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MOTOR AND POSTURAL EFFECTS OF BODY MASS DEFICIENCY IN CHILDREN AGED 6 YEARS IN POLAND.

Dr Elżbieta Olszewska[1*], Dr Piotr Tabor[1], Dr Renata Czarniecka[1]
*[*1]Józef Piłsudski University of Physical Education in Warsaw, Poland, Department of Theory and Methodic of Physical Education*

[*]***Corresponding Author:-***
Email: elzbietaawf@o2.pl phone: 502025154

Abstract:-

Aim: *The aim of the study was to evaluate physical fitness and body posture in underweight children aged 6 years.*

Methods*: The study examined 883 children aged six years, including 438 girls and 445 boys. The BMI values were used to divide the study group into two subgroups of participants, with normal weight and those underweight. Physical fitness was evaluated using a test made of 5 tests. Body posture was examined using a visual assessment method for selected parameters of body posture.*

Results: *Compared to peers with normal BMI, underweight children obtained significantly poorer results in the following physical fitness tests: sit-and-reach (boys), standing long jump (boys), medicine ball throw (boys, girls). In terms of body posture, significant differences between the subgroups with reduced height-to-weight ratio were observed in shoulder and scapulae positions in the sagittal plane (girls and boys), degree of thoracic kyphosis (girls) and shape of cervical-acromial angles and waist triangles (boys) in the frontal plane. Furthermore, underweight children obtained significantly better results in convexity of abdominal wall and the axis of lower limbs (girls and boys).*

Conclusions: *Some positive and negative motor and postural effects of body weight deficiency were observed in children aged 6 years.*

INTRODUCTION

Numerous auxological publications have devoted much attention to the problems of overweight and obesity (especially concerning the populations of children and young people), often defining these developmental disturbances as an epidemic of the 21st century [1, 2, 3, 4, 5, 6]. Analyses have also concerned dimorphic, ontogenetic and environmental determinants of overweight [7]. In a study by Trzcińska et al. concerning children at the age of between pre-school and early-school education period of life, the researchers found manifestations of urbanization-related and sexual differences in overweight and obesity. In this population, excess body mass was diagnosed more often in rural areas than in cities and more often in girls compared to boys [8]. The literature has thoroughly examined and discussed the negative effects of overweight and its correlations with improper nutrition and insufficient level of physical activity whereas the effects of underweight have been documented less frequently [9,10,11]. A noticeable reduction in somatic parameters, including body weight deficiency (and body height deficiency) has biological and social consequences which are as significant as overweight and obesity. Underweight is manifested in weaker bones and the immune system, low blood pressure, anaemia, feeling of constant cold and, in adolescent girls, irregular menstruation [12, 13, and 14]. Some studies also found that in school settings, the weakest pupils (including those low body height and underweight) fall victim to peer's violence more other students. Poorer social adjustment and manifestations of isolation have also been documented 15, 16]. Statistical data on underweight people in Poland show that the problem affects 5.6% men and 16.5% women, and it also concerns 10 to 14% of young people, including girls from junior high schools and secondary schools [17]. Examinations by Jerant and Franks revealed that underweight adults were exposed to risk of death three times higher than people with normal BMI [18]. The linkages between body posture and types of somatic built have also been explored [19, 20]. In light of the study by Górniak ET. al. [21], morphological tendencies for low-level scoliosis include a slim body build, poorer muscle mass and low fat percentage. Furthermore, children with this somatic structure are mostly characterized by normal shapes of the arches of the foot, whereas flat feet are linked to obese types and high body fat percentage. According to Rudzińska et al., a slim body type is accompanied by flattened physiological spinal curvatures or deepened lumbar lordosis in the sagittal plane and asymmetries of selected parameters in the frontal plane [20]. These tendencies are justified by poor musculature, which consequently leads to dystonia of postural muscles.In light of the above analyses, the aim of the study was to evaluate physical fitness and body posture in a group of children aged 6 years with body mass deficiency compared to peers with normal height-to-weight ratio.

Material & Methods

The examinations were performed in 2011, 2012 and 2013 in spring. In the next editions, the examinations involved children born in 2005, 2006 and 2007. The examinations were approved by the Senate's Research Bioethics Commission of the Józef Piłsudski University of Physical Education in Warsaw and legal guardians of children. The study examined children aged six years (x = 5, 87±0.30). Examinations were performed in the morning, before noon. Body height and mass were measured, next BMI was computed, and with its individual values were referred to international standards. Two groups of children were defined - with underweight and normal weight. To group of children with underweight was qualified boys with BMI below 14.07 and girls with BMI below 13.82 [22, 23]. The group size in absolute and percentage terms with consideration for sex is presented in Table 1.

Table 1. Number of children aged 6 years examined in the study

boys N=445		girls N=438	
underweight	norm weight	underweight	norm weight
74	371	57	381
14.3%	71.8%	10.6%	70.6%

Level of motor abilities was evaluated using a physical fitness test battery composed of the following tests: sit-and-reach test, 10x5m shuttle run, standing long jump, sits-ups in 30s and 1kg medicine ball overhead forward throw. Four of the tests were based on the Eurofit test battery, whereas the last one was part of the Wrocław physical fitness test for children from nursery schools developed by Sekita [24]. Body posture was diagnosed using a visual method with consideration for postural body parameters in the frontal and sagittal plane. Furthermore, the position of lower limb axis and arches of the foot were also examined. The following parameters were evaluated in the frontal plane: symmetry of cervical-acromial angles, shoulders, scapulae, waist triangles and presence of scoliosis. In the sagittal plane, we examined head and shoulder position, scapulae protrusion, abdominal wall convexity and physiological spinal curvatures (thoracic kyphosis, lumbar lordosis). Lower limb position was used to examine the degree of genu valgum or genu varum, pes valgus and arches of the foot [25].

The mathematical analysis of the obtained numerical data used selected techniques of descriptive statistics (means and percentage values). The level of physical fitness of underweight children compared to peers with normal body weight was evaluated using a standardization technique (arithmetic mean and standard deviation of children with normal weight). Significance of differences between mean values in the two compared subgroups was examined by means of the Student's t-test. The chi-squared test (logarithmic form) was used to evaluate significance of differences between prevalence of body posture disturbance in the subgroups of children studied. Typical levels of significance were adopted.

Results

The data presented in Fig. 1 show that in most of the physical fitness tests except for the standing long jump (girls) and 10x5m shuttle run (boys), underweight children obtained results worse than their peers with normal height-to-weight ratios. Significant differences were found mainly in boys in sit-and-reach tests, standing long jump and 1kg medicine ball throw. In the group of girls, significant differences were observed in the medicine ball throw test.

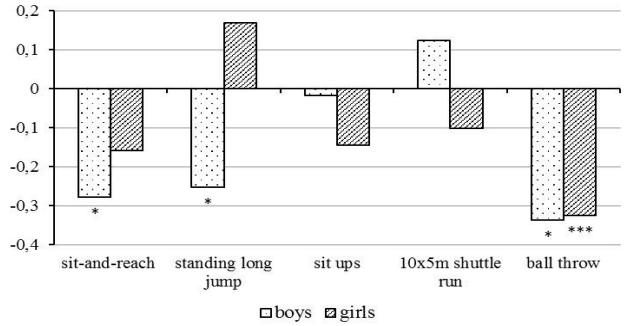

Figure 1. Standardized values for physical fitness tests of underweight children compared to children with normal height-to-weight ratios (* p≤0.05, *** p≤).0.01)

Analysis of body posture was performed separately for the frontal and sagittal planes. Furthermore, we analyzed lower limb and feet position in the discussed groups of children aged 6 years.

Body posture of children aged 6 years in the sagittal plane.

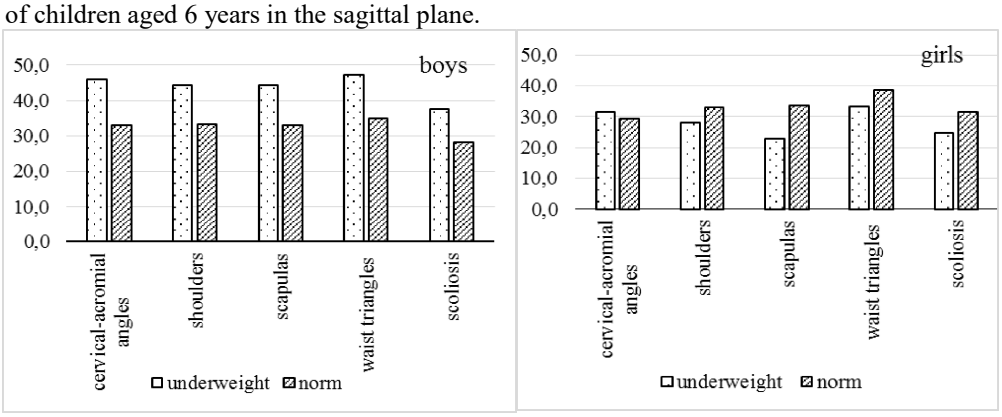

Figure 2. Frequency of asymmetry of selected body posture parameters in the frontal plane in underweight children aged 6 years and peers with normal body weight.

Analysis of body posture in the frontal plane in the group of boys aged 6 years found more frequent disturbances in the group of underweight children. Prevalence of postural disorder in this group ranged from 37.5% to 47.2%. Among peers with normal weight-to-height ratios, abnormalities ranged from 35.0% in the case of waist triangles to 28.3% in the case of scoliosis. No significant differences but only some tendencies were observed in prevalence of the analyzed asymmetries between the groups studied. Slightly different results were found in the group of girls. Frequency of disturbances in body posture parameters in the frontal plane was lower in girls compared to boys. Abnormal body posture in girls with correct weight-to-height ratios ranged from 29.2% (asymmetry of cervical-acromial angles) to 38.7% (asymmetry of waist triangles). Among underweight participants, asymmetries in evaluated parameters were found in 22.8% to 33.3% participants. Prevalence of disturbances in body posture was not statistically significant due to weight-to-height ratios. Body posture parameters of study participants in the sagittal plane in boys aged 6 years, shoulder protraction and shoulder blade protrusion was found to be more prevalent in underweight boys. It should be emphasized that disturbances in the position of these elements was significantly more frequent in both underweight boys and those with normal body weight.

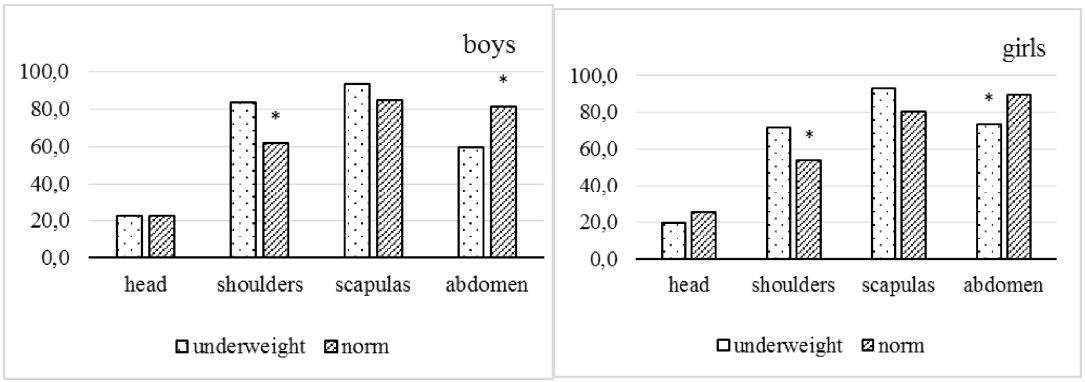

Figure 3. Frequency of disturbances of selected body posture parameters in the sagittal plane in children aged 6 years with underweight and peers with normal body weight (* p≤0.05).

In the case of shoulder protraction, the differences were not statistically significant. Their prevalence was over 80% in the underweight boys and over 60% in the participants with normal weight. Among boys with normal body weight excessive abdominal wall convexity was more prevalent (statistically significant differences) compared to underweight peers. Similar patterns were observed in subgroups of girls. However, the differences between the prevalence of disturbances were lower compared to the group of boys.

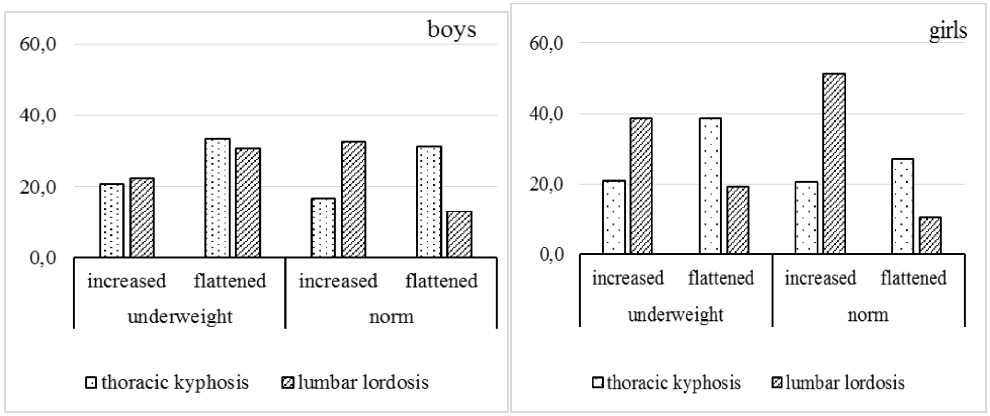

Figure 4. Prevalence of disturbances of physiological spinal curvatures in underweight children aged 6 years and peers with normal body weight.

Analysis of the physiological spinal curvatures in the group of boys aged 6 years revealed that underweight boys were characterized by flattened thoracic kyphosis and lumbar lordosis rather than more pronounced curvatures. Greater tendencies for increasing lumbar lordosis and flattened thoracic kyphosis (statistically significant differences) were observed in participants with normal body weight. In the group of girls with lower body weight, increased lumbar lordosis was found in 36.8% girls. A similar percentage (38.6%) in this group was also observed for flattened thoracic kyphosis. Slightly different patterns were documented in girls with normal body weight: increased lumbar lordosis was more prevalent in this group (50%), whereas flattened thoracic kyphosis was found in 27.1% of the girls (statistically significant differences).

Assessment of the position of lower limbs and arches of the foot

The assessment of the position of the axis of the lower limb in terms of the degree of genu valgum and genu varum found that genu valgum occurred more often in children with normal weight compared to those underweight. Genu valgus observed for the long axis of lower limbs was recorded in ca. 56% boys and ca. 54% of girls with normal weight, whereas in underweight children, these percentages were 41.9% and 40.4%, respectively. Genu varum concerned only sporadic cases.

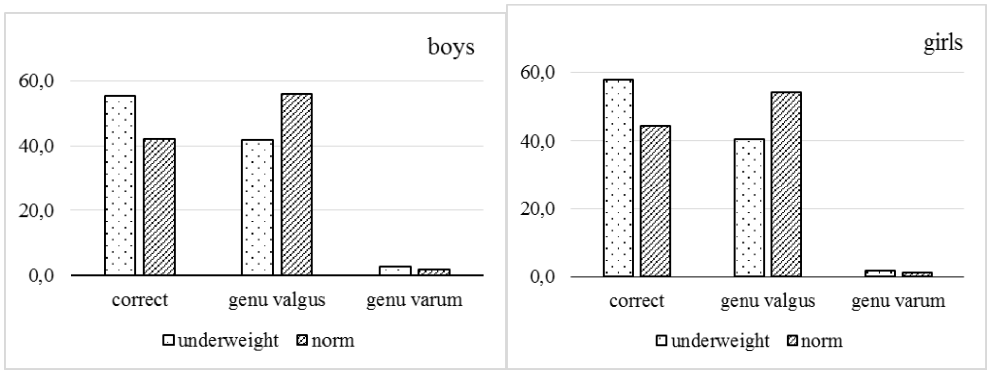

Figure 5. Prevalence of disturbances of the position of lower limb axes in underweight children aged 6 years and peers with normal body weight.

Analysis of the position of the feet in the study group found that flat feet concerned, to the same degree (ca. 60%), both underweight children and those with normal body weight. Flat valgus feet were documented in ca. 23% of boys, both underweight and with normal body weight. Prevalence of flat feet in girls was slightly lower compared to boys. It concerned 47.7% of underweight girls and 57.9% with normal body weight. Flat valgus feet concerned slightly fewer than 20% participants in both subgroups of girls.

Figure 6. Prevalence of disturbances of the arch of the foot in underweight children aged 6 years and peers with normal body weight.

Discussion

The results of the present study concerning physical fitness are mostly consistent with literature data. Examinations of children in pre-school age from the southern part of Poland revealed significantly worse results of the physical fitness tests with reduced body weight compared to peers with normal BMI [26].Examinations of children and young people in other countries have also indicated tendencies for deteriorated physical fitness in children with reduced body weight [10, 27, and 28]. The results of these studies have shown that underweight children had worse results in the sit-and-reach test compared to peers with normal height-to-weight ratios. In the group of boys, these differences were statistically significant. A study by Tomaszewski documented significantly worse flexibility in children and young people with reduced body weight [11]. Furthermore, the author emphasized that the results of the test depended more on physical activity and body proportions than on height-to-weight ratios. Better results are conducive to relatively longer body trunk compared to lower limbs and long upper limbs. In the standing long jump, underweight boys obtained results significantly worse than their peers with normal weight, whereas girls with reduced height-to-weight ratio had better results, without manifestations of statistical significance. Monyeki et al. [29] and Tomaszewski and Stupnicki [30] argued that in this test, the best results are obtained by taller individual with welldeveloped active tissue. It should be emphasized that the structure of standing long jump is complex in nature and mixed (hybrid), containing speed, strength and coordination components.In the sit-and-reach test, both underweight girls and underweight boys had insignificantly worse results than peers with normal weight. In the literature, the effect of somatic body build on the results of this test has been demonstrated to be insignificant. Only a negative effect of increased body mass on the number of repetitions has been observed [31, 32]. In the 10x5m run, difference in both sex categories between the groups of participants turned out to be statistically insignificant. According to Tomaszewski, short individuals obtain worse results in the 10x5m run compared to those taller (except for overweight tall people)[11]. In our study, the most unequivocal results were obtained in the medicine ball throw test. Both underweight boys and underweight girls obtained significantly worse results compared to children with normal body weight. In light of the selected literature items, the reverse patterns have been found in a static force test evaluated during the flexed arm hang, where more favourable results are obtained by shorter and lighter individuals [29, 31, 32, and 33]. Furthermore, children and young people with massive body build are dominant in various throwing competitions [34].Among various components of body build, one group was formed by those for which better results were obtained by

children with normal height-to-weight ratios, whereas the other group was girls and boys with reduced BMI who were characterized with lower prevalence of body posture disturbances. The first category included in sagittal plane: position of shoulders and shoulder blades, and thoracic kyphosis in both sexes and lumbar lordosis in boys; in the frontal plane: shape of cervical-acromial angles, waist triangles, position of shoulders and shoulder blades in boys. The latter category was abdominal wall convexity in both sexes and body posture parameters in the frontal plane in the group of girls. It can be expected that more pronounced shoulders and shoulder blades and lower abdominal wall convexity in overweight children is connected with their lower fat percentage compared to peers with normal body mass. More favorable position of the knees in participants with lower body weight compared to peers is justified anatomically. The pronating effect of the force of gravity, magnified by a still flexible capsuloligamentous apparatus results in genu valgus, overload to the medial edge of the feet, and reduced longitudinal arch of the feet. It should be emphasized that the examinations by other authors indicated that genu valgus can be considered physiological even until the age of 8 years [35, 36, and 37]. The studies have also shown that genu valgus intensifies in children as they gain body mass [38]. In a study by Rudzińska et al. [20], the researchers demonstrated greater (over 35%) differences in prevalence of flat back between children aged 6 to 7 years with slim (48.1%) compared to medium body build (12.7%). In the present study, the tendency for flattened thoracic curvature was maintained. However, it was less pronounced than in the paper cited above.

Conclusions

In light of our own study, some motor and postural effects of underweight were observed in the group of children aged 6 years. In the area of physical fitness, they consisted mainly in worse results of the throwing tests in both sex categories. In terms of body posture, negative consequences of underweight were more prevalent. Unfavorable effects were observed first and foremost in the form of protruding shoulders and shoulder blades in girls and boys, flattened thoracic kyphosis in girls and asymmetry of selected components of body build more prevalent in boys. Positive consequences of reduced body mass were found mainly in lower abdominal wall convexity and less knocked knees compared to children with normal BMI.

Acknowledgments

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