12 to U19: +24% in regular school, -2% in elite sports school). In the male group school type and age are significant (p=0.000 and p=0.000, respectively) and therefore both influence the performance in endurance shuttle run test. The performance increased within the male group from U12 to U19 by 86% in the regular school and by 23% in the elite sports school. Regarding differences due to the school type, girls from the elite sports school performed significantly better below the age of 16 years (U12: +43%, p=0.003; U14: +54%, p=0.0009; U16: +84%, p=0.002) while at the age of over 16 years, a trend was found which did not reach statistical significance (+13%, p=0.059). Boys from the elite sports school performed significantly better at the shuttle run test in every age group (U12: +59%, p=0.000; U14: +54%, p=0.000; U16: +31%, p=0.033; U19: +5%, p=0.035).

Table 20: Median, range and sample size of shuttle run performance [m]

	regular school						elite sports school					
	female			male			female			male		
	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)
U12	23	740	(380,1160)	38	880	(360,1560)	9	1060	(840,1360)	20	1400	(820,1940)
U14	23	700	(380,1240)	31	1100	(520,1840)	11	1080	(740,2020)	13	1700	(880,2020)
U16	15	740	(360,980)	20	1450	(700,2040)	9	1360	(900,2220)	10	1900	(1020,2040)
U19	19	920	(320,1540)	26	1640	(880,2120)	9	1040	(820,1680)	26	1720	(1040,2560)

4.3.7 Cycle Ergometer Test

This test was used to assess the maximum aerobic fitness of the children on a cycle ergometer. Aerobic fitness is expressed as relative power in watt/kg. Results for the cycle ergometer test are presented in figure 29 and table 21 as follows.

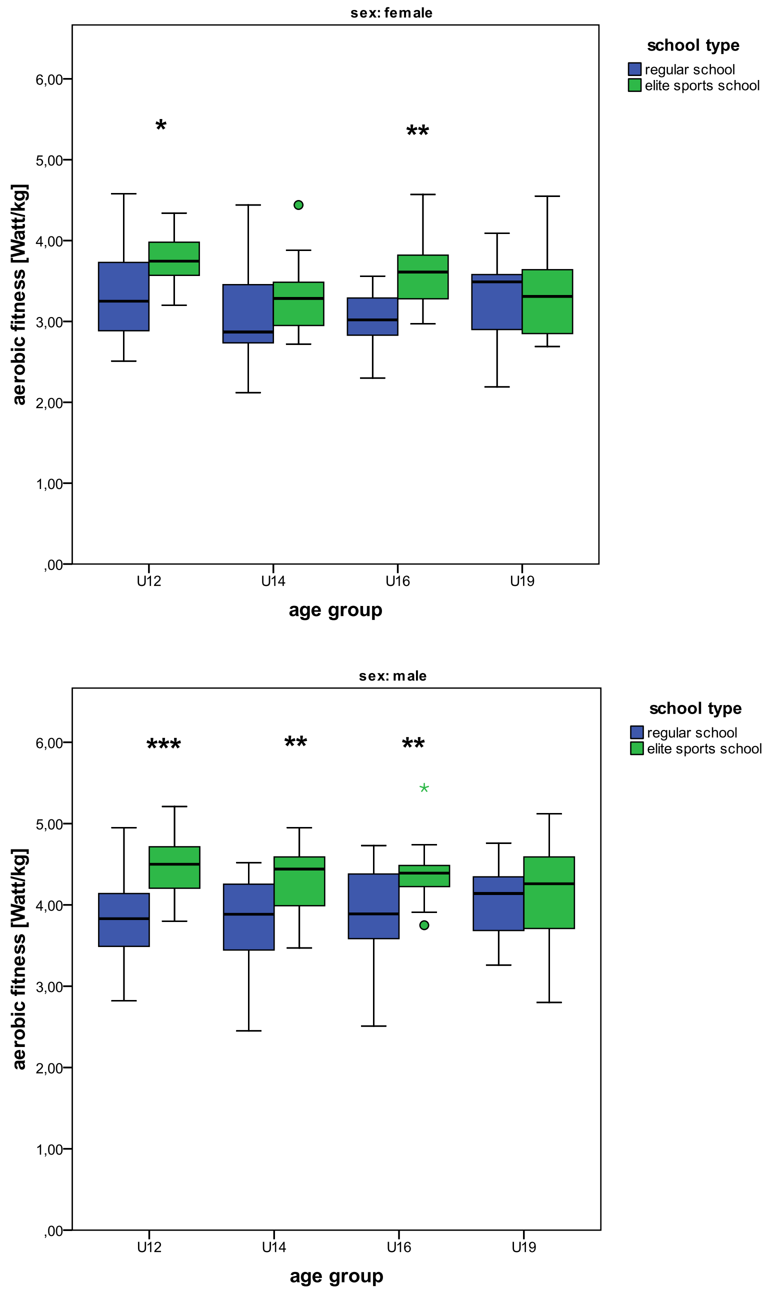


Figure 28: Influence of school type, age group and sex on cycle ergometer performance

Statistical comparisons were performed separately for girls and boys. A univariate factor analysis revealed a significant influence of school type (p=0.001) but not of the age group (p=0.105) regarding the girls´ cycle performance. Older girls do not perform significantly better in the cycle ergometer test compared to their younger colleagues (from U12 to U19: +7% in regular school, -13% in elite sports school). Looking at the boys results, only school type (p=0.000) has a significant influence on cycle performance. Age of boys has no statistical influence (p=0.671) and therefore does not influence the performance in cycle ergometer test. The performance increased within the male group from U12 to U19 by 8% in the regular and decreased by 5% in the elite sports school. Regarding differences due to the school type, girls from the elite sports school performed significantly better in 2 age groups (U12: +15%, p=0.024; U16: +20%, p=0.003) while in the age from 12 to 14 years and above 16 years no significant difference occurred (U14: p=0.235; U19: p=0.917). Boys from the elite sports school performed significantly better below the age of 16 in every age group (U12: +17%, p=0.000; U14: +15%, p=0.003, U16: +13%, p=0.007). Above the age of 16 years no statistical difference could be detected in the male group between the school types (p=0.424).

Table 21: Median, range and sample size of cycle ergometer performance [watt/kg]

	regular school						elite sports school					
	female			male			female			male		
	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)
U12	19	3.25	(2.51, 4.58)	24	3.83	(2.82, 4.95)	10	3.75	(3.20, 4.34)	20	4.50	(3.80, 5.21)
U14	16	2.87	(2.12, 4.44)	20	3.86	(2.45, 4.52)	12	3.29	(2.72, 4.44)	19	4.44	(3.47, 4.95)
U16	11	3.02	(2.30, 3.56)	20	3.89	(2.51, 4.73)	13	3.61	(2.97, 4.57)	15	4.39	(3.75, 5.44)
U19	18	3.49	(2.19, 4.09)	23	4.14	(3.26, 4.76)	18	3.31	(2.69, 4.55)	26	4.26	(2.80, 5.12)

4.3.8 Sit & Reach

This sit & reach test measures the flexibility of the lower back and hamstring muscles. Results are shown in figure 30 and table 22 as follows.

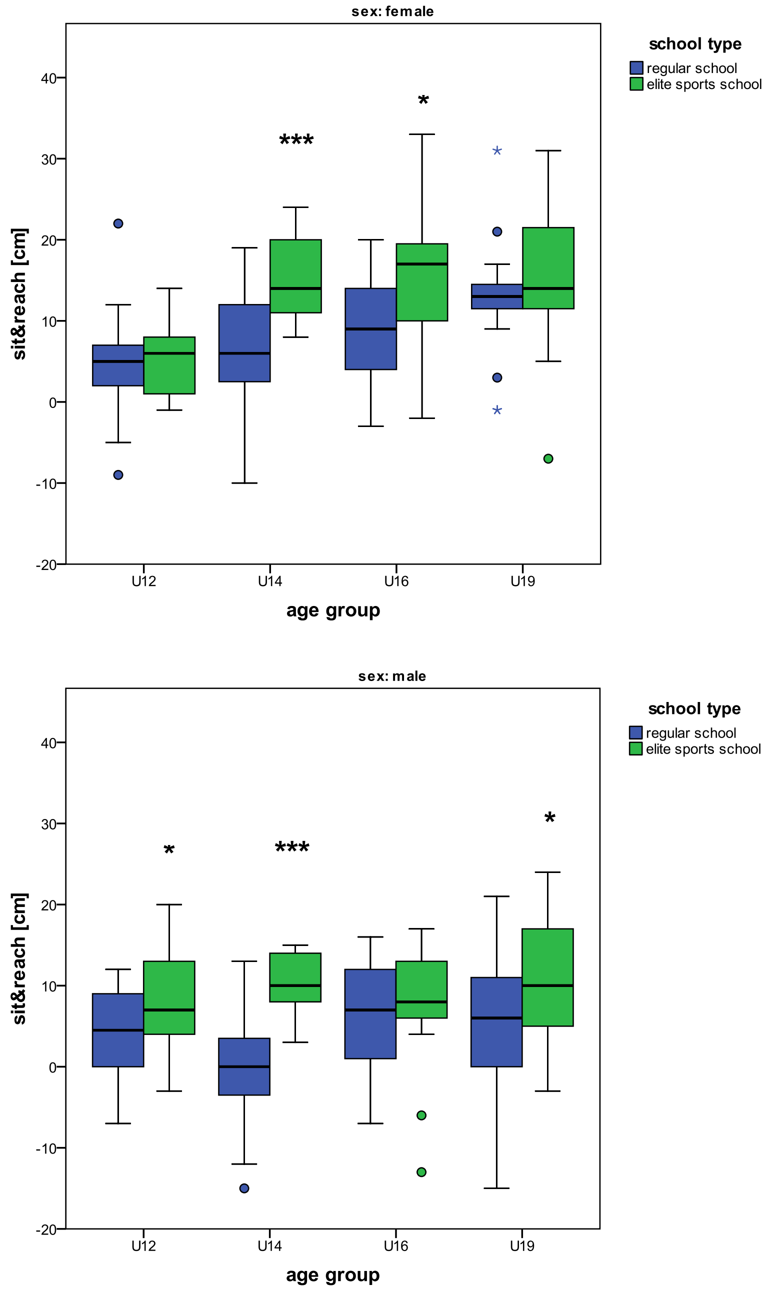


Figure 29: Influence of school type, age group and sex on sit & reach performance

At first, statistical comparisons were performed separately for girls and boys. A univariate factor analysis clarified a significant influence of the school type (p=0.000) and the age group (p=0.009) regarding the girls´ flexibility. Older girls are significantly more flexible compared to their younger colleagues (from U12 to U19: +8cm in regular and in elite sports school). In the male group only the school type is significant (p=0.000) while the age was not statistical significant (p=0.173) and therefore only the school type influences the boys´ performance in the sit & reach test. The boys´ performance increased from U12 to U19 by 1.5cm in the regular school and by 3cm in the elite sports school. Regarding differences due to school type, girls from the elite sports school performed significantly better from 12 to 16 years (U14: +8cm, p=0.0009; U16: +8cm, p=0.031) while in the girls aged below 12 and above 16 years no difference between school types could be found (U12: +1cm, p=0.753; U19: +1cm, p=0.256). Boys from the elite sports school performed better in 3 age groups (U12: +2.5cm, p=0.018; U14: +10cm, p=0.000; U19: +4cm, p=0.026). Boys aged between 14 and 16 years did not perform differently regarding the school type (+1cm, p=0.387).

Table 22: Median, range and sample size of sit & reach performance [cm]

	regular school						elite sports school					
	female			male			female			male		
	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)
U12	23	5.0	(-9, 22)	38	4.5	(-7, 12)	10	6.0	(-1, 14)	21	7.0	(-3, 20)
U14	24	6.0	(-10, 19)	32	0.0	(-15, 13)	11	14.0	(8, 24)	14	10.0	(3, 15)
U16	15	9.0	(-3, 20)	21	7.0	(-7, 16)	12	17.0	(-2, 33)	17	8.0	(-13, 17)
U19	19	13.0	(-1, 31)	27	6.0	(-15, 21)	15	14.0	(-7, 31)	30	10.0	(-3, 24)

4.3.9 Single Leg Balance

This test was performed to test balance ability of the children. 4 girls and 15 boys reached 45 seconds with both legs. From 329 children tested, 66 girls (53%) and 78 boys (42%) had their better trial on the left leg while 59 girls (47%) and 107 boys (58%) performed better with their right legs. Results for the single leg balance test are shown in figure 31 and table 23.

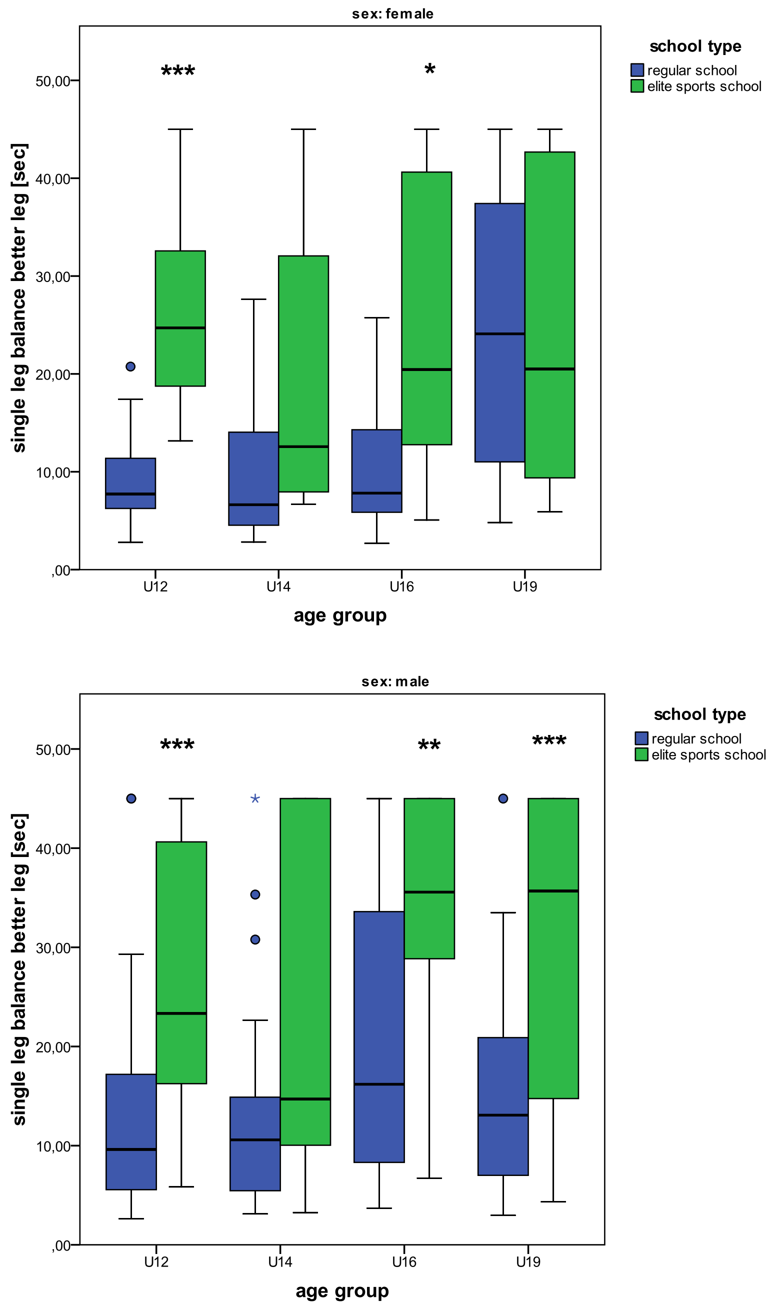


Figure 30: Influence of school type, age group and sex on balance performance

Statistical comparisons were performed separately for girls and boys. A univariate factor analysis stated a significant difference in the girls´ balance performance which is related to the school type (p=0.000) and to the age group (p=0.007). Older girls perform significantly better in the single leg balance test compared to their younger colleagues (from U12 to U19: +213% in regular school, -17% in elite sports school). In the male group school type and age are significant factors (p=0.000 and p=0.004) and therefore both influence the performance in the balance test. The performance increased within the male group from U12 to U19 by 36% in the regular school and by 53% in the elite sports school. Regarding differences due to the school type, girls from the elite sports school performed significantly better below the age of 12 years and between 14 and 16 years (U12: +221%, p=0.0005; U16: +162%, p=0.011) while at the age between 12 and 14 years and over 16 years, no statistical difference could be detected (U14: p=0.061; U19: p=0.956). Boys from the elite sports school performed significantly better at the balance test below 12 years of age and above 14 years (U12: +143%, p=0.0006; U16: +120%, p=0.0005; U19: +173%, p=0.000). From 12 to 14 years, a trend was found that did not reach statistical significance (U14: p= 0.058).

Table 23: Median, range and sample size of single leg balance performance [s]

	regular school						elite sports school					
	female			male			female			male		
	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)	N	median	(min,max)
U12	23	7.7	(2.8,20.8)	38	9.6	(2.6,45.0)	10	24.7	(13.2,45.0)	21	23.3	(5.8,45.0)
U14	24	6.6	(2.8,27.6)	32	10.6	(3.1,45.0)	11	12.6	(6.7,45.0)	14	14.7	(3.3,45.0)
U16	15	7.8	(2.7,25.8)	21	16.2	(3.7,45.0)	12	20.4	(5.1,45.0)	17	35.6	(6.7,45.0)
U19	19	24.1	(4.8,45.0)	27	13.1	(3.0,45.0)	15	20.5	(5.9,45.0)	30	35.7	(4.3,45.0)

5. Summary and Discussion of Different Age Groups

All findings will be presented and discussed in an overview table for each age group. Significant different performances between regular and elite sports school are highlighted in yellow.

5.1 Age Group U12 Female

Table 24 gives an overview of motor performance differences between regular and elite sports school for girls below the age of 12 years.

A Levene test reveals that with exception of shuttle run and single leg balance all variances of tested parameters are equal ($p>0.05$).

As highlighted in table 19, girls with competitive background are significantly better in medicine ball throw, standing broad jump, vertical jump test, 20m sprint, shuttle run, cycle ergometer and single leg balance test.

Girls attending the elite sports school have major advantages both in strength dominated areas (medicine ball throw, standing broad jump, vertical jump test), agility and balance fields (20m sprint, single leg balance) as well as aerobic fitness (shuttle run, cycle ergometer). With the exception of hand strength and flexibility girls from the elite sports school have a better motor competence than girls from the regular school.

Hypothesis 1 can therefore be accepted for all motor ability tests with significant differences as explained above.

H1: Girls below the age of 12 years who attend the elite sports school have a significantly better motor competence than girls from the regular school.

Table 24: Differences in motor abilities by school type in age group U12 female

	motor ability	Levene test		t-test	mean, SD , sample size	
			significance (p)	significance (double sided)	regular school	elite sports school
Upper body strength	**medicine ball throw** [m]	variance equal	0.730	0.011*	x̄=3.2; SD=0.8; N=23	x̄=4.0; SD=0.8; N=10
	hand grip dominant [kg]	variance equal	0.315	0.699	x̄=22.3; SD=4.5; N=23	x̄=22.9; SD=3.9; N=10
	hand grip non dominant [kg]	variance equal	0.591	0.299	x̄=20.0; SD=3.9; N=23	x̄=21.7; SD=4.7; N=9
Lower body explosive power, strength and quickness	**standing broad jump** [cm]	variance equal	0.373	0.029*	x̄=151; SD=18; N=23	x̄=166; SD=14; N=10
	vertical jump test (muscle stiffness index)	variance equal	0.096	0.012*	x̄=122; SD=35; N=23	x̄=154; SD=19; N=10
	20m sprint [sec]	variance equal	0.422	0.022*	x̄=3.93; SD=0.23; N=23	x̄=3.73; SD=0.21; N=10
Aerobic fitness	**shuttle run** [m]	variance non equal	0.018	0.003**	x̄=817; SD=227; N=23	x̄=1064; SD=165; N=9
	cycle ergometer [watt/kg]	variance equal	0.067	0.024*	x̄=3.30; SD=0.56; N=19	x̄=3.76; SD=0.32; N=10
Flexibility	**sit&reach** [cm]	variance equal	0.855	0.753	x̄=5; SD=6; N=23	x̄=6; SD=5; N=10
Balance ability	**single leg balance** [sec]	Variance non equal	0.001	0.0005***	x̄=9.0; SD=4.4; N=23	x̄=27.0; SD=11.1; N=10

5.2 Age Group U12 Male

Table 25 gives an overview of motor performance differences between regular and elite sports school for boys below the age of 12 years.

A Levene test reveals that with exception of 20m sprint and single leg balance all variances of tested parameters are equal ($p>0.05$).

As highlighted in table 20, boys with competitive background are significantly better in all tested motor abilities. They have major advantages throughout all motor competences like strength, agility, quickness, flexibility and aerobic fitness.

Hypothesis 1 can therefore be accepted for all motor ability tests.

H1: Boys below the age of 12 years who attend the elite sports school have a significantly better motor competence than boys from the regular school.

Table 25: Differences in motor abilities by school type in age group U12 male

	motor ability	Levene test		t-test	mean, SD, sample size	
			significance (p)	significance (double sided)	regular school	elite sports school
Upper body strength	**medicine ball throw** [m]	variance equal	0.054	0.000***	x̄=3.3; SD=0.5; N=38	x̄=4.3; SD=0.8; N=21
	hand grip dominant [kg]	variance equal	0.115	0.009**	x̄=20.8; SD=3.5; N=38	x̄=23.7; SD=4.4; N=20
	hand grip non dominant [kg]	variance equal	0.142	0.029*	x̄=19.8; SD=3.3; N=38	x̄=22.2; SD=4.9; N=21
Lower body explosive power, strength and quickness	**standing broad jump** [cm]	variance equal	0.334	0.000***	x̄=159; SD=21; N=38	x̄=184; SD=18; N=21
	vertical jump test (muscle stiffness index)	variance equal	0.211	0.000***	x̄=112; SD=30; N=38	x̄=158; SD=24; N=21
	20m sprint [sec]	variance non equal	0.039	0.000***	x̄=3.89; SD=0.28; N=38	x̄=3.64; SD=0.17; N=21
Aerobic fitness	**shuttle run** [m]	variance equal	0.612	0.000 ***	x̄=908; SD=295; N=38	x̄=1394; SD=279; N=20
	cycle ergometer [watt/kg]	variance equal	0.406	0.000***	x̄=3.86; SD=0.48; N=24	x̄=4.47; SD=0.36; N=20
Flexibility	**sit&reach [cm]**	variance equal	0.082	0.018*	x̄=4; SD=5; N=38	x̄=8; SD=7; N=21
Balance ability	**single leg balance** [sec]	variance non equal	0.014	0.0006***	x̄=13.2; SD=10.3; N=38	x̄=26.3; SD=13.9; N=21

5.3 Age Group U14 Female

Table 26 gives an overview of motor performance differences between regular and elite sports school for girls between the ages from 12 to 14 years.

A Levene test reveals that with exception of single leg balance all variances of tested parameters are equal ($p>0.05$).

As highlighted in table 21, girls with competitive background are significantly better in strength dominated areas (medicine ball throw, hand grip), agility (20m sprint), flexibility (sit&reach) and aerobic fitness areas (shuttle run).

Hypothesis 1 can be accepted for motor ability tests as described above.

H1: Girls between the ages from 12 and 14 years who attend the elite sports school have a significantly better motor competence than girls from the regular school.

Surprisingly girls from the elite sports school did not perform better in standing broad jump, vertical jump and cycle ergometer test. As the performances in 20m sprint were significantly better of girls with competitive background it was expected that explosive power tests like standing broad jump and vertical jump test would reveal similar results.

Analogically shuttle run performance was highly significantly better of girls attending the elite sports school but not in cycle ergometer test.

Table 26: Differences in motor abilities by school type in age group U14 female

	motor ability	Levene test		t-test	mean, SD , sample size	
			significance (p)	significance (double sided)	regular school	elite sports school
Upper body strength	**medicine ball throw** [m]	variance equal	0.198	0.000***	x̄=3.8; SD=0.6; N=24	x̄=5.3; SD=0.8; N=11
	hand grip dominant [kg]	variance equal	0.116	0.001**	x̄=25.4; SD=4.8; N=24	x̄=32.4; SD=6.8; N=11
	hand grip non dominant [kg]	variance equal	0.294	0.003**	x̄=24.3; SD=4.4; N=24	x̄=29.7; SD=5.7; N=11
Lower body explosive power, strength and quickness	**standing broad jump** [cm]	variance equal	0.521	0.252	x̄=157; SD=22; N=24	x̄=166; SD=21; N=11
	vertical jump test (muscle stiffness index)	variance equal	0.599	0.382	x̄=117; SD=26; N=24	x̄=126; SD=31; N=11
	20m sprint [sec]	variance equal	0.519	0.037*	x̄=3.88; SD=0.25; N=24	x̄=3.68; SD=0.26; N=11
Aerobic fitness	**shuttle run** [m]	variance equal	0.393	0.0009***	x̄=752; SD=226; N=23	x̄=1120; SD=356; N=11
	cycle ergometer [watt/kg]	variance equal	0.200	0.235	x̄=3.05; SD=0.66; N=16	x̄=3.32; SD=0.48; N=12
Flexibility	**sit&reach** [cm]	variance equal	0.730	0.0009***	x̄=7; SD=7; N=24	x̄=15; SD=6; N=11
Balance ability	**single leg balance** [sec]	variance non equal	0.001	0.061	x̄=9.9; SD=7.4; N=24	x̄=20.0; SD=15.4; N=11

5.4 Age Group U14 Male

Table 27 gives an overview of motor performance differences between regular and elite sports school for boys between the age of 12 and 14 years.

A Levene test reveals that with exception of hand grip non-dominant, sit&reach and single leg balance test all variances of tested parameters are equal (p>0.05).

As highlighted in table 22, boys with competitive background are significantly better in medicine ball throw, vertical jump, shuttle run, cycle ergometer and sit&reach test.

Hypothesis 1 can therefore be accepted for motor ability tests described above.

H1: Boys between the ages from 12 and 14 years who attend the elite sports school have a significantly better motor competence than boys from the regular school.

Even if boys from the elite sports school have a better performance in vertical jump test, they do not significantly perform better in standing broad jump test or at the 20m sprint which is a little bit strange. Anyway, a trend in standing broad jump performance indicates that probably the sample size of boys with competitive background was too low (n=13) compared to boys from the regular school (n=31).

Table 27: Differences in motor abilities by school type in age group U14 male

	motor ability	Levene test		t-test	mean, SD , sample size	
			significance (p)	significance (double sided)	regular school	elite sports school
Upper body strength	**medicine ball throw** [m]	variance equal	0.820	0.012*	x̄=4.4; SD=1.0; N=32	x̄=5.2; SD=1.0; N=13
	hand grip dominant [kg]	variance equal	0.157	0.547	x̄=28.0; SD=7.4; N=32	x̄=26.7; SD=4.6; N=13
	hand grip non dominant [kg]	variance non equal	0.041	0.888	x̄=26.2; SD=7.2; N=32	x̄=25.9; SD=3.7; N=14
Lower body explosive power, strength and quickness	**standing broad jump** [cm]	variance equal	0.207	0.080	x̄=171; SD=25; N=31	x̄=185; SD=15; N=13
	vertical jump test (muscle stiffness index)	variance equal	0.808	0.000***	x̄=115; SD=30; N=32	x̄=156; SD=29; N=14
	20m sprint [sec]	variance equal	0.084	0.225	x̄=3.64; SD=0.28; N=32	x̄=3.54; SD=0.15; N=13
Aerobic fitness	**shuttle run** [m]	variance equal	0.687	0.000***	x̄=1083; SD=336; N=31	x̄=1534; SD=361; N=13
	cycle ergometer [watt/kg]	variance equal	0.298	0.003**	x̄=3.78; SD=0.56; N=20	x̄=4.30; SD=0.44; N=19
Flexibility	**sit&reach** [cm]	variance non equal	0.044	0.000***	x̄=0; SD=7; N=32	x̄=11; SD=3; N=14
Balance ability	**single leg balance** [sec]	variance non equal	0.001	0.058	x̄=12.6; SD=9.5; N=32	x̄=22.2; SD=16.6; N=14

5.5 Age Group U16 Female

Table 28 gives an overview of motor performance differences between regular and elite sports school for girls between the ages from 14 to 16 years.

A Levene test reveals that with exception of shuttle run and single leg balance all variances of tested parameters are equal ($p>0.05$).

As highlighted in table 23, girls with competitive background are significantly better in all motor ability tests. They are better in all tested fields which comprise strength for upper body, explosive power and strength for lower limbs, agility, flexibility, aerobic fitness and balance.

Hypothesis 1 can therefore be accepted for all motor ability tests.

H1: Girls between the ages from 14 and 16 years who attend the elite sports school have a significantly better motor competence than girls from the regular school.

Table 28: Differences in motor abilities by school type in age group U16 female

	motor ability	Levene test		t-test	mean, SD , sample size	
			significance (p)	significance (double sided)	regular school	elite sports school
Upper body strength	**medicine ball throw** [m]	variance equal	0.775	0.000***	x̄=4.4; SD=0.9; N=15	x̄=6.1; SD=0.9; N=12
	hand grip dominant [kg]	variance equal	0.651	0.000***	x̄=29.1; SD=4.1; N=15	x̄=36.3; SD=4.2; N=12
	hand grip non dominant [kg]	variance equal	0.650	0.0006***	x̄=26.4; SD=4.5; N=15	x̄=33.5; SD=4.9; N=12
Lower body explosive power, strength and quickness	**standing broad jump** [cm]	variance equal	0.351	0.040*	x̄=162; SD=22; N=15	x̄=179; SD=16; N=12
	vertical jump test (muscle stiffness index)	variance equal	0.064	0.0009***	x̄=112; SD=20; N=15	x̄=154; SD=38; N=12
	20m sprint [sec]	variance equal	0.709	0.005**	x̄=3.75; SD=0.18; N=15	x̄=3.55; SD=0.15; N=11
Aerobic fitness	**shuttle run** [m]	variance non equal	0.020	0.002**	x̄=748; SD=189; N=15	x̄=1380; SD=439; N=9
	cycle ergometer [watt/kg]	variance equal	0.532	0.003**	x̄=3.04; SD=0.36; N=11	x̄=3.60; SD=0.44; N=13
Flexibility	**sit&reach** [cm]	variance equal	0.308	0.031*	x̄=9; SD=6; N=15	x̄=16; SD=10; N=12
Balance ability	**single leg balance** [sec]	variance non equal	0.04	0.011*	x̄=10.9; SD=6.8; N=15	x̄=24.3; SD=14.7; N=12

5.6 Age Group U16 Male

Table 29 gives an overview of motor performance differences between regular and elite sports school for boys between the ages from 14 and 16 years.

A Levene test reveals that with exception of cycle ergometer test all variances of tested parameters are equal ($p>0.05$).

As highlighted in table 24, boys with competitive background are significantly better in medicine ball throw, vertical jump, 20m sprint, shuttle run, cycle ergometer and single leg balance test.

Hypothesis 1 can therefore be accepted for motor ability tests described above.

H1: Boys between the ages from 14 and 16 years who attend the elite sports school have a significantly better motor competence than boys from the regular school.

Even if the performance in standing broad jump did not reach statistical significance, a trend could be detected for this test as well. Boys attending the elite sports school have major advantages in strength dominated areas (medicine ball throw), explosive power dominated fields (vertical jump test, 20m sprint), aerobic performance (shuttle run and cycle ergometer) as well as in balance abilities.

Table 29: Differences in motor abilities by school type in age group U16 male

	motor ability	Levene test		t-test	mean, SD , sample size	
			significance (p)	significance (double sided)	regular school	elite sports school
Upper body strength	**medicine ball throw** [m]	variance equal	0.663	0.015*	x̄=6.2; SD=1.4; N=21	x̄=7.5; SD=1.6; N=17
	hand grip dominant [kg]	variance equal	0.510	0.470	x̄=43.8; SD=10.9; N=21	x̄=46.3; SD=10.3; N=17
	hand grip non dominant [kg]	variance equal	0.530	0.265	x̄=40.4; SD=9.6; N=21	x̄=43.9; SD=9.1; N=17
Lower body explosive power, strength and quickness	**standing broad jump** [cm]	variance equal	0.976	0.068	x̄=200; SD=19; N=21	x̄=212; SD=19; N=17
	vertical jump test (muscle stiffness index)	variance equal	0.123	0.003**	x̄=143; SD=30; N=21	x̄=178; SD=39; N=17
	20m sprint [sec]	variance equal	0.379	0.022*	x̄=3.35; SD=0.15; N=21	x̄=3.24; SD=0.14; N=16
Aerobic fitness	**shuttle run** [m]	variance equal	0.983	0.033*	x̄=1449; SD=360; N=20	x̄=1762; SD=359; N=10
	cycle ergometer [watt/kg]	variance non equal	0.043	0.007**	x̄=3.91; SD=0.61; N=20	x̄=4.39; SD=0.38; N=15
Flexibility	**sit&reach** [cm]	variance equal	0.698	0.387	x̄=6; SD=7; N=21	x̄=8; SD=8; N=17
Balance ability	**single leg balance** [sec]	variance equal	0.126	0.005**	x̄=20.8; SD=14.7; N=21	x̄=34.1; SD=12.1; N=17

5.7 Age Group U19 Female

Table 30 gives an overview of motor performance differences between regular and elite sports school for girls above the age of 16 years.

A Levene test reveals that all variances of tested parameters are equal ($p>0.05$).

As highlighted in table 25, girls with competitive background are significantly better in strength dominated areas in upper body (medicine ball throw, hand grip dominant) as well as in lower body (standing broad jump, vertical jump, 20m sprint).

Hypothesis 1 can therefore be accepted for all motor ability tests described above.

H1: Girls above the age of 16 who attend the elite sports school have a significantly better motor competence than girls from the regular school.

Comparing shuttle run performance of the girls of each school type, one might diagnose a trend that girls attending the elite sports school perform better in shuttle run test, which indicates aerobic fitness. The same result might be expected for the cycle ergometer test, but obviously that was not the case. While the sample size in cycle test was 18 in each group, only 9 girls from the elite sports school participated at the shuttle run test which might be the reason for this result.

Table 30: Differences in motor abilities by school type in age group U19 female

	motor ability	Levene test		t-test	mean, SD , sample size	
			significance (p)	significance (double sided)	regular school	elite sports school
Upper body strength	**medicine ball throw** [m]	variance equal	0.370	0.000***	x̄=5.1; SD=0.9; N=19	x̄=7.1; SD=1.2; N=13
	hand grip dominant [kg]	variance equal	0.957	0.045*	x̄=34.3; SD=6.8; N=19	x̄=39.2; SD=6.4; N=14
	hand grip non dominant [kg]	variance equal	0.660	0.270	x̄=33.1; SD=6.4; N=19	x̄=35.3; SD=5.2; N=15
Lower body explosive power, strength and quickness	**standing broad jump** [cm]	variance equal	0.238	0.000***	x̄=163; SD=26; N=19	x̄=195; SD=20; N=15
	vertical jump test (muscle stiffness index)	variance equal	0.361	0.002**	x̄=118; SD=27; N=19	x̄=152; SD=32; N=15
	20m sprint [sec]	variance equal	0.074	0.000***	x̄=3.84; SD=0.26; N=19	x̄=3.50; SD=0.16; N=15
Aerobic fitness	**shuttle run** [m]	variance equal	0.406	0.059	x̄=911; SD=364; N=19	x̄=1187; SD=297; N=9
	cycle ergometer [watt/kg]	variance equal	0.770	0.917	x̄=3.32; SD=0.54; N=18	x̄=3.34; SD=0.50; N=18
Flexibility	**sit&reach** [cm]	variance equal	0.157	0.256	x̄=12; SD=7; N=19	x̄=16; SD=10; N=15
Balance ability	**single leg balance** [sec]	variance equal	0.413	0.956	x̄=24.5; SD=14.4; N=19	x̄=24.8; SD=15.9; N=15

5.8 Age Group U19 Male

Table 31 gives an overview of motor performance differences between regular and elite sports school for boys above the age of 16 years.

A Levene test reveals that with exception of single leg balance and cycle ergometer test all variances of tested parameters are equal ($p>0.05$).

As highlighted in table 26, boys with competitive background are significantly better in all motor ability tests except the cycle ergometer test.

Hypothesis 1 can therefore be accepted for all motor ability tests, except the cycle ergometer test.

H1: Boys above the age of 16 years who attend the elite sports school have a significantly better motor competence than boys from the regular school.

Comparing the weight of boys of both school types in that age group, it explains why the performance in cycle ergometer test was not statistically different. Boys from the elite sports school above the age of 16 years are significantly heavier ($p=0.034$) than boys from the regular school. As the results in cycle ergometer test are presented as relative performance based on body mass in watt/kg, the result seems obvious.

Table 31: Differences in motor abilities by school type in age group U19 male

	motor ability	Levene test		t-test	mean, SD , sample size	
			significance (p)	significance (double sided)	regular school	elite sports school
Upper body strength	**medicine ball throw** [m]	variance equal	0.224	0.000***	x̄=7.4; SD=1.6; N=27	x̄=9.3; SD=1.2; N=30
	hand grip dominant [kg]	variance equal	0.423	0.000***	x̄=47.4; SD=8.2; N=27	x̄=58.3; SD=9.7; N=30
	hand grip non dominant [kg]	variance equal	0.420	0.005**	x̄=46.0; SD=8.4; N=27	x̄=53.8; SD=11.2; N=30
Lower body explosive power, strength and quickness	**standing broad jump** [cm]	variance equal	0.237	0.002**	x̄=217; SD=21; N=27	x̄=234; SD=17; N=28
	vertical jump test (muscle stiffness index)	variance equal	0.051	0.001**	x̄=168; SD=23; N=27	x̄=197; SD=39; N=28
	20m sprint [sec]	variance equal	0.478	0.026*	x̄=3.23; SD=0.15; N=27	x̄=3.13; SD=0.17; N=27
Aerobic fitness	**shuttle run** [m]	variance equal	0.406	0.035*	x̄=1630; SD=320; N=26	x̄=1845; SD=392; N=26
	cycle ergometer [watt/kg]	variance non equal	0.042	0.424	x̄=4.05; SD=0.41; N=23	x̄=4.17; SD=0.60; N=26
Flexibility	**sit&reach** [cm]	variance equal	0.678	0.026*	x̄=6; SD=10; N=27	x̄=11; SD=8; N=30
Balance ability	**single leg balance** [sec]	variance non equal	0.000	0.000***	x̄=15.4; SD=10.7; N=27	x̄=29.8; SD=15.7; N=30

5.9 Correlations between BMI and Motor Performance

Following tables shall indicate possible correlations between BMI and achieved performance in each motor test of tested children and adolescents. Table 32 gives an overall overview split into female and male group at first followed by a classification into school type and gender as well.

In all following tables 32, 33 and 34 values with a positive correlation between BMI and a certain motor performance are highlighted in yellow. For instance BMI of female overall and medicine ball throw are highly correlated (0.545). This means, the higher the BMI is, the further the medicine ball can be thrown. Secondly, values with a positive negative correlation are highlighted in green. For example BMI of male overall is negatively correlated with performance in 20m sprint, which means, the higher the BMI of the boys is, the shorter the time is to run 20m. Lastly, values with a negative correlation between BMI and a motor performance are highlighted in red. For example BMI of female overall is negatively correlated with shuttle run performance. A higher BMI results in a lower shuttle run performance.

Analyzing table 32 it clearly indicates strong correlations within each group between BMI and performances in medicine ball throw and handgrip test. Male pupils attending the elite sports school have positive correlations between BMI and motor performance in every motor ability test except the cycle ergometer test and the single balance test. The last named test did not show any correlation between BMI in either group anyway. Performance in cycle ergometer test is expressed in watt/kg. The negative correlation between BMI and the performance in cycle ergometer test is evident. The higher the BMI, the lower is the aerobic fitness assessed on the cycle ergometer.

A higher BMI in boys is often connected with a higher muscle mass, which is indicated by the result of the correlation between BMI in male elite sports pupils and sprint time (-0.673**).

Table 32: Overall Correlations between BMI and Motor Performance

		BMI female overall	BMI male overall	BMI female regular school	BMI female elite sports school	BMI male regular school	BMI male elite sports school
medicine ball throw [m]	Correlation after Pearson	.545**	.634**	.554**	.685**	.553**	.831**
	Significance (2-sided)	.000	.000	.000	.000	.000	.000
	N	127	199	81	46	118	81
hand grip dominant [kg]	Correlation after Pearson	.497**	.624**	.414**	.660**	.480**	.855**
	Significance (2-sided)	.000	.000	.000	.000	.000	.000
	N	128	198	81	47	118	80
hand grip non-dominant [kg]	Correlation after Pearson	.568**	.634**	.463**	.794**	.483**	.870**
	Significance (2-sided)	.000	.000	.000	.000	.000	.000
	N	128	200	81	47	118	82
standing broad jump [cm]	Correlation after Pearson	-.041	.258**	-.212	.148	.102	.553**
	Significance (2-sided)	.643	.000	.058	.315	.275	.000
	N	129	196	81	48	117	79
muscle stiffness index	Correlation after Pearson	-.142	.137	-.267*	-.135	-.013	.348**
	Significance (2-sided)	.107	.054	.016	.360	.885	.002
	N	129	198	81	48	118	80
sprint 20m [s]	Correlation after Pearson	.052	-.281**	.208	-.087	-.107	-.673**
	Significance (2-sided)	.563	.000	.062	.562	.249	.000
	N	128	195	81	47	118	77
endurance shuttle run [m]	Correlation after Pearson	-.202*	.111	-.377**	-.023	-.001	.336**
	Significance (2-sided)	.028	.135	.001	.891	.993	.005
	N	118	184	80	38	115	69
aerobic fitness [watt/kg]	Correlation after Pearson	-.488**	-.424**	-.629**	-.414**	-.441**	-.515**
	Significance (2-sided)	.000	.000	.000	.002	.000	.000
	N	117	167	64	53	87	80
sit&reach [cm]	Correlation after Pearson	.209*	.197**	.123	.293*	.130	.286**
	Significance (2-sided)	.017	.005	.274	.043	.162	.009
	N	129	200	81	48	118	82
single leg balance [s]	Correlation after Pearson	-.067	.081	-.111	-.158	-.046	.187
	Significance (2-sided)	.449	.257	.323	.284	.623	.093
	N	129	200	81	48	118	82

**. Correlations are significant based on a level of 0.01 (2-sided).

*. Correlations are significant based on a level of 0.05 (2-sided).

Looking at table 33 it can be seen that far more results of motor performance tests of female pupils are negatively correlated with BMI in regular school than in the elite sports school. In every age group of female girls attending the regular school BMI is negatively correlated with performance in cycle ergometer test. Girls from the regular school with higher BMI perform significantly weaker than girls with lower BMI. In girls from the elite sports school, only girls below the age of 12 have a negative correlation within this motor test as well.

Table 33: Correlations between BMI and Motor Performance in Female Pupils split by Age and School Type

		Regular School				Elite Sports School			
		BMI U12 female	BMI U14 female	BMI U16 female	BMI U19 female	BMI U12 female	BMI U14 female	BMI U16 female	BMI U19 female
medicine ball throw [m]	Correlation after Pearson	.777**	.339	.721**	.254	.553	.825**	.404	.365
	Significance (2-sided)	.000	.106	.002	.294	.097	.002	.193	.220
	N	23	24	15	19	10	11	12	13
hand grip dominant [kg]	Correlation after Pearson	.532**	.253	.677**	.088	.577	.672*	.404	.315
	Significance (2-sided)	.009	.233	.006	.719	.081	.024	.193	.273
	N	23	24	15	19	10	11	12	14
hand grip non-dominant [kg]	Correlation after Pearson	.444*	.405*	.669**	.233	.473	.779**	.745**	.707**
	Significance (2-sided)	.034	.050	.006	.338	.199	.005	.005	.003
	N	23	24	15	19	9	11	12	15
standing broad jump [cm]	Correlation after Pearson	-.425*	-.390	-.077	-.287	.153	-.258	-.090	-.221
	Significance (2-sided)	.043	.059	.786	.233	.673	.443	.780	.429
	N	23	24	15	19	10	11	12	15
muscle stiffness index	Correlation after Pearson	-.412	-.447*	-.059	-.043	-.232	-.426	.243	-.370
	Significance (2-sided)	.051	.028	.834	.861	.519	.192	.446	.174
	N	23	24	15	19	10	11	12	15
sprint 20m [s]	Correlation after Pearson	.378	.445*	-.015	.247	-.041	.293	.352	.170
	Significance (2-sided)	.075	.029	.958	.307	.909	.382	.289	.544
	N	23	24	15	19	10	11	11	15
endurance shuttle run [m]	Correlation after Pearson	-.450*	-.522*	-.247	-.506*	-.275	-.565	-.259	.661
	Significance (2-sided)	.031	.011	.374	.027	.474	.070	.500	.052
	N	23	23	15	19	9	11	9	9
aerobic fitness [watt/kg]	Correlation after Pearson	-.730**	-.812**	-.636*	-.665**	-.855**	-.445	-.068	-.331
	Significance (2-sided)	.000	.000	.035	.003	.002	.147	.826	.180
	N	19	16	11	18	10	12	13	18
sit&reach [cm]	Correlation after Pearson	-.271	-.168	.419	.121	.407	.536	-.013	-.066
	Significance (2-sided)	.211	.432	.120	.623	.243	.090	.969	.816
	N	23	24	15	19	10	11	12	15
single leg balance [s]	Correlation after Pearson	-.066	-.276	-.041	-.595**	-.591	-.749**	-.197	.232
	Significance (2-sided)	.764	.192	.885	.007	.072	.008	.540	.405
	N	23	24	15	19	10	11	12	15

**. Correlations are significant based on a level of 0.01 (2-sided).

*. Correlations are significant based on a level of 0.05 (2-sided).

Table 34 indicates that more results of motor tests are negatively correlated with BMI in male pupils from the regular school as well. All boys attending the elite sports school with higher BMI are significantly better in medicine ball throw and hand grip test. In the age group U16, males from the elite sport school with a higher BMI are significantly faster in 20m sprint, which might be due to a higher muscle mass here as well.

Table 34: Correlations between BMI and Motor Performance in Male Pupils split by Age and School Type

		Regular School				Elite Sports School			
		BMI U12 male	BMI U14 male	BMI U16 male	BMI U19 male	BMI U12 male	BMI U14 male	BMI U16 male	BMI U19 male
medicine ball throw [m]	Correlation after Pearson	.537**	.379*	.616**	.699**	.552**	.713**	.718**	.390*
	Significance (2-sided)	.001	.032	.003	.000	.009	.006	.001	.033
	N	38	32	21	27	21	13	17	30
hand grip dominant [kg]	Correlation after Pearson	.187	.287	.645**	.461*	.726**	.756**	.726**	.616**
	Significance (2-sided)	.261	.111	.002	.016	.000	.003	.001	.000
	N	38	32	21	27	20	13	17	30
hand grip non-dominant [kg]	Correlation after Pearson	.151	.327	.666**	.453*	.697**	.781**	.852**	.649**
	Significance (2-sided)	.364	.067	.001	.018	.000	.001	.000	.000
	N	38	32	21	27	21	14	17	30
standing broad jump [cm]	Correlation after Pearson	-.283	-.452*	-.031	.075	.119	-.744**	.173	-.165
	Significance (2-sided)	.085	.011	.894	.708	.606	.004	.506	.403
	N	38	31	21	27	21	13	17	28
muscle stiffness index	Correlation after Pearson	-.438**	-.389*	-.252	.141	-.081	-.458	.167	.142
	Significance (2-sided)	.006	.028	.270	.483	.728	.100	.522	.471
	N	38	32	21	27	21	14	17	28
sprint 20m [s]	Correlation after Pearson	.453**	.335	-.183	-.154	.025	.261	-.652**	-.138
	Significance (2-sided)	.004	.061	.428	.443	.915	.390	.006	.492
	N	38	32	21	27	21	13	16	27
endurance shuttle run [m]	Correlation after Pearson	-.478**	-.549**	-.401	.150	.110	-.308	.570	-.305
	Significance (2-sided)	.002	.001	.080	.466	.646	.306	.085	.130
	N	38	31	20	26	20	13	10	26
aerobic fitness [watts/kg]	Correlation after Pearson	-.503*	-.850**	-.721**	-.158	-.116	-.731**	-.522*	-.639**
	Significance (2-sided)	.012	.000	.000	.473	.628	.000	.046	.000
	N	24	20	20	23	20	19	15	26
sit&reach [cm]	Correlation after Pearson	-.064	-.037	.369	.263	-.045	.120	.025	.597**
	Significance (2-sided)	.703	.841	.100	.184	.845	.682	.925	.000
	N	38	32	21	27	21	14	17	30
single leg balance [s]	Correlation after Pearson	-.120	-.157	-.201	.065	.065	-.289	.165	.292
	Significance (2-sided)	.473	.390	.382	.746	.779	.316	.527	.118
	N	38	32	21	27	21	14	17	30

**. Correlations are significant based on a level of 0.01 (2-sided).

*. Correlations are significant based on a level of 0.05 (2-sided).

5.10 Comparison of BMI between School Types

Comparing the mean values of BMI of all groups, no statistical differences between the school types could be detected. After analyzing BMI within each age group and each gender based on the cut off points from Cole et al. (2000), prevalence of overweight and obesity in children and adolescents is being described in the following figures.

Comparing figure 21 with figure 22 it reveals a difference in the prevalence of overweight and obese pupils between both school types. While in the regular school, approximately 12% of pupils are overweight or obese, only 8% of female pupils of the elite sports school are overweight or obese.

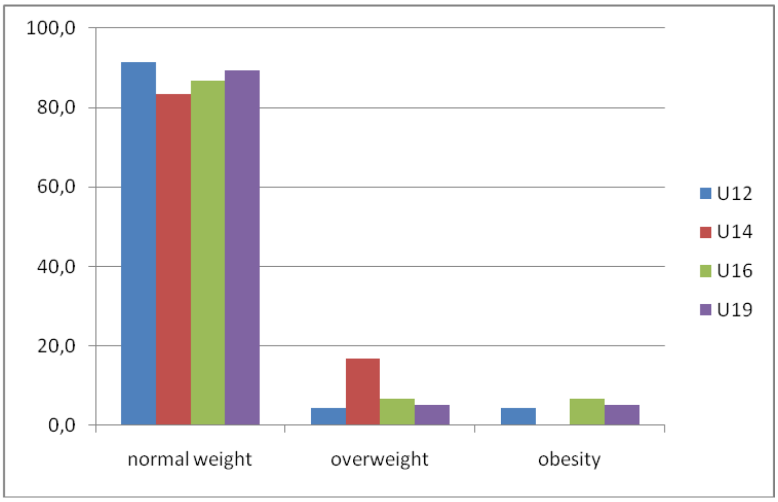


Figure 31: Prevalence of normal, overweight and obese female children and adolescents attending the regular school

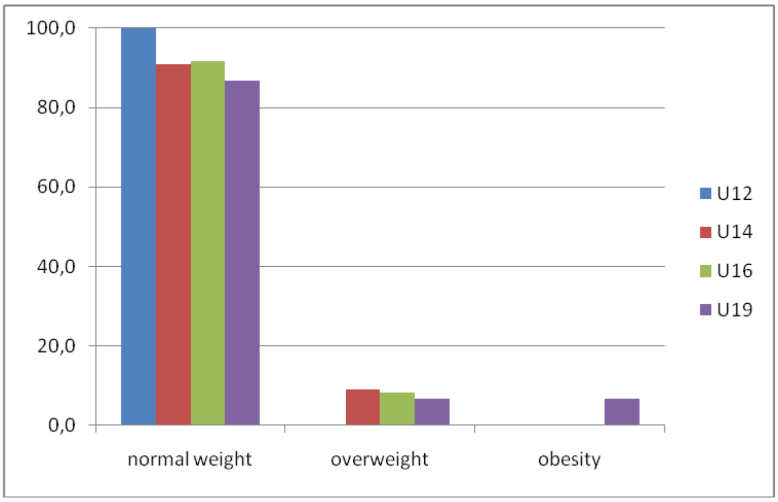


Figure 32: Prevalence of normal, overweight and obese female children and adolescents attending the elite sports school

In the male group, the differences are more evident. Comparing figure 23 with figure 24 following differences in the prevalence of overweight and obese pupils between both school types are found. While in the regular school, approximately 15% of pupils are overweight or obese, only 5% of male pupils of the elite sports school are overweight and not even one pupil is obese according to the cut off points.

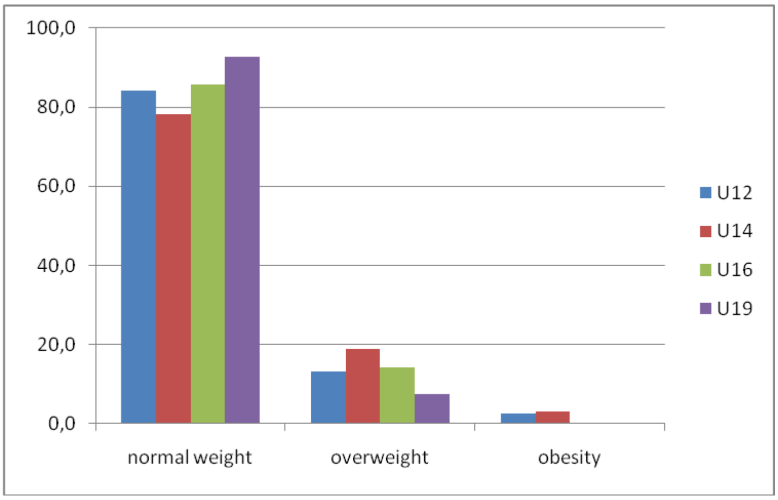


Figure 33: Prevalence of normal, overweight and obese male children and adolescents attending the regular school

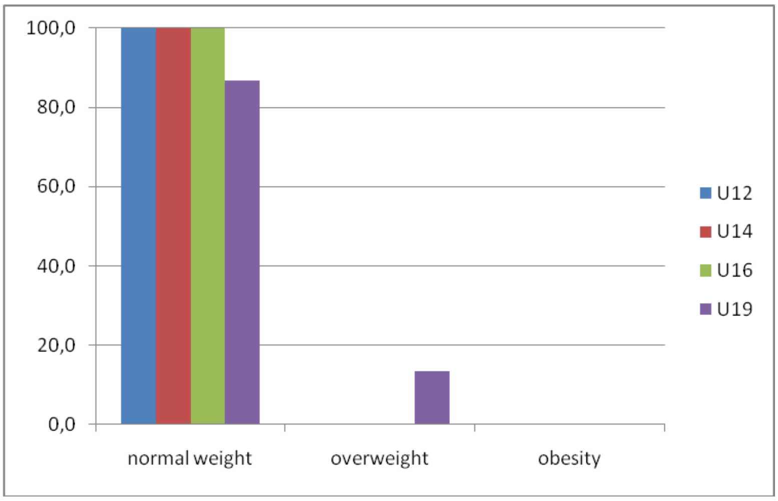


Figure 34: Prevalence of normal, overweight and obese male children and adolescents attending the elite sports school

The figures indicate that the prevalence of overweight and obese children and adolescents is lower in the elite sports school than in the regular school.

6. Summarized Discussion

The given findings and detailed described results from above will be summed up in the context of this master thesis and shall try to support and underline the answered hypothesises. For all age groups a precise statement for each motor performance and possible differences between both school types has been explained earlier. Pupils attending the elite sports school have advantages throughout all age groups regarding their motor performance, some in more motor ability fields than others. Very dominant were the results from girls attending the sports school between the ages from 14 to 16 years and from boys below the age of 12 and over 16 years who have performed significantly better in all motor ability tests (except cycle ergometer test of male group U19).

Juran (2008) evaluated the performance of more than 12.000 pupils from different school types within the project “Check Your Limitz” determining the same result that children attending a sports school having a significant better motor performance than children from regular schools.

Sandmayr (2004) confirmed in his study, that pupils attending a school focused on sports or on young elite athletes perform better in motor ability tests and have therefore a higher motor competence and physical performance.

Sandmayr analyzed school aged pupils from 11 to 14 years, which makes comparisons between his and our study quite difficult. Comparing some data of Sandmayr´s study with the ones from this present study it reveals that girls in the age groups U12 and U14 from our sample school performed weaker in standing broad jump in both school types. Comparing mean values of 20m sprint times it shows that girls from our sample school performed better in age groups U12 and U14 in both school types apart from the girls in U14 from the elite sports school who had slightly slower 20m sprint times compared to the ones from Sandmayr in that certain age (3.68s vs. 3.62s).

Single leg balance allows only comparison between elite school pupils of both studies as Sandmayr did not split up his results for both school types separately. Anyway, the comparison shows that girls and boys from our sample school performed weaker than the ones from Sandmayr.

Boys below the age of 12 years from our study performed better compared to Sandmayr´s study (3.89s vs. 4.03s in regular school; 3.64s vs. 3.71s in sports school). Male pupils between 12 and 14 years performed better in our regular school (3.64s vs. 3.83s) but not in the elite sports school (3.54s vs. 3.49s). Finally a comparison of standing broad jump performance reveals that boys aged below 12 years from our study were better in the elite sports school (184cm vs. 179cm) but a little bit weaker in the regular classes (159cm vs.

169cm). In the age group U14, boys from our current study did not perform as good as the ones from Sandmayr (171cm vs. 182cm in regular schools; 185cm vs. 199cm in sport schools).

Of course we need to take into account that a comparison between both studies is quite deceptive, because Sandmayr had a sample size from more than thousands within each age group and we sometimes only had ten to twenty subjects. Anyhow, a trend might be recognised that the motor competence and the physical performance of our children and adolescents decrease as many studies document the same situation (Matton et al., 2007; Wedderkopp et al., 2004).

Sandmayr (2004) writes that the actual physical performance of 11 to 14 year old pupils in Austria is very alarming. Especially musculature of trunk (risk of postural deformity, spinal diseases), coordinative abilities (risk of detraction of daily motor abilities like balance or reaction) and aerobic fitness (risk of CVD) are concerned. Those deficits together with risk factors of the metabolic syndrome may lead to later problems in health as explained earlier.

Even if the performance of children and adolescents is decreasing over the last decades, this present study shows that pupils having more possibilities for sports or get special treatments, like young elite sports athletes, have a better motor competence and a higher physical performance than pupils from a regular school and hence the chance of getting serious diseases decreases.

BMI may probably be a rather weak parameter for health status, but the prevalence of overweight and obese children and adolescents within the elite sports school was found to be lower than in regular classes. Juran (2008) came to the conclusion that children and adolescents from sports schools have significant lower BMI´s than pupils from regular schools. This matter of fact could not be confirmed within this thesis as the mean values of pupils of both school types did not differ significantly.

However, there are also some limitations of the study so far. A major problem is that not all pupils of each class participated, as it was a voluntary study. This may influence the results as children and adolescents who are likely to be overweight or obese did not participate as they were probably ashamed or didn´t have enough confidence to attend the tests. As this was a pilot study, the sample classes were chosen and not randomly selected. When we look at the results of the medicine ball throw, we might have picked classes where the main sport of the girls and boys was for example handball, and therefore the better results are probably not related to PA but to the special demand of the sport itself, to have good throwing abilities. For further studies and to have a representative cohort this needs to be taken into account. To have a representative sample would ask for an additional questionnaire filled in by the pupils which determines the leisure activity habits, sports club participation and other important parameters. Actually a questionnaire was assessed within the overall project, but was not evaluated for this present master thesis as this would go beyond the scope of this thesis. A very important fact is the sample size. It needs to be increased as the power of the statistics in this present study is quite weak sometimes due to having too small number of subjects per age group.

Another important fact which should not be ignored is that pupils attending the elite sports school need to pass a fitness test before entering the elite sports school and they need to have a recommendation of their specific federal sports association. This may raise the question about this study anyway as those children and adolescents have been selected out of the best of their age which makes comparisons with pupils from a regular school a little bit odd.

As the results show, good motor performances are not only linked to the elite sports school. Children and adolescents from the regular school may also participate up to three or more times per week at a sports club or are gifted above average, which was not part of this thesis to be determined.

This present thesis concentrated on comparing the results of the motor ability tests between both school types. Health benefits were only discussed marginally as described above with BMI. A very good predictor for health and for the metabolic syndrome would have been the blood pressure. But as mentioned above due to the small sample size and the number of different tests it was an economical decision to omit the blood pressure measurement. For further studies the blood pressure should be taken into consideration to be measured however.

7. Conclusion

The results of the current study show that pupils, especially in the age groups U12, U14 and U16, who attend the elite sports school have a better motor performance in aerobic fitness (cycle ergometer and/or endurance shuttle run) which is a good predictor for cardiorespiratory fitness and health as explained earlier. In U19 only boys performed better in the shuttle run. Girls from the elite sports school in that age however did not show better aerobic fitness parameters than girls from the regular school. Medicine ball throw is considered to be the only motor ability test where pupils from the elite sports school performed significantly better in all age groups throughout the test. There was a great difference found between those two groups. Upper body strength seems to be highly related to the amount and intensity of PA as the pupils of all ages from the elite sports school had better results. There was no difference found between BMI mean values of both school types but the prevalence of overweight and obese children and adolescents was higher in the regular classes than in the elite sports classes. Girls from the elite sports school in the age groups U16 and U19 weigh more than the girls from the regular school which might result from a higher muscle mass of the girls attending the elite sports school.

Finally is to conclude that pupils attending the elite sports school perform better throughout all motor ability tests, although there are differences between the age groups. A very important parameter in this respect is aerobic fitness as it is linked to cardiorespiratory fitness and health as well.

Children with special treatments in sport like young elite athletes obviously reach given PA standards and their risk of developing later diseases decreases. Therefore the demand for more sports schools, more PE lessons or more extracurricular activities grows as the health of our children will be important in the future for our own and others lives as well.

Participation in additional curricular and extracurricular physical activity and sports in young ages helps to enhance health competences in all ages and thereby helps to reduce the socio-economic burden caused by inactivity for the whole community.

8. Reference List

Ainsworth, B.E., Haskell, W.L., Leon, A.S., Jacobs, D.R., Montoye, H.J., Sallis, J.F. & Paffenbarger, R.S.(1993). Compendium of physical activities: classification of energy costs of human physical activities. *Med Sci Sports Exerc*, 25(1),71-80.

Andersen, L.B., Harro, M., Sardinha, L.B., Froberg, K., Ekelund, U., Brage,S. & Anderssen, S.A. (2006). Physical activity and clustered cardiovascular risk in children: a cross-sectional study (The European Youth Heart Study). *Lancet,* 368, 299–304.

Andersen, Lars B., Sardinha, Luis B., Froberg, Karsten, Riddoch, Chris J., Page, Angie S. & Anderssen, Sigmund A. (2008) 'Fitness, fatness and clustering of cardiovascular risk factors in children from Denmark, Estonia and Portugal: The European Youth Heart Study'. *International Journal of Pediatric Obesity*, 3,1, 58 – 66.

Biddle, S.J.H., Fox, K.R., & Boutcher, S.H. (2000). *Physical activity and psychological well-being*. London: Routledge.

Biddle, S.J., Gorely, T., & Stensel, D.J.(2004). Health-enhancing physical activity and sedentary behavior in children and adolescent. *Journal of Sports Science,* 22, 679-701.

Boot, A.M., De Ridder, M.A., Pols, H.A., Krenning, E.P. & De Muinck Keizer-Schrama, S.M.(1997). Bone Mineral Density in Children and Adolescents: Relation to Puberty, Calcium Intake, and Physical Activity. *Journal of Clinical Endocrinology and Metabolism,* 82, 1, 57-62.

Bouchard, C., Shephard, R.J., Stephens, T., Sutton, J.R. & McPherson, B.D.E.(1990). Exercise, Fitness and Health: A Consensus of Current Knowledge. Champaign, IL: Human Kinetics.

Boyle-Holmes, T., Grost, L., Russell, L., Laris, B.A., Robin, L., Haller, E., Potter, S. & Lee, S. (2009). Promoting Elementary Physical Education: Results of a School-Based Evaluation Study. *Health Education & Behavior,* published online first on September 11, 2009.

Bundesministerium für Unterricht, Kunst und Kultur.(2008). Zahlenspiegel 2008. Zugriff am 2.12.2009 unter http://www.bmukk.gv.at/medienpool/17605/zahlenspiegel_2008_e.pdf

Bundesministerium für Unterricht, Kunst und Kultur.(2008). Development of Education in Austria 2004-2007.Zugriff am 1.12.2009 unter http://www.bmukk.gv.at/medienpool/17147/bildungsentwicklung_07_e.pdf

Brockman, R., Jago, R., Fox, K.R., Thompson, J.L., Cartwright, K. & Page, A.S.(2009). "Get off the sofa and go and play": Family and socioeconomic influences on the physical activity of 10–11 year old children. *BMC Public Health,* 9,253.

Cantell, M., Crawford, S.G. & Doyle-Baker, P.K. (2008). Physical fitness and health indices in children, adolescents and adults with high or low motor competence. *Human Movement Science* 27, 344–362.

Carrel, A.L., McVean, J.J., Clark, R.R., Peterson, S.E., Eickhoff, J.C. & Allen, D.B.(2009). School-based Exercise Improves Fitness, Body Composition, Insulin Sensitivity, and Markers of Inflammation in Non-Obese Children. *Journal of Pediatric Endocrinology & Metabolism*, 22, 409-415.

Castro-Piñero, J., Artero, E.G., España-Romero, V., Ortega, F.B., Sjöström, M., Suni, J. & Ruiz, J.R.(2009). Criterion-related validity of field-based fitness tests in youth: A systematic review. *Br J Sports Med,* published online on April 12th 2009.

Cole, T.J., Bellizzi, M.C., Flegal, K.M. & Dietz, W.H. (2000). Establishing a standard definition for child overweight and obesity worldwide: International survey. *British Medical Journal*, Vol.320,1240-1243.

Dollman, J., Norton, K. and Norton, L. (2005). Evidence for secular trends in children´s physical activity behaviour. *British Journal of Sports Medicine*, 39, 892-897.

Donnelly, J.E, Greene, J.L., Gibson, C.A., Smith, B.K., Washburn, R.A., Sullivan, D.K., DuBose, K., Mayo, M.S., Schmelzle, K.H., Ryan, J.J., Jacobsen, D.J. & Williams, S.L. (2009). Physical Activity Across the Curriculum (PAAC): A randomized controlled trial to promote physical activity and diminish overweight and obesity in elementary school children. *Preventive Medicine.* Article in press.

Dür, W., Griebler, R.(2007). Die Gesundheit der österreichischen SchülerInnen im Lebenszusammenhang. Ergebnisse des WHO-HBSC-Surveys 2006. Bundesministerium für Gesundheit, Familie und Jugend.

Europäisches Informationszentrum für Lebensmittel. Zugriff am 15.10.2009 unter http://www.eufic.org/jarticle/de/lebensmittel-ernahrungsfuhrer/sport-korperliche-aktivitat/expid/basics-korperliche-aktivitat/

Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. *JAMA*, 285, 2486-2497.

Fogelholm, M. (2008). How Physical Activity can work? *International Journal of Pediatric Obesity,* 3 ,1,10-4.

Fox, K.R.(1999).The influence of physical activity on mental well-being. *Public Health Nutrition,* 2(3a), 411–418.

Gesundheitsberichterstattung des Bundes. Zugriff am 24.10.2009 unter http://www.gbe-bund.de/gbe10/abrechnung.prc_abr_test_logon?p_uid=gastg&p_aid=&p_knoten=FID&p_sprache=D&p_suchstring=9590::K%F6rperliche%20Aktivit%E4t

Haga, M.(2008).The relationship between physical fitness and motor competence in children. *Child: care, health and development*, 34, 3, 329–334.

Hu, G., Lindström, J., Valle, T.T., Eriksson, J.G., Jousilahti, P., Silventoinen, K.,Qiao, Q. & Tuomilehto, J.(2004). Physical Activity, Body Mass Index, and Risk of Type 2 Diabetes in Patients With Normal or Impaired Glucose Regulation. *Arch Intern Med,* 164, 892-896.

Hurtig-Wennlöf, A., Ruiza, J.R., Harrod, M. & Sjöström, M. (2007). Cardiorespiratory fitness relates more strongly than physical activity to cardiovascular disease risk factors in healthy children and adolescents: the European Youth Heart Study. *European Journal of Cardiovasc Prev Rehabil*. 14(4), 575-81.

Janda, V. (2004). *Manuelle Muskelfunktionsdiagnostik* (4. überarbeitete. und erweiterte. Aufl.). München: Urban und Fischer.

Janssen, I. (2007). Physical activity guidelines for children and youth. *Canadian Journal of Public Health,* 98*,* 109-121.

Juran, W. (2007). *Untersuchung der sportmotorischen Leistungsfähigkeit bei Kindern und Jugendlichen nach anthropometrischen und soziodemografischen Gesichtspunkten*. Wien: Universität Wien, Institut für Sportwissenschaft.

Kavookjian, J., Elswick, B.M. & Whetsel,T.(2007).Interventions for Being Active Among Individuals With Diabetes: A Systematic Review of the Literature. *The Diabetes Educator,* 33, 962.

Klaes, L., Cosler, D., Rommel, A. & Zens, Y. (2003). WIAD-AOK-DSB-Studie II: Bewegungsstatus von Kindern und Jugendlichen in Deutschland. Hrsg. Deutscher Sportbund. Zugriff am 2.11.2009 unter http://www.richtigfit.de/index.php?id=480

Kramer, A.F, Hahn, S., Cohen, N., Banich, M.T., McAuley, E., Harrison, C. R., Chason, J., Vakil, E., Bardell, L., Boileau, R.A. & Colcombe, A. (1999). Ageing, fitness and neurocognitive function. *Nature*. 400, 418-419.

Kristensen, P.L., Wedderkopp, N., Møller, N.C., Andersen, L.B., Bai, C.N. & Froberg, K.(2006).Tracking and prevalence of cardiovascular disease risk factors across socio-economic classes: A longitudinal substudy of the European Youth Heart Study. *BMC Public Health,* 6, 20.

Kromeyer-Hauschild, K., Wabitsch, M., Kunze, D., Geller, F., Geiß, H.C., Hesse, V., von Hippel, A., Jaeger, U., Johnsen, D., Korte, W., Menner, K., Müller, G., Müller, JM., Niemann-Pilatus, A., Remer, T., Schaefer, F., Wittchen, H.-U., Zabransky, S., Zellner, K., Ziegler, A. & Hebebrand, J. (2001). Perzentilen für den Body-Mass-Index für das Kindes- und Jugendalter unter Heranziehung verschiedener deutscher Stichproben. *Kinderheilkunde,* 149, 807-18.

LaMonte, M.J., Blair, S.N. & Church. T.S.(2005) Physical activity and diabetes prevention. *J Appl Physiol,* 99,1205-1213.

Lund Nilsen, T.I. & Vatten, L.J. (2001). Prospective study of colorectal cancer risk and physical activity, diabetes, blood glucose, and BMI: exploring the hyperinsulinemia hypothesis. *British Journal of Cancer*, 84, 417-422.

Malina, R.M.(1996). Tracking of physical activity and physical fitness across the lifespan. *Res Q Exerc Sport,* 67*,* 48–57.

Matton, L., Duvigneaud, N., Wijndaele, K., Philippaerts, R., Duquet, W., Beunen, G., Claessens, A.L., Thomis, M. & Lefevre, J. (2007). Secular trends in anthropometric characteristics, physical fitness, physical activity, and biological maturation in Flemish adolescents between 1969 and 2005.*American Journal of Human Biology,* 19*,* 345-357.

Micozzi, M.S., Albanes, D., Jones, D.Y. & Chumlea, W.C.(1986). Correlations of body mass index with weight, stature, and body composition in men and women in NHANES I and II. *Am J Clin Nutr,* 44, 725–731.

Opper, E., Worth, A. & Bös, K. (2005). Kinderfitness - Kindergesundheit. Bundesgesundheitsblatt – Gesundheitsforschung – Gesundheitsschutz, 48, 854-862.

Rechnungshof Bericht Bund 2009/1. Zugriff am 1.12.2009 unter http://www.rechnungshof.gv.at/berichte/ansicht/detail/bewegungserziehung-an-schulen-1.html

Rizzo, N.S., Ruiz, J.R., Ojy, L., Veidebaum, T. & Sjöström, M.(2008). Associations between physical activity, body fat, and insulin resistance (homeostasis model assessment) in adolescents: the European Youth Heart Study. AM J Clin Nutr. 2008 Mar; 87(3):586-92.

Sandmayr, A.(2004). *Das motorische Leistungsniveau der österreichischen Schuljugend*. Aachen: Meyer & Meyer.

Sallis, J., Simons-Morton, B., Stone, E., Corbin, C., Epstein, L., Fuacette, N., Iannotti, R., Killen, J., Klesges, R., Petray, C., Rowland, T. & Taylor, W. (1992). Determinants of physical activity and interventions in youth. *Medicine and Science in Sports and Exercise,* 24*,* 248-257

Smoll, F.L. & Smith, R.E.(1990). Psychology of the young athlete. Stress-related maladies and remedial approaches. *Pediatric Clinics of North America,* 37*,* 1021-1046.

Spyckerelle, Y., Gueguen, R., Guillemont, M., Tosi, E. & Deschamps, J.P.(1988). Adiposity indices and clinical opinion. *Ann Hum Biol,* 15, 45–54.

Statistik Austria. Zugriff am 2.12.2009 unter http://www.statistik.at/web_de/statistiken/gesundheit/gesundheitszustand/chronische_krankheiten/index.html

Statistic Austria.(2007). *Physical Activity in Austria*. Zugriff am 18.06.2009 unter http://www.statistik.at/web_en/static/results_overview_physical_activity_029137.pdf

Steele, R. M., Brage, S., Corder, K., Wareham, N. J. & Ekelund, U.(2008). Physical activity, cardiorespiratory fitness, and the metabolic syndrome in youth. *J Appl Physiol,* 105,342-351.

Strong, W.B., Malina, R.M., Blimkie, C.J., Daniels, S.R., Dishman, R.K., Gutin, B., Hergenroeder, A.C., Must, A., Nixon, P.A., Pivarnik, J.M., Rowland, T., Trost, S., & Trudeau, F.(2005). Evidence based physical activity for school-age youth. *J Pediatrics,* 146,732–737.

Trost, S.G., Sirard, J.R., Dowda, M., Pfeiffer, K.A. & Pate, R.R.(2003). Physical activity in overweight and nonoverweight preschool children. *International Journal of Obesity* , 27**,** 834–839.

US Department of Health and Human Services. Zugriff am 12.11.2009 unter www.health.gov/paguidelines

US Department of Health and Human Services (1996). Physical activity and health: A report of the Surgeon General. Centers for Disease Control and Prevention. Zugriff am 27.10.2009 unter http://www.cdc.gov/nccdphp/sgr/index.htm

Vuori, I.M. (2001). Dose-response of physical activity and low back pain, osteoarthritis, and osteoporosis. *Medicine and Science in Sports and Exercise*, 33, 551-86.

Wedderkopp, N., Froberg, K., Hansen, H.S. & Andersen, L.B.(2004). Secular trends in physical fitness and obesity in Danish 9-year-old girls and boys: Odense School Child Study and Danish substudy of the European Youth Heart Study. *Scand J Med Sci Sports,* 14, 1–6.

WHO Global Database on BMI. Zugriff am 9.11.2009 unter http://apps.who.int/bmi/index.jsp?introPage=intro_3.html

Wright, M.S., Wilson, D.K., Griffin, S. & Evans, A.(2008). A qualitative study of parental modeling and social support for physical activity in underserved adolescents. *Health Education Reasearch*, published online on August, 14, 2008*.*

Yach, D., Hawkes, C., Gould, C.L. & Hofman, K.J.(2004). The Global Burden of Chronic Diseases: Overcoming Impediments to Prevention and Control. *JAMA*, Vol 291, No. 21, 2616-22.

Zahner, L., Puder, J. J., Roth, R., Schmid, M., Guldimann, R., Pühse, U., Knöpfli, M., Braun-Fahrländer, C., Marti, B. & Kriemler, S.(2006). A school-based physical activity program to improve health and fitness in children aged 6–13 years ("Kinder-Sportstudie KISS"): study design of a randomized controlled trial. *BMC Public Health,* 6, 147.

Zimmet, P., Alberti, K.G. & Shaw, J.(2001). Global and societal implications of the diabetes epidemic. *Nature,* 414, 782-787.

9. List of Figures

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11. Annex

Sparkling Science: „Körperliche Aktivität macht Schule“

Erfassungsbogen

Name, Vorname:_______________		Datum: 02.12.2008	Klasse:______
Geschlecht: □ Junge □ Mädchen	Geb.-Dat.:__________	Größe:_____cm	Gewicht:_____kg

1. Einbeinstand	2 Versuche barfuß hintereinander (links, rechts) dann alle anderen Kinder, dann 2. Versuch. Ein Fuß positioniert sich in der Mitte der Balancierschiene, Hände sind in Hüfte fixiert. Testperson löst Stützbein vom Boden (Beginn Stoppung) und versucht so lange wie möglich stehen zu bleiben. Versuch endet wenn Spielbein Boden berührt oder Hände aus Hüfte genommen werden. Bei max. 45 sec Ende.	Links / Rechts Versuch 1 ________sec ________sec Versuch 2 ________sec ________sec
2. 10sec Sprungtest	1 Versuch; Vor Wertung Sprungtechnik erklären und vorzeigen und kurz neben Matte einüben lassen. Testperson steht beidbeinig vor Matte und hält Arme in Hüfte fixiert. Nach Kommando „Los“ auf Matte springen und 10sec lang beidbeinige Sprünge, mit möglichst kurzen Bodenkontakt und maximaler Höhe ausführen. Hände bleiben in der Hüfte. Nur bei Fehlversuch gibt es einen zweiten.	Kontaktzeit (tc):_______ Flugzeit (tf):_________ Höhe (cm):________ Index (cm/tc):________
3. Medizinball Wurf	3 Wertungsversuche gleich hintereinander; Kniestand, ein Bein aufgestellt (hinter Linie), der MedBall wird mit beiden Händen gehalten. Ball über Kopf nach hinten führen und sogleich, ohne seitlich auszuweichen frontal nach vorne geworfen. Weder Fuß noch Hände dürfen über Markierung gelangen. Hintere Knie darf nicht abgehoben werden. Wertung auf 10cm genau.	Versuch 1:____________m Versuch 2:____________m Versuch 3:____________m Mädchen: 1993 und jünger 1kg sonst 2kg Burschen: 1995 und jünger 1kg sonst 2kg
4. 0-10-20m Sprint	2 Versuche; Hochstart 50cm vor Startlinie, wobei Testperson nicht aus gehen starten darf. Auf Kommando „Fertig“ startet Testperson selbständig. Antritt und Lauf mit maximaler Intensität. Erst nach der Ziellinie abbremsen.	Versuch 1: 10m_______sec 20m_______sec Versuch 2: 10m_______sec 20m_______sec
5. Sit & Reach	Langsitz, barfuß, Füße an die Box stellen, Kniegelenke sind gestreckt (Testleiter Hand auf Knie). Langsam nach vorne beugen und Schieber mit Fingerspitzen so weit wie möglich nach vorne schieben (nicht ruckartig!). Endposition muss mind. 2 sec gehalten werden.	Versuch 1:____________cm
6. Standweitsprung	2 Versuche; Beidbeiniger Stand vor Startlinie. Maximaler beidbeiniger Weitsprung mit Armschwung und Tiefgehen. Beidbeinige Landung. Kein Weggehen oder Zurückgreifen/ oder -fallen. Entfernung zwischen Absprunglinie und Ferse des hinteren Fußes in cm wird gemessen. 1. Versuch, dann alle anderen Kinder, dann 2. Versuch	Versuch 1:____________cm Versuch 2:____________cm
7. Handkraftmessung	Je ein Versuch mit dominanter und nichtdominanter Hand, dann alle anderen Kinder, dann 2. Versuch; Testperson sitzt auf Sessel, nimmt Dynamometer nach individueller Einstellung in Hand und drückt so fest wie möglich zusammen.	Dominante Hand kennzeichnen Links / Rechts Versuch 1 ________kg ________kg Versuch 2 ________kg ________kg

Nr:

20m Shuttle Run Test
Sparkling Science

Name: ______________________ **Nummer:** __________

Testdatum: 02.12.2008 **Klasse:** __________

km/h	Level	Shutlle Nummer															
8	1	1	2	3	4	5	6	7									
9	2	1	2	3	4	5	6	7	8								
9,5	3	1	2	3	4	5	6	7	8								
10	4	1	2	3	4	5	6	7	8	9							
10,5	5	1	2	3	4	5	6	7	8	9							
11	6	1	2	3	4	5	6	7	8	9	10						
11,5	7	1	2	3	4	5	6	7	8	9	10						
12	8	1	2	3	4	5	6	7	8	9	10	11					
12,5	9	1	2	3	4	5	6	7	8	9	10	11					
13	10	1	2	3	4	5	6	7	8	9	10	11					
13,5	11	1	2	3	4	5	6	7	8	9	10	11	12				
14	12	1	2	3	4	5	6	7	8	9	10	11	12				
14,5	13	1	2	3	4	5	6	7	8	9	10	11	12	13			
15	14	1	2	3	4	5	6	7	8	9	10	11	12	13			
15,5	15	1	2	3	4	5	6	7	8	9	10	11	12	13			
16	16	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
16,5	17	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
17	18	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
17,5	19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
18	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Sparkling Science: „Körperliche Aktivität macht Schule“		
Muskelfunktion		
Name, Vorname:________________	Datum:	Klasse:________

Test auf Verkürzung		
M. Iliopsoas	Links 3 ☐ 4 ☐ 5 ☐	Rechts 3 ☐ 4 ☐ 5 ☐
M. rectus femoris	Links 3 ☐ 4 ☐ 5 ☐	Rechts 3 ☐ 4 ☐ 5 ☐
Mm. ischiocrurales	Links 3 ☐ 4 ☐ 5 ☐	Rechts 3 ☐ 4 ☐ 5 ☐
Mm. adductores	Links 3 ☐ 4 ☐ 5 ☐	Rechts 3 ☐ 4 ☐ 5 ☐
M. pectoralis major	Links 3 ☐ 4 ☐ 5 ☐	Rechts 3 ☐ 4 ☐ 5 ☐
Test auf Abschwächung		
M. gluteus medius	Links 3 ☐ 4 ☐ 5 ☐	Rechts 3 ☐ 4 ☐ 5 ☐
M. gluteus maximus	Links 3 ☐ 4 ☐ 5 ☐	Rechts 3 ☐ 4 ☐ 5 ☐
Erect. Spinae BWS	3 ☐ 4 ☐ 5 ☐	
Scapulafixatoren	Links 3 ☐ 4 ☐ 5 ☐	Rechts 3 ☐ 4 ☐ 5 ☐
Mm. abdominales	3 ☐ 4 ☐ 5 ☐	

Sparkling Science: „Körperliche Aktivität macht Schule“		
MFT – S3 Check **Messung:**		
Name, Vorname:__________________________	Datum:	Klasse:________

S3 Stabilität	
Referenzwert	
Messwert	
Prozentuale Bewertung	
S3 Sensomotorik	
Referenzwert	
Messwert	
Prozentuale Bewertung	
S3 Symmetrie	
Empfohlene Symmetrie	50:50
Gemessene Symmetrie	
Prozentuale Aufteilung	
Bereich 1 (Grün)	
Bereich 2 (Grün zu Gelb)	
Bereich 3 (Gelb)	
Bereich 4 (Gelb zu Rot)	
Bereich 5 (Rot)	

Schriftliche EINWILLIGUNGSERKLÄRUNG

SPARKLING SCIENCE – GESUNDHEITSPROJEKT
„Körperliche Aktivität macht Schule"

Ich habe das Informationsblatt gelesen und verstanden, worum es bei diesem Projekt geht. Ich habe mich mit meinen Eltern beraten und es wurden mir alle offenen Fragen von den zuständigen Pojektmitarbeitern beantwortet.

Ich nehme freiwillig an dieser Studie teil und weiß, dass ich jederzeit und ohne zu sagen warum, aus dieser Studie aussteigen kann, ohne dass mir dadurch irgendwelche Nachteile entstehen.

Zutreffendes bitte ankreuzen!

Ich nehme an den **Sportmotorischen Tests** und der **Aktivitätsmessung mittels Accelerometer** teil:	☐ Ja	☐ Nein
Ich nehme an den **Sportmedizinischen Tests** teil:	☐ Ja	☐ Nein
Ich nehme an der immunologischen und metabolischen Statuserhebung mittels **Speichelprobe** teil:	☐ Ja	☐ Nein
Ich nehme an der immunologischen und metabolischen Statuserhebung mittels **Blutprobe** teil:	☐ Ja	☐ Nein

....
NAME des Kindes (Blockschrift)

.... **Geb.-Datum**	.... **Schulklasse**	.... **SV Nummer (optional)***

....
PLZ, Adresse (Blockschrift)

....
NAME des Erziehungsberechtigten (Blockschrift), ev. ERKRANKUNGEN, TELEFONNUMMER

.... **Datum**	.... **Unterschrift des Kindes**	.... **Datum**	.... **Unterschrift des/der Erziehungsberechtigten**
.... **Datum**	.... **Univ.Prof. Dr. Norbert BACHL** (Projektleiter)	.... **Datum**	.... **Dr. Reinhard FESSL** (Sportmedizin. Untersuchung)

* dient nur zur Erleichterung der Administration

Annex Table 1: Univariate factor analysis for medicine ball throw; fixed factors: schooltype, agegroup; split by sex

Tests der Zwischensubjekteffekte[c]

Abhängige Variable: medicine ball throw [m]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	182,206(a)	7	26,029	36,786	,000	257,505	1,000
Konstanter Term	2723,133	1	2723,133	3848,510	,000	3848,510	1,000
schooltype	65,690	1	65,690	92,838	,000	92,838	1,000
Altersst_SpoMo_4	97,476	3	32,492	45,920	,000	137,759	1,000
schooltype * Altersst_SpoMo_4	6,013	3	2,004	2,833	,041	8,498	,668
Fehler	84,202	119	,708				
Gesamt	3006,609	127					
Korrigierte Gesamtvariation	266,408	126					

a. R-Quadrat = ,684 (korrigiertes R-Quadrat = ,665)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = female

Tests der Zwischensubjekteffekte[c]

Abhängige Variable: medicine ball throw [m]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	839,191(a)	7	119,884	89,577	,000	627,037	1,000
Konstanter Term	6305,715	1	6305,715	4711,583	,000	4711,583	1,000
schooltype	67,096	1	67,096	50,133	,000	50,133	1,000
Altersst_SpoMo_4	658,578	3	219,526	164,028	,000	492,085	1,000
schooltype * Altersst_SpoMo_4	8,778	3	2,926	2,186	,091	6,559	,549
Fehler	255,624	191	1,338				
Gesamt	7858,955	199					
Korrigierte Gesamtvariation	1094,814	198					

a. R-Quadrat = ,767 (korrigiertes R-Quadrat = ,758)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = male

Annex Table 2: Univariate factor analysis for hand grip dominant; fixed factors: schooltype, agegroup; split by sex

Tests der Zwischensubjekteffekte[c]

Abhängige Variable: hand grip dominant [kg]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	4449,979(a)	7	635,711	22,530	,000	157,710	1,000
Konstanter Term	106293,364	1	106293,364	3767,096	,000	3767,096	1,000
schooltype	701,390	1	701,390	24,858	,000	24,858	,999
Altersst_SpoMo_4	3221,623	3	1073,874	38,059	,000	114,176	1,000
schooltype * Altersst_SpoMo_4	192,174	3	64,058	2,270	,084	6,811	,561
Fehler	3385,951	120	28,216				
Gesamt	119405,000	128					
Korrigierte Gesamtvariation	7835,930	127					

a. R-Quadrat = ,568 (korrigiertes R-Quadrat = ,543)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = female

Tests der Zwischensubjekteffekte[c]

Abhängige Variable: hand grip dominant [kg]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	36508,683(a)	7	5215,526	87,542	,000	612,796	1,000
Konstanter Term	240756,491	1	240756,491	4041,080	,000	4041,080	1,000
schooltype	623,250	1	623,250	10,461	,001	10,461	,896
Altersst_SpoMo_4	31616,033	3	10538,678	176,891	,000	530,673	1,000
schooltype * Altersst_SpoMo_4	972,325	3	324,108	5,440	,001	16,320	,934
Fehler	11319,681	190	59,577				
Gesamt	312710,000	198					
Korrigierte Gesamtvariation	47828,364	197					

a. R-Quadrat = ,763 (korrigiertes R-Quadrat = ,755)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = male

Annex Table 3: Univariate factor analysis for hand grip non dominant; fixed factors: schooltype, agegroup; split by sex

Tests der Zwischensubjekteffekte[c]

Abhängige Variable: hand grip non dominant [kg]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	3892,577(a)	7	556,082	22,733	,000	159,132	1,000
Konstanter Term	90010,999	1	90010,999	3679,735	,000	3679,735	1,000
schooltype	498,273	1	498,273	20,370	,000	20,370	,994
Altersst_SpoMo_4	2742,769	3	914,256	37,376	,000	112,127	1,000
schooltype * Altersst_SpoMo_4	140,778	3	46,926	1,918	,130	5,755	,485
Fehler	2935,352	120	24,461				
Gesamt	103463,000	128					
Korrigierte Gesamtvariation	6827,930	127					

a. R-Quadrat = ,570 (korrigiertes R-Quadrat = ,545)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = female

Tests der Zwischensubjekteffekte[c]

Abhängige Variable: hand grip non dominant [kg]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	31613,508(a)	7	4516,215	76,808	,000	537,656	1,000
Konstanter Term	218888,920	1	218888,920	3722,676	,000	3722,676	1,000
schooltype	512,930	1	512,930	8,723	,004	8,723	,836
Altersst_SpoMo_4	28256,836	3	9418,945	160,189	,000	480,568	1,000
schooltype * Altersst_SpoMo_4	416,840	3	138,947	2,363	,073	7,089	,586
Fehler	11289,372	192	58,799				
Gesamt	278750,000	200					
Korrigierte Gesamtvariation	42902,880	199					

a. R-Quadrat = ,737 (korrigiertes R-Quadrat = ,727)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = male

Annex Table 4: Univariate factor analysis for standing broad jump; fixed factors: schooltype, agegroup; split by sex

Tests der Zwischensubjekteffekte[c]

Abhängige Variable: standing broad jump [cm]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	21724,997(a)	7	3103,571	7,189	,000	50,322	1,000
Konstanter Term	3297873,794	1	3297873,794	7638,930	,000	7638,930	1,000
schooltype	9609,839	1	9609,839	22,259	,000	22,259	,997
Altersst_SpoMo_4	7875,895	3	2625,298	6,081	,001	18,243	,956
schooltype * Altersst_SpoMo_4	2222,389	3	740,796	1,716	,167	5,148	,439
Fehler	52238,042	121	431,719				
Gesamt	3611444,000	129					
Korrigierte Gesamtvariation	73963,039	128					

a. R-Quadrat = ,294 (korrigiertes R-Quadrat = ,253)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = female

Tests der Zwischensubjekteffekte[c]

Abhängige Variable: standing broad jump [cm]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	132928,205(a)	7	18989,744	45,855	,000	320,985	1,000
Konstanter Term	6748424,489	1	6748424,489	16295,595	,000	16295,595	1,000
schooltype	12731,263	1	12731,263	30,743	,000	30,743	1,000
Altersst_SpoMo_4	97104,455	3	32368,152	78,160	,000	234,481	1,000
schooltype * Altersst_SpoMo_4	1345,598	3	448,533	1,083	,358	3,249	,290
Fehler	77855,631	188	414,126				
Gesamt	7527036,000	196					
Korrigierte Gesamtvariation	210783,837	195					

a. R-Quadrat = ,631 (korrigiertes R-Quadrat = ,617)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = male

Annex Table 5: Univariate factor analysis for vertical jump; fixed factors: schooltype, agegroup; split by sex

Tests der Zwischensubjekteffekte[c]

Abhängige Variable: muscle stiffness index

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	33432,100(a)	7	4776,014	5,550	,000	38,848	,998
Konstanter Term	2043694,733	1	2043694,733	2374,775	,000	2374,775	1,000
schooltype	25443,348	1	25443,348	29,565	,000	29,565	1,000
Altersst_SpoMo_4	4558,335	3	1519,445	1,766	,157	5,297	,451
schooltype * Altersst_SpoMo_4	4608,501	3	1536,167	1,785	,154	5,355	,455
Fehler	104130,744	121	860,585				
Gesamt	2274510,520	129					
Korrigierte Gesamtvariation	137562,844	128					

a. R-Quadrat = ,243 (korrigiertes R-Quadrat = ,199)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = female

Tests der Zwischensubjekteffekte[c]

Abhängige Variable: muscle stiffness index

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	179722,454(a)	7	25674,636	26,797	,000	187,581	1,000
Konstanter Term	4225229,658	1	4225229,658	4409,987	,000	4409,987	1,000
schooltype	64276,347	1	64276,347	67,087	,000	67,087	1,000
Altersst_SpoMo_4	77918,500	3	25972,833	27,109	,000	81,326	1,000
schooltype * Altersst_SpoMo_4	2190,901	3	730,300	,762	,517	2,287	,212
Fehler	182039,915	190	958,105				
Gesamt	4755683,170	198					
Korrigierte Gesamtvariation	361762,370	197					

a. R-Quadrat = ,497 (korrigiertes R-Quadrat = ,478)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = male

Annex Table 6: Univariate factor analysis for 20m sprint; fixed factors: schooltype, agegroup; split by sex

Tests der Zwischensubjekteffekte[c]

Abhängige Variable: sprint 20m [sec]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	2,651(a)	7	,379	7,752	,000	54,265	1,000
Konstanter Term	1612,441	1	1612,441	33001,657	,000	33001,657	1,000
schooltype	1,600	1	1,600	32,747	,000	32,747	1,000
Altersst_SpoMo_4	,594	3	,198	4,053	,009	12,159	,832
schooltype * Altersst_SpoMo_4	,112	3	,037	,763	,517	2,289	,210
Fehler	5,863	120	,049				
Gesamt	1823,772	128					
Korrigierte Gesamtvariation	8,515	127					

a. R-Quadrat = ,311 (korrigiertes R-Quadrat = ,271)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = female

Tests der Zwischensubjekteffekte[c]

Abhängige Variable: sprint 20m [sec]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	14,029(a)	7	2,004	45,438	,000	318,064	1,000
Konstanter Term	2092,770	1	2092,770	47447,347	,000	47447,347	1,000
schooltype	,874	1	,874	19,821	,000	19,821	,993
Altersst_SpoMo_4	10,845	3	3,615	81,958	,000	245,873	1,000
schooltype * Altersst_SpoMo_4	,208	3	,069	1,570	,198	4,709	,409
Fehler	8,248	187	,044				
Gesamt	2403,124	195					
Korrigierte Gesamtvariation	22,277	194					

a. R-Quadrat = ,630 (korrigiertes R-Quadrat = ,616)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = male

Annex Table 7: Univariate factor analysis for shuttle run; fixed factors: schooltype, agegroup; split by sex

Tests der Zwischensubjekteffekte[c]

Abhängige Variable:endurance shuttle run [m]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	4,498E6	7	642583,746	7,960	,000	55,720	1,000
Konstanter Term	1,010E8	1	1,010E8	1250,881	,000	1250,881	1,000
schooltype	3678983,294	1	3678983,294	45,573	,000	45,573	1,000
Altersst_SpoMo_4	355456,269	3	118485,423	1,468	,227	4,403	,379
schooltype * Altersst_SpoMo_4	537431,301	3	179143,767	2,219	,090	6,657	,549
Fehler	8879991,742	110	80727,198				
Gesamt	1,152E8	118					
Korrigierte Gesamtvariation	1,338E7	117					

a. R-Quadrat = ,336 (korrigiertes R-Quadrat = ,294)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = female

Tests der Zwischensubjekteffekte[c]

Abhängige Variable:endurance shuttle run [m]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	2,028E7	7	2896933,850	25,922	,000	181,451	1,000
Konstanter Term	3,266E8	1	3,266E8	2922,007	,000	2922,007	1,000
schooltype	5195561,260	1	5195561,260	46,490	,000	46,490	1,000
Altersst_SpoMo_4	1,033E7	3	3443733,719	30,814	,000	92,443	1,000
schooltype * Altersst_SpoMo_4	569593,916	3	189864,639	1,699	,169	5,097	,439
Fehler	1,967E7	176	111757,708				
Gesamt	3,874E8	184					
Korrigierte Gesamtvariation	3,995E7	183					

a. R-Quadrat = ,508 (korrigiertes R-Quadrat = ,488)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = male

Annex Table 8: Univariate factor analysis for cycle ergometer test; fixed factors: schooltype, agegroup; split by sex

Tests der Zwischensubjekteffekte[c]

Abhängige Variable:aerobic fitness [Watt/kg]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Partielles Eta-Quadrat	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	5,048[a]	7	,721	2,757	,011	,150	19,298	,897
Konstanter Term	1237,567	1	1237,567	4730,981	,000	,977	4730,981	1,000
schooltype	2,992	1	2,992	11,437	,001	,095	11,437	,918
Altersst_SpoMe_4	1,646	3	,549	2,097	,105	,055	6,291	,523
schooltype * Altersst_SpoMe_4	1,295	3	,432	1,650	,182	,043	4,951	,423
Fehler	28,513	109	,262					
Gesamt	1327,369	117						
Korrigierte Gesamtvariation	33,561	116						

a. R-Quadrat = ,150 (korrigiertes R-Quadrat = ,096)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = female

Abhängige Variable:aerobic fitness [Watt/kg]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Partielles Eta-Quadrat	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	9,123[a]	7	1,303	5,290	,000	,189	37,033	,998
Konstanter Term	2761,821	1	2761,821	11211,449	,000	,986	11211,449	1,000
schooltype	7,620	1	7,620	30,933	,000	,163	30,933	1,000
Altersst_SpoMe_4	,382	3	,127	,517	,671	,010	1,552	,154
schooltype * Altersst_SpoMe_4	1,640	3	,547	2,219	,088	,040	6,656	,554
Fehler	39,168	159	,246					
Gesamt	2859,662	167						
Korrigierte Gesamtvariation	48,291	166						

a. R-Quadrat = ,189 (korrigiertes R-Quadrat = ,153)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = male

Annex Table 9: Univariate factor analysis for sit&reach; fixed factors: schooltype, agegroup; split by sex

Tests der Zwischensubjekteffekte[c]

Abhängige Variable: sit and reach [cm]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	2487,871(a)	7	355,410	6,705	,000	46,935	1,000
Konstanter Term	13470,157	1	13470,157	254,120	,000	254,120	1,000
schooltype	742,194	1	742,194	14,002	,000	14,002	,960
Altersst_SpoMo_4	1312,564	3	437,521	8,254	,000	24,762	,991
schooltype * Altersst_SpoMo_4	294,239	3	98,080	1,850	,142	5,551	,470
Fehler	6413,850	121	53,007				
Gesamt	21922,000	129					
Korrigierte Gesamtvariation	8901,721	128					

a. R-Quadrat = ,279 (korrigiertes R-Quadrat = ,238)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = female

Tests der Zwischensubjekteffekte[c]

Abhängige Variable: sit and reach [cm]

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	2526,206(a)	7	360,887	7,030	,000	49,208	1,000
Konstanter Term	7821,064	1	7821,064	152,346	,000	152,346	1,000
schooltype	1372,099	1	1372,099	26,727	,000	26,727	,999
Altersst_SpoMo_4	258,223	3	86,074	1,677	,173	5,030	,435
schooltype * Altersst_SpoMo_4	406,254	3	135,418	2,638	,051	7,913	,639
Fehler	9856,789	192	51,337				
Gesamt	19571,000	200					
Korrigierte Gesamtvariation	12382,995	199					

a. R-Quadrat = ,204 (korrigiertes R-Quadrat = ,175)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = male

Annex Table 10: Univariate factor analysis for single leg balance; fixed factors: schooltype, agegroup; split by sex

Tests der Zwischensubjekteffekte[c]

Abhängige Variable:bestleg

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	6957,269[a]	7	993,896	7,786	,000	54,504	1,000
Konstanter Term	41492,281	1	41492,281	325,052	,000	325,052	1,000
schooltype	3206,703	1	3206,703	25,121	,000	25,121	,999
Altersst_SpoMo_4	1638,033	3	546,011	4,277	,007	12,832	,854
schooltype * Altersst_SpoMo_4	1319,958	3	439,986	3,447	,019	10,341	,762
Fehler	15445,420	121	127,648				
Gesamt	60854,865	129					
Korrigierte Gesamtvariation	22402,688	128					

a. R-Quadrat = ,311 (korrigiertes R-Quadrat = ,271)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = female

Tests der Zwischensubjekteffekte[c]

Abhängige Variable:bestleg

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.	Nichtzentralitäts-Parameter	Beobachtete Schärfe[b]
Korrigiertes Modell	11230,530[a]	7	1604,361	9,959	,000	69,715	1,000
Konstanter Term	86043,617	1	86043,617	534,127	,000	534,127	1,000
schooltype	7191,266	1	7191,266	44,641	,000	44,641	1,000
Altersst_SpoMo_4	2219,768	3	739,923	4,593	,004	13,780	,884
schooltype * Altersst_SpoMo_4	137,503	3	45,834	,285	,837	,854	,104
Fehler	30929,661	192	161,092				
Gesamt	125963,143	200					
Korrigierte Gesamtvariation	42160,191	199					

a. R-Quadrat = ,266 (korrigiertes R-Quadrat = ,240)

b. Unter Verwendung von Alpha = ,05 berechnet

c. sex = male

Declaration

„Ich erkläre, dass ich die vorliegende Arbeit *selbstständig* verfasst habe und nur die ausgewiesenen Hilfsmittel verwendet habe. Diese Arbeit wurde daher weder an einer anderen Stelle eingereicht noch von anderen Personen vorgelegt."

Des Weiteren habe ich mich zur Einhaltung der Regeln der guten wissenschaftlichen Praxis verpflichtet sowie die gesetzlichen Grundlagen zur Kenntnis genommen.

Wien, im Dezember 2009 Harald Maderthaner

Curriculum Vitae

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Schul- und akademische Bildung

1986-1990	Volksschule Weyer
1990-1994	BRG Waidhofen/Ybbs
1994-1999	HTBLuVA Waidhofen/Ybbs,
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2003-2009	Universität Wien
	Lehramt Bewegung und Sport
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Zusatzausbildung

2005	staatl. gepr. Mountainbikeinstruktor
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