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Niedowaga i nadwaga a sprawność fizyczna dziewcząt ze wschodniej Polski

Streszczenie

Wprowadzenie. Kształtowanie się zdolności motorycznych u dzieci i młodzieży związane jest z niektórymi cechami i wskaźnikami budowy somatycznej.

Cel pracy. Celem niniejszych badań było poznanie struktury sprawności fizycznej dziewcząt z niedowagą i nadwagą na tle badanych o prawidłowym poziomie BMI.

Materiał i metody. Badaniami objęto 1421 dziewcząt ze wschodniej Polski. Częstość występowania niedowagi oraz nadwagi i otyłości oceniono wykorzystując wartości graniczne BMI dla dzieci i młodzieży zalecane przez Cole i wsp. (2000, 2007). Badane dziewczęta w poszczególnych kategoriach wieku (10-15 lat) zakwalifikowano do następujących grup: z niedowagą (grupa A), o prawidłowym BMI (grupa B) oraz z nadwagą i otyłością (grupa C). Poziom sprawności fizycznej w wydzielonych grupach oceniono na podstawie wyników uzyskanych w wytrzymałości biegowej, sile tułowia, sile ramion, gibkości i równowadze. Wyniki dziewcząt z niedowagą (grupa A) oraz z nadwagą i otyłością (grupa C) zostały znormalizowane względem średniej arytmetycznej i odchylenia standardowego wyników badanych o prawidłowym BMI (grupa B).

Wyniki. W badanej populacji częściej spotykana była niedowaga (14,9%) niż nadwaga i otyłość (8,6%). Dziewczęta z niedowagą osiągnęły najlepsze rezultaty w wytrzymałości biegowej i sile ramion. W pozostałych zdolnościach motorycznych ich rezultaty były zbliżone do wyników badanych o prawidłowym poziomie BMI. Natomiast dziewczęta z nadwagą lub otyłością charakteryzowały się najniższym poziomem wytrzymałości biegowej i równowagi oraz siły ramion w młodszych kategoriach wieku.

Wnioski. Z przeprowadzonych badań wynika, że zarówno niedowaga, jak i nadwaga oraz otyłość różnicują poziom sprawności fizycznej dzieci i młodzieży, przy czym obniżona sprawność fizyczna związana była z nadmiarem masy ciała.

Słowa kluczowe: zdolności motoryczne, BMI, dziewczęta.

Relationship between underweight or overweight and the physical fitness of girls from Eastern Poland

Abstract

Introduction. The development of motor capabilities in children and adolescents is determined by selected traits and the parameters of their somatic build.

Aim. The objective of this study was to determine the structure of physical fitness of underweight or overweight girls compared to subjects with normal BMI levels.

Material and Methods. The study involved 1421 girls from Eastern Poland. The incidence of underweight, overweight or obesity was evaluated with boundary BMI values for children and adolescents recommended by Cole et al. (2000, 2007). Surveyed girls from particular age categories (10-15 years of age) were classified into the following groups: underweight subjects (Group A), subjects with normal BMI values (Group B), and overweight and obese subjects (Group C). The physical fitness of particular groups was assessed using trials of running endurance, trunk strength, arm strength, flexibility, and total body balance. The results of Group A and Group C subjects were standardized to the arithmetic mean and standard deviation of the results obtained by girls with normal BMI values (Group B).

Results. In the surveyed population, the incidence of underweight subjects was higher than the occurrence of overweight or obese subjects (14.9% vs. 8.6%, respectively). Underweight girls achieved the best results in tests assessing running endurance and arm strength. Their remaining motor capabilities were similar to those in girls with normal BMI values. Overweight and obese girls from lower age categories were characterized by the lowest levels of running endurance, total body balance, and arm strength.

Conclusions. The results obtained in this study allow us to conclude that children and adolescent girls who are underweight, overweight and obese have different physical fitness levels. Lower levels of physical fitness are often associated with excessive body mass.

Key words: motor capabilities, BMI, girls.

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INTRODUCTION

Relationships between physical activity or fitness and health have been known for a long time, however the theory of „health-related fitness" was formulated no earlier than in the 1980s. According to this theory, health related components include: body composition, aerobic capacity, flexibility, endurance and muscle strength [1].

During the child's growth, physical activity determines multiple aspects of the development of the body and helps form proper body stature. Physical activity is associated with improvements in basic motor skills, particularly agility, flexibility, speed and strength. However, the incidence of physical passivity has been observed to increase systematically. This physical passivity is one of the reasons behind the increasing frequency of overweight or obese children and adolescents. According to the Institute of Food and Nutrition [2], the frequency of Polish overweight boys and girls aged 1-18 years is 15.9% and 11.1%, respectively, whereas the fraction of obese boys and girls equals to 4% and 3.4%, respectively. A similar incidence of overweight and obese children has been observed amongst young Germans [3]. However, these figures are still lower than in children from the United States [4], Canada [5], and Australia [6], as well as from such European countries as Spain, Greece, Portugal and Italy. Nonetheless, the incidence of child and adolescent overweight/obesity in Poland is higher compared to Lithuania, Estonia and Slovakia [3]. In most of the aforementioned studies, the incidence of overweight and obesity was estimated using percentile categories for body mass index (BMI). Application of this index allows for quick examination of large groups of children and adolescents and is not associated with high costs. Moreover, it may be used by primary care physicians and even properly trained school teachers.

Besides detecting overweight and obesity, BMI lets us determine the frequency of body weight depletion. Studies performed at the Institute of Food and Nutrition [2] revealed that underweight occurs in 12% and 14% of Polish boys and girls, respectively, and half of them suffers severe grades of depletion of body mass. Similar underweight figures were reported in Russia, while this condition is noted more frequently in China and is of rarer evidence in the United States [7].

There is some evidence for a relationship between overweight or obesity and certain components of physical fitness [8,9,10]. Little is known, however, on the effects of underweight on the physical fitness of children and adolescents. Therefore, the aim of this study was to determine the structure of physical fitness amongst over- and underweight girls.

MATERIAL AND METHODS

This study was performed in 2005, as a part of the DS.69 statute project. This cross-sectional study included children and adolescents aged from 10 to 15 years of age living in three provinces of Eastern Poland (Podkarpackie, Lubelskie and Podlaskie provinces). The investigated schools were selected at random from a list of all primary, grammar and secondary schools located in the studied area. The list was kindly provided by school superintendents. Subsequently, one class per school was randomly selected from each age category in order to obtain a proper representation of the sample.

This paper presents data obtained from 1421 girls who had no contraindications to participation in physical education classes. It was voluntary to participate in this study, and all subjects and their parents gave their informed consent before the start of any procedure. Moreover, parents were asked to provide the date of birth of the child in question, in order to divide the participants into age categories. The study protocol was approved by the Local Bioethical Committee of the University of Physical Education in Warsaw. All the procedures were supervised by the staff from the Department of Human Biological Development (authors of this paper).

Anthropometric measurements

Body height (B-v) was measured in a straight standing position using an anthropometer with a precision of 0.1 cm. Body weight was determined with an electronic medical scale with a precision of 0.1 kg. Based on these values, the body mass index (BMI) was calculated for every participant (kg/m^2).

Grouping criteria depending on BMI values

The incidence of underweight, overweight and obesity was determined using cut off values recommended for adults by the International Obesity Task Force, i.e. values of BMI corresponding to grade 3 (BMI≤16), grade 2 (BMI≤17), and grade 1 underweight (BMI≤18.5), overweight (BMI≥25), and obesity (BMI≥30), with all of them adjusted for developmental variability of BMI typical for children and adolescents [11,12]. The girls within each particular age category were qualified to one of the following groups: with grade 1, 2 or 3 underweight (Group A), with normal BMI (Group B), and with overweight or obesity (Group C).

Physical fitness

The physical fitness of participating girls was determined during classes of physical education. The test included selected trials from protocols of the European Test of Physical Fitness [13] and the International Test of Physical Fitness [14]. Testing allowed for the determination of levels of the following motor skills: running endurance (time trial during 600 m or 800 m run), trunk strength (number of sit-ups performed during 30 seconds), arm strength (the time of bent arm hang), flexibility (the length of sit-and-reach), and balance (number of attempts needed to keep balance during single leg standing on the beam for one minute).

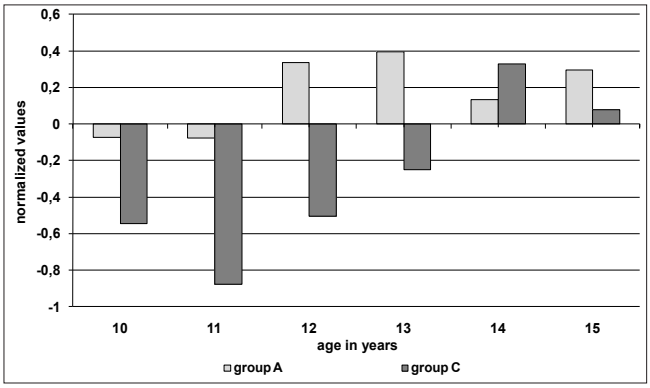
Statistical methods

The arithmetic means and standard deviations of the analyzed motor skills were calculated for each of the three basic groups (A, B, C) and analyzed in every age category. Moreover, the results achieved by underweight (Group A) and overweight or obese girls (Group C) were adjusted to the arithmetic means and standard deviations of results recorded by the girls with normal BMI (Group B). The significance of differences between Group A and B or B and C was assessed using one-way ANOVA with the Scheffe post-hoc test. Differences in arithmetic means were considered significant at the level of at least 5% ($p<0.05$).

RESULTS

As presented in Table 1, the incidence of underweight girls aged from 10 to 15 years of age was more frequent (14.9%) compared to overweight and obese girls (8.6%). The fraction of girls with excessive body weight (14.4%) was higher than the percentage of underweight individuals (11,3%) only amongst participants aged 11. Most girls with body mass depletion had grade 1 underweight. The highest incidence of overweight and obesity was observed in 10 and 11 year-old girls (16.9% and 14.5%, respectively), and was markedly lower in older age groups.

Comparison of trial results achieved by the three analyzed groups (A, B and C) revealed that the worst results of running endurance test (the longest time) occurred amongst overweight or obese girls aged from 10 to 13 years of age. In older age groups, however, the results achieved by overweight or obese girls were better than or similar to Group B participants. In the case of underweight girls from two of the youngest age categories (10 or 11 years of age), the results were similar as in subjects with normal BMI. In the remaining age categories, girls from this group were characterized by the highest levels of running endurance. Significant differences in relation to Group B pertained to 10 and 11 year-old girls with obesity as well as to 13 year-old underweight individuals (Fig.1).



* significant differences at p<0.05

FIGURE 1. Running endurance in underweight (Group A) and overweight girls (Group C) adjusted to the results achieved by participants with normal BMI.

Trunk strength was another analyzed motor skill. In most age categories, the values of this parameter in Group A and C participants were similar to Group B participants (adjusted values did not exceed 0.4 SD). Exceptions pertained to 11 year-old girls from Group C and 12 year-old girls from Group A, whose results were significantly worse than in Group B (Fig.2).

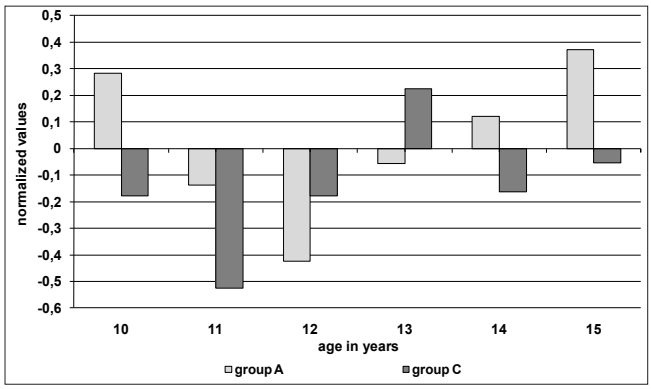


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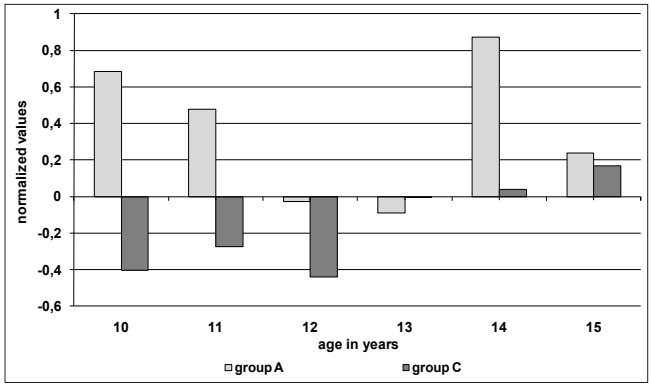
FIGURE 2. Trunk strength in underweight (Group A) and overweight girls (Group C) adjusted to the results achieved by participants with normal BMI.

In most age categories, the most satisfactory results of the arm strength trial were achieved by underweight girls. The lowest level of this parameter was observed amongst overweight and obese girls from younger age categories (10 to 12 years of age), whereas in the remaining age categories the results of Group C participants were similar to Group B (Fig.3).



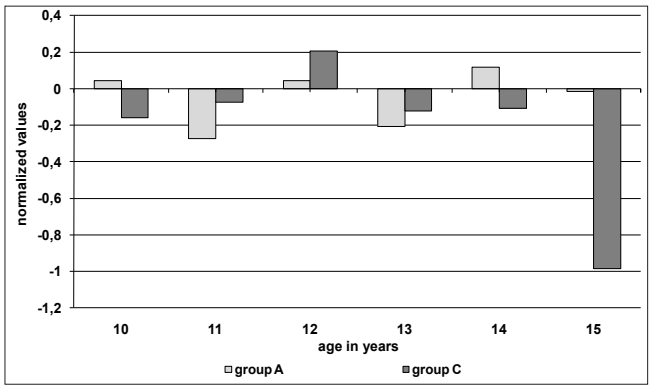
* significant differences at p<0.05

FIGURE 3. Arm strength in underweight (Group A) and overweight girls (Group C) adjusted to the results achieved by participants with normal BMI.

In regard to flexibility, results achieved by girls from Group A and C were similar to those of Group B. The only exception pertained to 15 year-old girls from Group C, whose results in the flexibility trial were significantly worse compared to the other two groups of participants (Fig.4).

TABLE 1. Incidence of underweight, overweight and obesity (%) in the studied population (according to the criteria published by Cole et al. 2000, 2007).

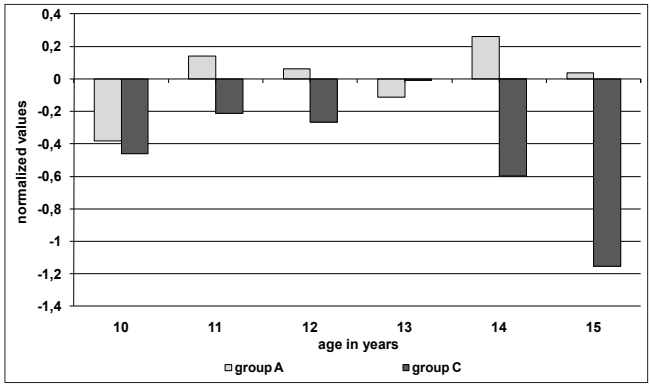
	Group	10 years	11 years	12 years	13 years	14 years	15 years	Total
A	underweight 3^0	3,5	1,5	0,4	2,0	2,2	0,4	1,7
	underweight 2^0	3,5	3,1	3,0	5,2	1,9	1,2	3,0
	underweight 1^0	11,3	6,7	9,7	12,0	10,5	10,7	10,3
	group A in total	18,2	11,3	13,1	19,2	14,6	12,4	14,9
B – normal BMI		64,9	74,4	80,5	72,4	79,8	86,0	76,5
C	overweight	14,7	13,3	5,9	8,0	5,2	1,7	7,9
	obesity	2,2	1,0	0,4	0,4	0,4	0,0	0,7
	group C in total	16,9	14,4	6,4	8,4	5,6	1,7	8,6



* significant differences at p<0.05

FIGURE 4. Flexibility in underweight (Group A) and overweight girls (Group C) adjusted to the results achieved by participants with normal BMI.

Balance was the last analyzed component of physical fitness. This parameter was determined based on the number of attempts needed to keep one's balance while standing on a single leg on a beam for one minute. The more attempts needed to keep one's balance, the worse the level of this motor ability. The worst results in this trial were achieved by the girls from Group C, with significant differences in comparison to Group B observed amongst 14 and 15 year-old participants. In case of Group A participants, the results observed in most age categories were similar to those recorded in Group B (Fig.5).



* significant differences at p<0.05

FIGURE 5. Body balance in underweight (Group A) and overweight girls (Group C) adjusted to the results achieved by participants with normal BMI.

DISCUSSION

This study pertained to children and adolescents from the provinces of Eastern Poland (Podlaskie, Lubelskie and Podkarpackie provinces). In terms of gross domestic product (GDP), which is considered to be an established measure of welfare, these provinces rank among those with the lowest GDP per capita. This is one possible explanation for the higher fraction of underweight or overweight girls observed in this region. Also mass media, promoting slender silhouettes as fashionable, may consequently lead to dietary restrictions being imposed on purpose by many girls. Low body weight may be in turn reflected by delays in sexual maturation. This is related to the fact that some girls do not reach the limit of body weight (so-called „critical mass") which is required for the occurrence of first menstrual bleeding [15].

This study revealed no adverse effects of underweight in terms of physical fitness levels. In all analyzed trials, underweight girls achieved better or similar results as participants with normal BMI. However, overweight or obese participants had lower levels of most evaluated motor skills. This pertained particularly to running endurance, balance and arm strength determined in younger age categories. Similar results were described by other authors who analyzed the relationships between the morphological structure of the body and physical fitness in children and adolescents.

In their study of American children aged from 5 to 14 years of age, Kim et al. [9] observed a strong negative relationship between overweight and the results achieved during running endurance and arm strength trials. Weaker relationships with overweight pertained to agility and trunk strength, and no significant relation was observed between excessive body weight and the results of the flexibility trial. In a study by Tokmakidis et al. [10] performed amongst 8 to10 year-old children from Greece (with normal BMI, overweight, or obesity), the best results of fitness trials (5 trials included in the Eurofit protocol: flexibility, explosive power, trunk strength, agility, and cardiorespiratory endurance) were achieved by normal BMI participants. The only exception pertained to the flexibility trial. The worst results were achieved by obese subjects whilst overweight participants had moderate values of all analyzed trials. The lack of significant differences in body flexibility between normal BMI and overweight or obese subjects was also revealed by Fogelholm et al. [16].

In this study, underweight individuals were characterized by the most satisfactory levels of arm strength, while the worst values of this parameter were observed amongst overweight or obese subjects from younger age categories. Fat tissue, being an internal burden to the body, negatively affects relative muscle strength which is necessary for everyday activities. Moreover, excessive body mass increases the force of gravity and impairs the results achieved during some of the force trials [17]. These worse results are irrespective of the fact highlighted by Jebb [18], who revealed that overweight subjects usually have a larger muscle mass when compared to subjects with normal weight.

Excessive body weight negatively influenced the level of body balance in the study participants. Similar findings were described by Deforche et al. [8]. Maintenance of body balance is a complex process that requires high coordination abilities. Factors that are responsible for this skill improvement include proper development of the central nervous system, sensory organs (in particular – vestibular organ), as well as skeletal and muscular systems.

The results of this study suggest that special attention should be paid to the development and control of physical fitness in overweight or obese children and adolescents. Child obesity is usually associated with the risk of obesity in adulthood. According to some evidence, about 80% of obese children will remain obese during their adulthood and one-third of obese adults developed obesity as early as in their childhood [19]. Therefore, studies on BMI in early childhood seem of crucial importance. Following an intense increase in BMI observed during the first year of life, the value of this parameter decreases, reaching its minimum between four and eight years of age. According to Rolland-Cacher

[20], the younger the age of secondary increase in BMI values (also known as „adiposity rebound"), the higher the risk of obesity development in adulthood.

Consequently, prevention of overweight and obesity becomes of special importance during the development of children and adolescents. Preventive actions should be oriented towards providing children with proper amounts of physical activity along with proper and rational nutrition, since these two components are crucial for maintaining proper body mass and body fitness. Additionally, health education is necessary, addressed both to children and adolescents and to their parents.

CONCLUSIONS

1. Underweight rather than overweight or obesity is a more frequent finding in the population of girls from Eastern Poland.
2. In contrast to excessive body weight, underweight does not negatively influence levels of physical fitness.

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