Effects of Daily Physical Education Participation on the Somatic and Motoric Development of Young Students

Zsolt Szakal 7, Jozsef Bognar 8, Balazs Lengvari 9 & Akos Koller10

Abstract

Regular physical activity is one of the dominant elements among environmental factors, which promotes young individuals’ healthy somatic and motoric development. In the present investigation it was hypothesized that participation in daily physical education (DPE) has a positive effect on the age-dependent anthropometric and fitness characteristics of primary school boys. The investigation took place in six primary schools in a mid-sized city in Hungary before and four years after the implementation of DPE. Group 1 had three PE lessons a week (n=562) and Group 2 had five PE lessons a week (n=551). According to our results, there were no differences in the BMI between the two groups; however, Group 1 had a significantly higher waist-hip ratio in all age-groups except for the 10-11 age cohort. In the 7-8 age cohort, Group 2 demonstrated significantly better results in the shuttle run test; conversely, in the older age groups Group 1 did significantly better. Altogether, daily PE had an age-dependent effect on the somatic development. Daily PE had a positive protective effect on BMI, the waist-hip ratio of the 10-11 age cohort, and also the fitness level of the 7-8 age cohort. It can be proposed that, through careful planning in DPE, exercise intensity and teaching methodology should be increased in an age-specific manner.

Keywords: daily physical education, school-aged boys, age-dependent characteristics, waist-hip ratio, BMI, 20 m shuttle run

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Introduction

Besides genetic and epigenetic factors, a health-conscious lifestyle has a major impact on optimal somatic and mental development (Beunen, 2003; Post, Kemper, Twisk, 1997). With supportive social and environmental factors, school physical education might play an important role in maintaining a healthy lifestyle, as it provides a science-based, systematic and conscious physical activity program for all students (Meszaros, Szabo, Mohacsi et al., 2002).

Due to recent developments in the areas of science, economics, education and sport, the anthropometric parameters of students have generally improved in the past few decades (Bodzsar, 1998). In contrast to such improvements, the physical and motor performance of youth in Hungary show a decreasing trend (Toth, Eiben, 2004) – many aspects of this problem have already been discussed in the literature (Bedros, 2017; Rowland, 2003). According research, there has been a clear negative trend in motor development and fitness levels among schoolchildren (Phiotiou, Anning, Meszaros, et al., 2008). One of the main reasons for this negative trend might be increased living standards together with unhealthy behaviour, which resulted in excessive energy intake and, together with a sedentary lifestyle, a decreased energy consumption (Ross, Janssen, Tremblay, 2000; Telama, Yang, 2000; Turi et al., 2017).

All students benefit from regular PE regardless of ability and skills if it is interesting, fun and developmentally appropriate (Capel, 2000). It is well known that regular physical activity, especially at a young age, increases psychosomatic development and motor performance, thereby significantly contributing to the optimization of body composition, fitness and altogether to better quality of life (Molnar, Erhardt, Felso, 2017). The harmony of physique and the operation of organs and organ systems are essential for schoolchildren because they are displayed at the level of motor performance. As a result, the analysis of fitness levels is of critical importance in terms of assessing somatic development.

Through a longitudinal study of a representative youth sample in the 1960s and 1980s, Bakonyi (1984) demonstrated that the physical development between the two examinations indicated major positive differences, while the trend in motor performance gradually decreased. Similarly, lately Phiotiou et al. (2008) and Meszaros et al. (2002, 2008) experienced negative trends in both anthropometric and motor parameters.

Daily Physical Education

Recognising these negative trends, the Hungarian government introduced daily physical education (PE) in the academic year of 2012-2013, which prescribes 45 minutes of daily physical activity for all students during school time. According to the legislation, daily physical education had to be introduced into the education system in first, fifth and ninth grades from September 1, 2012 and later in other grades as children proceeded with their
education. The new law placed a distinct emphasis on the in-school organisation of physical education and other sport and physical activities, aiming at the establishment of a more active and health-conscientious society.

The key strategic objective of the PE in the Hungarian National Core Curriculum (2012) is to help students develop and maintain healthy and physically active lifestyle (Fugedi, Capel, Dancs, & Bognar, 2016). Experience shows that the introduction of daily physical education might be a significant step in the motivation of schoolchildren towards lifelong sports and also in the improvement of their anthropometric parameters and motor performance (Mura et al. 2015; Szakaly, Ihasz, Konczos, et al., 2016). However, there have been limited studies examining the effects the introduction of daily physical education on the anthropometric parameters and motor performance of schoolchildren.

**Research Questions**

The purpose of the study was to examine the effects of a four-year-long daily physical education program on the anthropometric and motor parameters of 7-14-year-old schoolboys. In order to have a more homogenous sample and solid set of data, we focused our examinations on groups of boys. The reason behind this is that girls of a similar age often go through an early adolescent period, which comes together with a leap in the level of hormones that determine somatic and motor development (Loesch, Hopper, Rogucka, et al., 1995; Marceau, Ram, Houts et al., 2011).

Based on the abovementioned issues, it was assumed that daily physical education has a positive effect on the age-dependent development of young students in terms of fitness as related to anthropometric parameters and motor performance.

**Method**

**Sample**

Our tests were performed on two groups (2x8 groups) of 7-14-year-old boys (Table 1). Group 1 was measured before the introduction of daily physical education (three sessions per week during 2010-2011, n=562); Group 2 was measured four years after the introduction of daily physical education (five sessions per week during 2015-2016, n=551). All members of Group 2 have already been part of daily physical education for four years. The two samples did not include the same schoolboys, therefore it can be considered as a limitation in this study.

The tests were performed in six elementary schools in the city of Gyor, which are average in terms of indoor and outdoor PE infrastructure in Hungary, and therefore provide reasonable sample reliability. During the classification of our participants, the human-biological guidelines of Weiner and Lourie [18] was followed (the child is seven years old when older than 6.51 years and younger than 7.50 years). Those participants who can be designated as athletes represented less than 5% of the sample.
The tests were carried out in accordance with the suggestions of the International Biological Program (1969). Anthropometric characteristics were recorded by specialist personnel (2 persons) while motor performances were assessed by qualified PE teachers within one week of the anthropometric measurements. These measurements were performed using a certified Sieber-Hegner anthropometer and tape measure. Body weight was measured with a digital personal scale with a reading accuracy of 0.1 kg. For classical anthropometric parameters (body height, body weight), body mass index according to suggestion of the NETFIT (2013) and waist-hip ratio was also measured. In order to characterize endurance, the 20 m shuttle-run test was used, which counted the number of completed lengths.

<table>
<thead>
<tr>
<th>Age cohort</th>
<th>Number of students Group 1. (Academic year 2010-2011)</th>
<th>Number of students Group 2. (Academic year 2015-2016)</th>
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**Ethical Considerations**

The study was ethically approved by the University's Ethical Committee and ethical consent was gained from every student and their parents. Parents were contacted in a teacher-parent conference prior to data collection and no objections were made regarding their child/children participation in this study.

All students voluntarily participated in this study. The research was based on the anonymity of the participants.

**Statistical Analysis**

In the first step of statistical analysis, descriptive statistical measures were calculated for the age groups. We analyzed the differences in mean values of measured and calculated variables using a single factor variance analysis (ANOVA) followed by an F-test. In the case of a significant F-value, critical differences were calculated according to Fisher’s suggestions. The assessment differences of age groups were characterized with the use of two-sample t-test. During the interpretation of our statistics, the maximum random error was defined at 5%. Measured and calculated data were processed using Statistics for Windows (version 13.2, StatSoft Inc., Tulsa, OK 74104, USA, 2006).
Results

**Anthropometrical Data**

The results of body height and its comparative statistics of schoolboys classified into Group 1 and Group 2 can be seen in Figure 1. According to age, the difference between the two groups was significant for both measures ($F_{1.\text{measures}}=272.92 \ p<0.000$; $F_{2.\text{measures}}=210.12 \ p<0.000$). A post-hoc analysis shows that the difference in body height means increased significantly in both assessments for consecutive age groups. Depending on age, variation coefficients were around 5%. According to the t-test, there was no difference between the identical age groups of Group 1 and Group 2.

*Figure 1. Height of students in cm in age-cohorts in Group 1 (2010-2011) and Group 2 (2015/2016).*

The difference in body weight (Figure 2) was significant in both tests ($F_{1.\text{measures}}=122.18; \ p<0.000$; $F_{2.\text{measures}}=90.16; \ p<0.000$) as related to age. The standard deviations around the means were similar for all measures, but increased with age. In the case of Group 1, the difference in means of the consecutive age groups increased significantly. In Group 2, there were no differences between the seven and eight year olds, while the difference was significant for older participants. Within the two groups there were no significant differences in respective body weights.
The internationally accepted body mass index (BMI) was used to characterise nutrition status (Marceau, Ram, Houts, et al., 2011). There was a significant increase in BMI (Figure 3) for both groups ($F_{1,measures}=22.73, p<0.000; F_{2,measures}=16.86; p<0.000$). However, within Group 1 there was a significant difference only between 7 and 8, 9 and 10, and 13 and 14 year old pupils. In the case of Group 2, the only significant difference was between 9 and 10 year olds (analysis of variance). The means of the two groups showed no significant differences in any of the age groups.
The difference between the age group waist-hip ratio (Figure 4) was statistically significant for both Groups (F_{1,measures}=2.51, p<0.000; F_{2,measures}=5.32, p<0.000). Nevertheless, the post-hoc analysis indicated significant differences in means for only the 13-14 year olds (1^{st} measure), and 9-10 year olds with 13-14 year olds (2^{nd} measure). According to the values of the t-test, the results of Group 2 were significantly higher for all age groups except for 10-11 year olds.

Figure 4. Waist-hip ratio of students in cm in age-cohorts in Group 1 (2010-2011) and Group 2 (2015/2016)

**Data of Motor Performance**

Based on the suggestions of Leger et al. (1988), we used the 20 m shuttle run test to measure endurance (Figure 5). The difference between means of the completed lengths was significant (F_{1,measures}= 9.57, p<0.000; F_{2,measures} = 4.15, p<0.000). After the post-hoc analysis, the mean differences of the test were significant except for 7-8, 11-12 and 13-14 year olds (assessment of Group 1). In the case of Group 2, the test results of consecutive age groups only showed statistically significant differences for 11-12 year olds.

The difference in means increased in the case of the Group 1 tests, while standard deviations decreased. The tests of Group 2 resulted in decreasing mean values amongst different age cohorts, while deviations around means increased. The motor performances of students in the age groups were significantly different during the examinations of Group 1 and 2 – except for 9-10 year olds. For 7 and 8 year olds, we found significantly better results for Group 2. However, this trend is the opposite for higher age groups, as in the case of older Group 1 subjects, for whom motor performance was significantly better.
Discussion

With our examination we tested the hypothesis of the effects of daily physical education on schoolboys' anthropometric characteristics and motor performance. Based on our results, we can state that daily physical education has a remarkable effect on the endurance of 7-8 year old boys. Similarly, daily PE classes have a positive impact on BMI and the waist-hip ratio and endurance of 10-11 year old schoolboys. We can consider these results positive, since the level of fitness has demonstrated a gradually deteriorating trend in the past decades. Despite this fact, no effect of daily physical education is present regarding the waist-hip ratio of 7-9 and 12-14 year olds and the endurance of 11-14 year olds.

Anthropometric Data (Height, Weight, BMI)

The difference in body height and body weight means was significant in every age group for both groups. There was a real difference between consecutive age groups. Standard deviations around mean values were generally large; larger than in previous decades (Meszaros, Szabo, Peng, et al., 2011).

Over the last 25 years, there has been a notable change in the employment structure and living standards of the Hungary and in the lifestyle of the population (Saghi et al. 2002; Photiou et al. 2008). Comparing our data against earlier representative results, we can state that our participants are taller and heavier in both test groups than in the earlier studies (Eiben, Pantoo, Barabas, 1989; Joubert, Darvay, Gyenis, et al., 2006).

A logical explanation for the increased body weight might be the bigger muscle mass of young boys. In contrast, examinations of body composition and motor performance
suggest that the quantity of fat and muscle mass are unstable, but the increase in fat mass is dominant (Meszaros, Vajda, Meszaros, et al., 2007; Protzner, Trajer, Bosnyak, et al., 2015). In their research on differences in secular changes among schoolboys, Vajda et al. (2010) concluded that the acceleration in body mass increase is rather specific. They were not able to explain the bigger ratio of fat with the difference in body height in their study. Since the age-related change velocity of anthropometric parameters is very similar to the data published by Vajda et al. (2010), our results confirm the outcome of the mentioned researchers.

Body composition cannot be reliably estimated with BMI (Malina, Bouchard, Bar-Or, 2004) because the index is not sensitive to the allometry of different body composition factors and the justified age dependency of specific tissues’ density change (Neovius et al. 2004). Furthermore, Malina et al. (2004) emphasized that BMI can be used for the comparison of body weights of individuals, and is less suitable for indicating the specific components of the body.

Nevertheless, BMI has been justified and supported in sport science. If we calculate BMI according to the mean values described in the work of Eiben et al. (1989), we can say that the BMI mean values of age groups are smaller within the 1989 sample. The BMI values of age groups in both of our test populations are exceeding national averages – similarly to body height and body weight – and are approximating the 75th-90th percentiles. Freedman et al. (2009) have shown that when a child’s BMI reaches the 85th-90th percentiles, the probability of having body fat mass that increases health risks is rather high. In accordance with this fact, the values our participants have represent health risks.

**Anthropometric Data (Waist-hip Ratio)**

The simple-to-measure and calculate waist-hip ratio is a good predictor of overweight- and sedentary lifestyle-related civilization diseases (Dobbelsteyn, Joffres, MacLean et al., 2011; Heid, Jackson, Randall, et al., 2010; Huxley, Mendis, Zheleznyakov et al., 2010; Vazquez, Duval, Jacobs, et al., 2007). Researchers define the healthy upper limit of the waist-hip ratio at 0.90 (Kiss, Barna, Dankovics, et al., 2014; Nadas, Jermendy, 2009). There were limited meaningful differences in this study between the results of the age groups, but the means of the two groups significantly increased, with the exception of 9-10 year olds.

Although the waist-hip ratio of our participants could be classified as healthy for individuals, even in the case of Group 2, this is a warning sign because the increase we witnessed over five years draws our attention to a large-scale health hazard. If we accept the opinion of YoonMung and SoJung (2009), who say that physical activity has a protective effect on the amount of abdominal fat, then we can estimate that daily physical education might decelerate the growth of abdominal fat mass.

Our research confirms the trend published by Chaoyang et al. (2006), which shows that the waist-hip ratio of children has been growing in the past two or three decades. The
basic explanation reinforces the conclusion of the team led by Flegal (2002). Energy intake that exceeds consumption in the long term soon results in the accumulation of storage fat, and therefore to an overweight condition and obesity. However, the danger of intensified energy storage (which exceeds the age-dependent effects of biological regulation) puts school-aged children at health risk.

Eisenmann et al. (2004) draw attention to the critical nature of health education including nutrition in childhood. The authors emphasize energy intake and consumption, and concludes that during childhood and adolescence, 50% of energy intake that exceeds the basal metabolic rate is counterbalanced by daily physical activity. Frenkl’s (1990) calculations suggest that the energy needs for physical activity (not competitive sport training) is relatively low. Depending on the type and intensity of the activity, it takes about 25-30 minutes of continuous action to consume 100 kcal (419 kJ). As the excess energy intake of our children is greater than this, 75-90 minutes of daily activity is required to control the amount of storage fat. The other group of restricting factors is the development of motion techniques that do not evolve properly without an appropriate and well-timed training stimulus.

**Motor Performance**

The results of the shuttle run test points out that the effect of daily physical education on endurance improvement is not significant. The examination of Group 1 (before daily physical education) demonstrated that the difference in means significantly improved with age throughout the test. The results show that the change among age groups is not consistent and the standard deviations around mean values decrease with age, which indicates the improved homogeneity of groups. In the case of Group 2 (four years after the introduction of daily physical education), the age-related “motor” results are decreasing, while standard deviations show a growing trend, which means more heterogeneous groups.

Further researches should definitely discover the mechanisms that explain the unexpected result of Group 2, in which younger students (7-9 year olds) had better motor performance in comparison to their older (10-14 year old) peers, and also why the motor performance of Group 2 was significantly below the performance of the Group 1 students. A logical explanation might be that under-motivation, which is common during puberty, plays a part in this trend. Lack of interest, little or no success and enjoyment in PE have a clear negative influence on level of endurance and fitness. As a result, the mental, psychological and cognitive development of students also appears to be important in order to demand a long lasting health-conscious, physically active lifestyle. This is particularly important, as improved lifestyle promotes obesity in a young age as well, which has a negative effect not only on somatic, motor and psychic development, but – among others – on the cardiovascular system (Koller, Lelbach, Kovacs, 2017).
Conclusion

Despite the introduction of daily physical education, there is no difference between children taking part in daily or regular (2-3 sessions a week) PE classes in terms of relative body fat mass (Protzner, Trajer, Bosnyak, et al. 2015). This study also confirms that the positive effect-mechanism of daily physical education on anthropometric and endurance tests are minimally apparent for a four-year research period. It is worth noting that each alteration in the curriculum provides pedagogical and professional development possibilities in the long term, but brings major methodological and content challenges in the short run (Ennis, 2013).

Our study mainly highlights the challenge caused by the introduction of daily physical education. The fact that the legislative changes did not clearly bring improvements in anthropological and endurance results might also be caused by a number of external (facilities, tools, curriculum documentation, school management, etc.) and human (knowledge, motivation, methodology and attitude of PE teachers) factors as well. Based on experience, we can state that, in the long term, the complex effects of systematic and organized physical education with proper content and methodology are definitely positive on psychosomatic development (Ericsson and Karlsson, 2014).

Following the suggestion of WHO and the results of Szmodis et al. (2014), systematic exercise for children and students is a minimum of sixty minutes of physical activity at moderate intensity. What we should expect from daily physical education is for it to be methodologically sound, enjoyable, motivating, and successful, while reaching at least a medium or even high level of intensity relevant to age (Mura, Rocha, Helmich, et al., 2015). There is no doubt that the establishment of exercise therapy for obesity requires the involvement of professionals from many disciplines (Simonyi, Pados, Bedros, 2017).

School is still one of the most important scenes for education (though the effects of the internet and media have gradually prevailed and are not always positive), where there is an excellent opportunity to establish health-conscious habits, standards and attitudes through examples. It also seems important that the teaching-learning process of physical education focuses on individual abilities, skills and interests. Daily physical education is an important tool for prevention, and also assists in the improvement of quality of life and socialization for a life-long, health-conscious and active lifestyle, as emphasized in our National Curriculum of 2012. In order to achieve the optimal effects of daily physical education, social expectations, support at the macro-level and the support and attitude of different stakeholders, plus well-working teacher-student relationships at the micro-level have major influences (Fugedi, Capel, Dansc, & Bognar, 2016). It might be important – and might just as well improve the effectiveness of PE classes and the motivation of students towards physical activity – to link daily physical education to health-conscious school programs, where students could be motivated and engaged with the use of interactive and experience-focused knowledge transfers suitable for generations Y and Z (Feith, Melicher, Mathe, 2016).
It was not an objective of this study to measure the previously mentioned influential factors related to the implementation of DPE. However, aspects besides anthropometrical and motor performances, researchers might want to discover the impact of such curriculum changes on these factors in the near future.

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