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PHYSICAL ACTIVITY AND PARAMETERS OF BODY POSTURE IN THE FRONTAL PLANE IN CHILDREN

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Abstract

Introduction. Physical activity may have an impact on the parameters of body posture. Scientific reports suggest that levels of physical activity are declining among society, which may result in incorrect changes in body posture. This study aimed to assess the relationship between physical activity and the parameters characterizing posture in the frontal plane in children. ***Material and Methods.*** Sixty-seven primary school students aged 9 were enrolled in the study, including 29 girls and 38 boys. The posture was evaluated with the photogrammetric method. Also, anthropometric measures and the level of physical activity were investigated. ***Results.*** The highest percentage of examined children was characterized by a moderate level of physical activity. Children with a high level of physical activity were characterized by the greater asymmetry of position between the right and left shoulder as compared to those with a low and a moderate level of physical activity. ***Conclusions.*** There were statistically significant differences only in the height of shoulders in children with a high level of physical activity. This study should be repeated in adolescence, characterized by changes in development and a reluctance to physical activity.

Key words: physical activity, children, posture

Introduction

Body posture is the positioning of body segments in relation to each other and the relationships between them [1]. Human posture is subject to changes throughout entire life [2]. Particularly a period of dynamic development, but also exposure to physical and environmental changes, can cause changes in body posture [1, 3].

Today's lifestyle is characterized, on the one hand, by the lack of diversified physical activity and, on the other hand, by asymmetrical, static activities and overloads that can lead to permanent changes in the body's motivational system. These negative changes result in a lower level of physical fitness and can cause postural deviations already in the preschool age. The situation worsens when children go to school [4]. There is a high frequency of posture changes in school-age children. With the beginning of school education, spontaneous physical activity (PA) of children is limited. They are exposed to stress resulting from school duties. They stay in a sitting position for a long time. Additionally, schools often lack an ergonomic workplace. All these factors affect the musculoskeletal system, which can result in changes in body posture. Some of them reflect normal postural development and will be corrected as the child grows. On the other hand, some changes are asymmetries that may be caused by the daily stresses of the body and may have a negative impact on the quality of life both in childhood and adulthood [5].

Moreover, the level of PA also has a significant impact on the parameters of body posture [1]. Evidence suggests that PA is associated with health benefits, including cardiorespiratory fitness, muscle performance, bone health, and cardiometabolic health in school-age children. It reduces the risk of depression and has a positive effect on cognition and academic performance [6]. The study by Rodriguez-Ayllon et al. [7] showed that physical activity may support young people's current and future mental health. These results were significant only in adolescents but not in children. The World Health Organization (WHO) guideline for children and adolescents aged 5-17 years recommends an average of 60 minutes per day of moderate-to-vigorous intensity (mostly aerobic) PA across the week [8].

Despite the positive effects of PA on health and wellness, some studies suggest that levels of PA are declining. Research by the Public Opinion Research Center (CBOS) shows that only 7% of people exercise regularly and intensively and 74% do not [9].

It is worth emphasizing that many children suffer from excessive physical activity, often one-sided and poorly performed. The rapid biological development that occurs in younger school-age children, in the absence of physical activity and poor movement habits, worsens the situation in terms of body posture and can result in various orthopedic problems [10, 11]. Most often, lack of exercise causes a statically overloaded spine, increased obesity, poorer cardiometabolic health, physical performance, behavioral behavior, and decreased sleep time [6]. The most disturbing thing is that these threats concern not only middle-aged and elderly people but also adolescents and even children.

The research shows that postural problems in children are one of the most common health problems, and the scale of the problem is significant [12]. Early diagnosis of posture, striving to change social behavior of children, and a reduction in harmful factors are especially important. It is extremely necessary to create an image of children's body posture at a very early stage that contributes to overall growth and development and quality of life. In order to determine the condition of the body posture, it is necessary to use screening tests, which play an important role in the quick and reliable assessment of the proper development of children and adolescents [13]. Good posture is one of the basic requirements for good health, normal growth, and development as a whole [14].

Moreover, by emphasizing the importance of PA, it is worth taking advantage of the child's natural need for movement, which should be intentionally and constantly stimulated. Physical education (PE) lessons aimed at positively influencing their physical and mental health, functional, motor, and psychological development, as well as shaping intellectual and moral characteristics play a key role in this process [6].

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Therefore, it is important to consider implementing the educational system for parents and children which would provide information about normal health behavior patterns, and the consequences of not following these patterns.

The aim of this study was to assess the relationship between physical activity in children and the parameters characterizing their posture in the frontal plane.

Material and Methods

The Ethical statement

The study was approved by the Faculty and Senate Committee on the Ethics of Scientific Research at Józef Piłsudski University of Physical education in Warsaw under resolution No. DM. 74 - SKE 01 30/2018. All procedures performed in the studies conformed to the Helsinki Declaration. Parents or legal guardians of the children provided written informed consent.

Participants

The study included 67 primary school students aged 9 (29 girls and 38 boys).

Children with mobility disorders, neurological deficits, orthopedic diseases, serious injuries within the musculoskeletal system, poor general health, and lack of consent of the parents or legal guardians for the child's participation in the study or the use of the findings in publications were excluded from the study. At this stage, no one was excluded.

The study was performed in 2018 in the Body Posture Laboratory at the Regional Centre for Research and Development of the University College in Biala Podlaska (Poland). The research was multifaceted and carried out in cooperation with parents, teachers, and school management. Academic lecturers and a physiotherapist were involved in organizing and conducting the research.

Physical activity

The level of PA in the examined children was checked using a questionnaire. During the examination of the child, the parents were asked to complete the questionnaire. The response time was approximately 10 minutes on average.

The study was based on a self-designed questionnaire. Questions about PA were related to lifestyle elements: PE, exercise, games, sports, plays, transportation, recreation in the context of school, family and community activities, especially activities undertaken at school and additional leisure activities weekly and during weekends. All information is covered by a confidentiality clause.

According to the level of PA in school and leisure time, specified by parents, all children were divided into 3 groups:
Group I (a low level of PA) – children only attended PE lessons at school;
Group II (a moderate level of PA) – children attended PE lessons at school and took up additional physical activity in a week of 1-3 hours;
Group III (a high level of PA) – children attended PE lessons at school and took up additional physical activity in a week of more than 4 hours.

Additional PA undertaken during leisure time by children included swimming, martial arts and dance.

Anthropometric Measurements

Measurements of body weight and body height of children were taken. Based on these measurements, body mass index (BMI) was calculated [15].

Photogrammetric Method

The assessment of body posture was carried out using the projection Moire topography (MT) (MORA 4 Generation, CQ Electronic System) [16]. MT is a non-invasive, repeatable body posture examination technique [17, 18, 19]. It is an alternative to X-ray examination [19].

To ensure the reliability of measurements before the test, the device was calibrated. Moreover, the examination was performed at the same time of the day by an experienced physiotherapist.

The test was carried out in accordance with the procedure required by the manufacturer of the device [16]. At first, the points suggested by the Society on Scoliosis Orthopedic and Rehabilitation Treatment (SOSORT) were marked with a dermograph on the back of the examined children [20]. These were spinous processes C7-S1, acromial angle of the shoulders, superior and inferior angle of the scapula, posterior superior iliac spines. Then, the child stood in a fixed place, back to the camera at a distance of 2.6 m. The measurement was made after the participant adopted a relaxed and habitual posture. The computer determined the body posture parameters. The range 1 mm/1^0 – -1 mm/-1^0 was adopted as the measurement error.

The following body posture parameters in the frontal plane were evaluated: the coronal inclination of the trunk (KNT), the difference in the height of shoulders (KLB), the difference in the height of the lower corners of the scapulae (UL), the difference in the height of the waist (waistline) (TT), the difference in the height of the pelvis (KNM).

Statistical analysis

Data were described using mean values (M), standard deviation (SD), percent (%), and group size (n). Normality variables were examined using the Kolmogorov-Smirnov test. The analysis showed that the measured variables had normal distribution compatibility. Relationships between variables were checked with the analysis of variance (one-way ANOVA), adopting the level of significance at $p < 0.05$. Differences in the compared means were calculated with the Post Hoc Tests (Tukey's HSD test). Calculations were performed using STATISTICA 13 (StatSoft, Poland).

Results

Table 1 presents group size in terms of the level of physical activity in the examined children. The highest percentage of children was characterized by a moderate level of physical activity (approximately 50%) (Tab. 1).

Characteristics of somatic parameters of the children taking into account the division into groups in terms of the level of physical activity are presented in Table 2. The values of the

Table 1. Group size in terms of the level of physical activity

Group deviation	Girls		Boys		Total	
	n	%	n	%	n	%
Group I	9	31.0	10	26.3	19	28.4
Group II	14	48.3	18	47.4	32	47.8
Group III	6	20.7	10	26.3	16	23.8

N – number of children, % – frequency of parameters occurrence among children, group I – a low level of physical activity, group II – a moderate level of physical activity, group III – a high level of physical activity.

measured parameters between the groups were similar and the differences were not statistically significant (Tab. 2).

The results showed that the greatest differences between the groups were observed in the height of shoulders (KLB). The differences were statistically significant (p = 0.006). Children with a high level of physical activity were characterized by the greater asymmetry of position between the right and left shoulder as compared to those with a low and a moderate level of physical activity. The analysis of differences in the following parameters: the coronal inclination of the trunk (KNT), the difference in the height of the lower corners of the scapulae (UL), the difference in the height of the waist (waistline) (TT), the difference in the height of the pelvis (KNM) characterizing body posture, depending on the level of physical activity, did not show statistically significant relationships (Tab. 3).

Table 2. Anthropometric parameters in relation to physical activity

Parameters	Group I		Group II		Group III	
	M	SD	M	SD	M	SD
Body weight [kg]	31.8	6.35	29.5	5.01	30.2	5.20
Body height [cm]	136.7	7.12	134.6	5.31	135.1	5.36
Body mass index [kg/m^2]	16.9	1.96	16.2	1.94	16.5	2.08

M – mean values, SD – standard deviation, group I – a low level of physical activity, group II – a moderate level of physical activity, group III – a high level of physical activity.

Table 3. Differences in the measured parameters characterizing body posture in the frontal plane, depending on the level of physical activity

Parameters	Group I		Group II		Group III		p	HSD
	M	SD	M	SD	M	SD		
KNT [°]	0.9	0.8	1.0	0.8	0.8	1.0	0.825	0.76
KLB [mm]	4.8	2.9	4.8	3.0	7.1	4.8	0.006*	12.17
UL [mm]	4.8	3.1	5.0	3.7	6.0	4.4	0.581	13.92
TT [mm]	5.7	5.2	4.9	3.4	5.4	3.5	0.772	16.19
KNM [mm]	2.0	2.0	1.8	1.7	2.0	2.6	0.945	4.04

KNT – the coronal inclination of the trunk, KLB – the difference in the height of shoulders, UL – the difference in the height of the lower corners of the scapulae, TT – the difference in the height of the waist (waistline), KNM – the difference in the height of the pelvis, M – mean values, SD – standard deviation, group I – a low level of physical activity, group II – a moderate level of physical activity, group III – a high level of physical activity, * – statistically significant results (one way-ANOVA), HSD – Post Hoc Tests (Tukey's HSD test).

Discussion

The aim of this study was to assess the relationship between physical activity and the parameters characterizing posture in the frontal plane in children.

The present study revealed that the highest percentage of the examined children were characterized by a moderate level of physical activity. Children with a high level of physical activity showed the highest difference in the height of the shoulders. These differences were statistically significant (p = 0.006).

The same results were obtained by Coelho et al. [14]. The authors verified the effect of physical activity on the posture of children of both genders aged between 5 years and 14 years. The study showed statistical significance in the height of shoulders and in the general analysis of the body posture in the frontal plane in active children compared to the sedentary group. Also, Vojtikova [21] evaluated the body posture and regular physical activity in children of young school-age. Boys had worse body posture depending on physical activity. Only a poor association between body posture and physical activity was measured in the group of girls. Girls with higher physical activity had better body posture; however, this effect was small. Hrickova et al. [22] investigated body posture in 7-year-old children. Postural deviations have already been observed in preschoolers. Lack of physical activity in preschool children causes more serious health problems in school-age and later into adulthood.

Different results were obtained by Balko et al. [23]. The authors investigated the influence of physical activity on body posture in 50 school-age children. Poor posture was observed in children with less physical activity, while good posture was most often noted in schoolchildren who had a lot of physical activity (3 or more hours per week). Bogdanović and Marković [24] also showed that physically active children outside of school were more likely to have a good or a perfect posture compared with physically passive children, who had a poor or a very bad posture.

Justifying the observed results, the scientific reports provide several conclusions which are inconclusive. For example, Kratěnová et al. [25] indicated that physically active children do not suffer from poor posture. However, studies by Vrbas [26] or Bunc [27] or Vojtikova [21] showed that the amount of physical activity or physical fitness has little influence on the occurrence of poor body posture.

The type of practiced physical activity should be taken into account [14]. Volleyball training can influence the position of the shoulders [28]. In a study by Vojtikova [21], differences in body posture resulted from types of activities girls usually do – dance, ballet, gymnastics.

In sports practice, there is a repetition of asymmetric movements, especially in the upper limbs, which may predispose to postural deviations [29]. However, more research is needed to support this hypothesis as postural-related physical activity has not yet been extensively studied. Exercises are considered a category of planned and repetitive physical activity [30], which may or may not change the symmetry of the body. Trained activity may be influenced by some factors, such as time, type, and level of exercise, in addition to musculoskeletal balance. That is why it is important to be careful when preparing tasks during physical activity because changes in posture can be attributed to the way the exercises are performed.

Therefore, appropriate compensation classes, specific exercises in the field of body posture, and the observation of deviations in body posture should be a priority.

Moreover, it is very important to include exercises which improve physical fitness. The lack of exercise stimulation deters children and teenagers from many physical activities and games and leads to their inactivity. The development of preventive and intervention measures such as controlled physical activity is important to prevent future complications and ensure good posture alignment in schoolchildren. Therefore, it is important to note that the training program should be properly customized to physical condition, age and group of children [31].

Although previous scientific reports have investigated the relationship between physical activity and postural deviations in children and adolescents, due to a large increase in the published studies there is a need for an update and quantitative synthesis of effects. The relationship between physical activity and body posture in children is inconclusive.

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The limitation of this study is a relatively small sample size. It was limited only to the analysis of the relationship between physical activity and body posture parameters in one plane (frontal plane). The division of groups into girls and boys was not taken into account. However, these limitations did not significantly affect the quality of the results. Future and further studies require consideration of issues indicated above.

The study used an objective measurement method (MT), which is non-invasive, repeatable, and an alternative to X-ray examination. The results of the study are the basis for considering the relationship between the level of physical activity and posture parameters after the COVID-19 pandemic.

Conclusion

The present study suggests that there are statistically significant differences only in the height of shoulders in children with a high level of physical activity.

Bearing in mind the importance of physical activity in the development of body posture, parameters characterizing posture should be monitored, especially in the period of developmental changes (adolescence and reluctance to undertake physical activity).

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