

Relation of the Effect of Relative Age on Certain Anthropometric Characteristics of Adolescents

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Abstract

Background: Studying the differences of relative age and relation to selected anthropometric parameters that occur in adolescents, it was concluded that other social, economic and psychological factors influence the phenomenon whose significance should be reduced.

Objective: The aim of the study was to determine how much adolescents differ in certain anthropometric characteristics in relation to the relative age effect (RAE).

Methods: The study included a sample of 73 students of the first grade of Miloje Dobrašinović High School in Bijelo Polje (Montenegro), divided into two sub-samples. The first sub-sample included 27 boys, while the second sub-sample included 46 girls divided into four groups according to RAE.

Results: Research results indicate that as many as 76.7% of children in the total sample are obese. Of these, 63% are girls and 13.7% boys who were born in April May and June, while the other boys 23.3% have normal nutritional values.

Conclusion: Adolescents are advised to exercise at least 60 minutes daily, with notion that they should be included in moderate or high-intensity aerobic physical activity, but also at least three times a week in high-intensity physical activity.

Keywords: Obesity; Type II diabetes; Ischemic heart disease; Hypertensive diseases

Introduction

Each independent state unit has in its education system the norms according to which children must have a certain maturity, measured by the number of years, in order to participate in the educational system. Thus, e.g. different education systems have adopted a law that a child becomes mature enough to go to school at the age of seven, and if a parent wants that a child starts at the age of six, he or she must undergo additional psychological and sociological checks to prove that the child is mature enough to be able to begin schooling. With this approach to the problem, there is a possibility of differences in the average level of maturity within each group. Such an initial effect of relative age difference (RAE) for children according to research [1,2] should diminish or even overcome over time, although there are differences in children who have an innate ability to adjust more quickly in the midst and biological maturity [3-5]. The differences in chronological age between children in one age group is known as relative age and its significance as RAE. A great deal of scientific research provides information about RAE in the teaching process [6-9] as a possible cause of variation observed in the performance of children born in the same year [9,10]. Also, the existence of RAE has been studied as a secondary factor influencing the development of talents in sport and their ability to achieve top sporting outcomes [11].

The positive impact of physical activity is largely neglected today, although physical exercise affects all systems of the body: cardiovascular, respiratory, immune, musculoskeletal systems. The sedentary lifestyle has contributed to the energy intake of food being higher than energy consumption leading to weight gain and obesity. Overweight and obesity factors, according to Hajmer [12] represent a new global challenge for public health. According to a report by the World Health Organization (WHO), insufficient physical activity has been declared an independent risk factor and is a health problem for a nation. The trend of physical activity in developed countries is characterized by a lower degree of physical activity than ever before, and according to Trost et al. [13] 2/3 of the total population is physically inactive. In general, the level of physical activity decreases with age and this decline is particularly pronounced during adolescence [14-16]. A decrease in the level of physical activity in girls compared to boys was noticeable and slightly higher in adolescent girls [17].

The Body Mass Index (BMI) has been used to define the medical standard of obesity in many countries since the mid-1980s, and this method of assessment is used in WHO statistics [18]. An increase in the percentage of BF is observed after puberty when differences in the sex composition and topological composition of the body are visible. However, the dynamics of body composition are associated with the growth of children and may change due to the high prevalence of obesity in the younger population [19]. Previous studies have found that BMI is correlated with BF in children [20,21], $r = 0.73$ in boys and $r = 0.70$ in girls [22]. Body composition in children is extremely difficult to measure because precise techniques require a high degree of compliance and are available only to specialized research centers [23], however, Van Itallie & Segal [24] found that bioelectric impedance analysis (BIA) can quickly and conveniently assess body fat (BF) levels in children and is a non-invasive tool for assessing BF in children.

Studying the differences of relative age and relation to selected anthropometric parameters that occur in adolescents, it was concluded that other social, economic, and psychological factors influence the phenomenon whose significance should be reduced [25]. To reduce negative RAE in athletes, a new categorization system based on either biological [26] or chronological age [27-29] is proposed. Research relating to adolescents participating in sports clubs has led to the finding that the existence of RAE is more pronounced in athletes participating in a highly competitive novice [30] than at the recreational level [31,32]. Based on all of the above, the aim of the study was to determine how much adolescents differ in certain anthropometric characteristics relative to RAE.

Methods

Participants

The study included a sample of 73 students of the first grade of Miloje Dobrašinović High School from Bijelo Polje (Montenegro), divided into two sub-samples. The first sub-sample included 27 boys of average body height (Mean 182.05 ± 5.66 cm Std.Dev.), Body weight (74.64 ± 13.31 kg), BMI (22.43 ± 3.57 kg/m²), year (15 ± 0.5),

and the second sub-sample 46 girls of average body height (164.3 ± 5.44 cm), body weight (63.47 ± 11.64 kg), BMI (23.47 ± 4.16 kg/m²), year (15 ± 0.5).

Procedure

The students were divided into four groups according to the relative age effect. The first group consisted of students born in January, February and March. The second group consisted of students born in April, May and June. The third group consisted of students born in July, August and September, while the fourth group consisted of students born in October, November and December. All anthropometric variables (Body Height, Body Weight, Body Fat and Body Mass Index) were measured according to the standard procedures of the International Society for the Advancement of Kinanthropometry (ISAK) by Marfell-Jones et al. [33]. Body height (BH) was measured with an anthropometer, while body weight (BW), body fat percentage (BF) and body mass index (BMI) were measured with Tanita BC-545N bioelectrical impedance analyzer (<https://tanita.eu/tanita-bc-545n>). The research was carried out in the physical education hall of the Miloje Dobrašinović gymnasium, in the school year 2018/19. from 08:00 am to 10:00 am. The study was approved by the Ethics Committee of the Faculty of Sport and Physical Education, University of Niš, in accordance with the Declaration of Helsinki [34]. The study was supported by all parents, who gave their written consent. The research was non-invasive in nature, held in the hall of the gymnasium in Bjelo Polje. The conditions in the sports hall met the optimal criteria for humidity and light.

Data analyses

All data collected through the survey were processed by comparative statistics. From the space of comparative statistics, the discriminant parametric procedure multiple analysis of variance MANOVA and Post Hoc was used to determine differences with respect to the effect of relative age, while Pearson's correlation coefficient (r) was used to determine the correlation. The statistical program for personal computers SPSS for Windows version 20.0 was used for data processing.

Results

Looking at Table 1, the results of the MANOVA test indicate that there is a statistically significant difference ($p = .000$). It can be concluded that boys and girls differ in anthropometric characteristics with respect to RAE. The analysis of Post Hoc results (Table 2) shows the differences in anthropometric characteristics between boys and girls relative to RAE, while Table 3 shows the correlation between BF and BMI. Figure 1 shows the percentile BMI values of boys and girls relative to RAE.

Table 1: Multivariate Analysis of Variance (MANOVA).

	Value	F	Sig.	Partial eta Squared
Wilks' Lambda	0.108	3.405	0	0.272

Table 2: Legend: BH: Boys 1st vs Girls 1st, 2nd, 3rd and 4th p<.000 †; Boys 2nd vs Girls 1st, 2nd, 3rd and 4th p<.000 ‡; Boys 3rd vs Girls 1st, 2nd, 3rd, and 4th p<.000 †; Boys 4th vs Girls 1st, 2nd, 3rd and 4th p<.000 ‡. BW: Boys 3rd vs Boys 1st p<.05 ◊; Boys 2nd vs Girls 2nd p<.004, 3rd and 4th p<.05 ‡; Boys 3rd vs Girls 2nd p<.000, 3rd and 4th p<.002 †. BF: Boys 1st vs Girls 1st p<.001, 2nd p<.002, 3rd and 4th p<.000 †, Boys 3rd p<.002 ◊; Boys 2nd vs Girls 1st p<.012, 3rd p<.008, 4th p<.003 ‡, Boys 3rd p<.05 >; Boys 3rd vs Boys 4th p<.006 <; Boys 4th vs Girls 1st p<.003, 2nd p<.013, 3rd p<.002, and 4th p<.001 ‡. BMI: Boys 3rd vs Boys 1st p<.05 ◊.

Variables	1 st Group		2 nd Group		3 rd Group		4 th Group	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
BH (cm)	178.14±6.706†	165.92±5.219	183.16±7.341‡	164.25±6.892	180.57±6.321†	165.54±5.517	186.33±2.309‡	161.55±4.165
BW (kg)	65.72±10.848	68.43±19.277	75.51±13.356‡	60.48±8.543	81.95±20.951◊,†	62.91±11.433	75.38±8.094	62.06±7.323
BF (%)	24.08±6.126†,◊	34.90±7.581	27.70±4.654‡, >	31.62±3.902	33.41±6.799 <	33.89±6.025	22.93±6.426‡	34.93±3.955
BMI (kg/m ²)	20.65±3.249	24.61±6.134	22.43±3.464	22.47±3.387	24.96±5.215 ◊	22.97±4.347	21.71±2.357	23.83±2.791

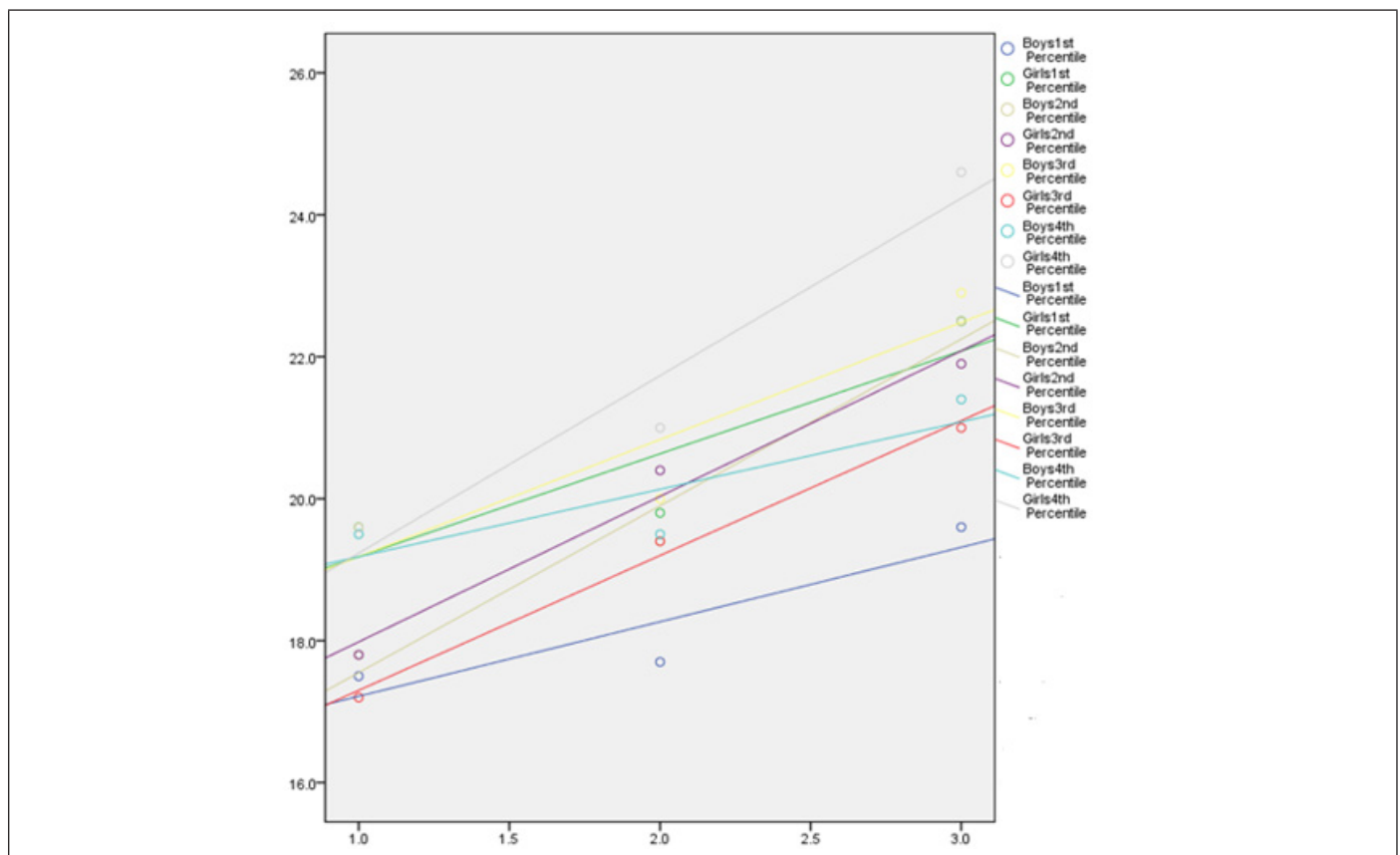


Figure 1: Percentile values for BMI in boys and girls by different age categories.

Table 3: Correlation between BF and BMI.

Group/sex	Variables	BF	BMI
1 st /Female	BF	1	.941**
	BMI		1
3 rd /Female	BF	1	.883**
	BMI		1
4 th /Female	BF	1	.723*
	BMI		1

Discussion

The aim of the study was to determine how much adolescents differ in anthropometric characteristics in relation to RAE. Measuring the anthropometric characteristics of the human body, processing

and studying the data obtained are an integral part of a series of basic applied research in the field of physical education and sport [35]. Through the realization of transversal research, i.e. A single measurement of a larger number of subjects in a given population gives insight into the average state of physical development [36]. Analyzing the BH results in Table 2, it is noticeable that boys in all groups had higher BH values than girls in all groups. In terms of BW, boys in group 3 had higher body weight than boys in group 1 (p = .05). Also, boys in group 3 had higher BW values than girls in 2nd (p = .000), 3rd and 4th groups (p <.002), while boys in group 2 had higher BW values than girls from 2nd (p = .004), 3rd and 4th groups (p = .05). Higher body height values in boys compared to girls can be explained by the fact that during periods of rapid adolescent development, the lower extremities of boys grow relatively faster

than in girls [37]. During adolescence, about 40% of bone mass is obtained, making the puberty phase an optimal time to accumulate bone mass and reduce the risk of fractures. Minimal differences in bone mass between the sexes exist in the pre-pubertal period, while significant differences occur during puberty, when bone growth is influenced by sex hormones.

Estrogen limits periosteal bone expansion but promotes endocortical contraction, while androgenic hormones stimulate periosteal bone apposition, resulting in boys having wider bones, greater cortices thickness, and wider medullary cavities than girls [38]. Growth hormone (GH) secretion is suppressed in children with high BMI [39]. GH decreases in obese individuals, and peak GH levels are lower in obese children than in normal-weight children [40], also, GH in obese children with high BMI levels may result from decreased production and secretion of GH [41,42]. Research indicates that it is known that at any age, the average body height of girls is closer to the height they reach at adulthood than is the case for boys. As early as the third year of life, girls reach half the total height they will reach at adulthood, and boys reach at three and a half years of age [37]. On average, girls with fast acceleration, at 10.7 years of age, reach a peak in body weight unlike boys who achieve this at 12.6 years. Girls who matured at the expected rate were 12.1 years old and boys 14.0 years old at the time of peak body mass [37,43]. All these are benchmarking that gender differences are evident and have a corresponding upward trend, as confirmed in the study [44]. Also, the results of the current research are in line with the research of Šegregur et al. [45] which showed significant differences in the BH and BW between girls and boys. Similar results to the current study were obtained by Nakata et al. [46] where they recorded significant RAE in boys aged 7 to 15 years in anthropometric characteristics, whereas in girls they did not record statistical significance in RAE.

Hook et al. [17] state that a decline in physical activity in adolescence is noticeably observed in girls. This is also confirmed by our results where girls had higher BF and BMI values than boys (Table 2). Also, BMI is used worldwide to classify people as malnourished, normal and obese [47]. Early detection of overweight and obesity in children is usually based on the use of Body Mass Index, due to its simplicity and relatively large association with BF [48-50]. The correlation between BMI and BF was observed in girls from the 1st group ($r = .941$), 3rd group ($r = .883$) and 4th group ($r = .723$), while the association between BMI and BF was not observed in boys. Similar results were obtained by Maynard et al. [20], Roche et al. [21], Skrzypczak et al. [51], Amini [52], Centers for Disease Control and Prevention (CDC) set thresholds for BMI in percentiles where children with percentiles (85th - 94th) are classified as overweight, while children with percentiles ($\geq 95^{\text{th}}$) are classified as obese [53]. In our study, boys in the 1st, 3rd, and 4th groups had a BMI (<85th percentile), while boys in the 2nd as well as girls in all four groups had a BMI (> 95th percentile). Freedman et al. [54] state that children with a BMI of the (85th-94th percentile) have high levels of BF, which was confirmed in this study. Ogden, et al. [55] state that in the USA, 17% of children have a BMI (> 95th percentile),

while 16% have a BMI of (85th -94th percentile). Ayers & Sariscsany [56] recommend reference intervals of physiological BF values in percentages for boys aged 15 years (20.1%) and girls (29.1%). Comparing the average values of BF of boys and girls (Table 2), it is noticeable that their values exceed the stated standards.

Insufficient physical activity during adolescence can have long-term effects on the health of an individual in adulthood as a consequence of chronic illness and a sedentary lifestyle [57]. Studies have shown Guo et al. [58] correlation of overweight in adolescence and overweight in adulthood, where overweight and obesity are responsible for 80% of type II diabetes, 35% of ischemic heart disease, and 55% of hypertensive diseases in adults [59]. Based on all of the above, adolescents are advised to exercise at least 60 minutes daily for physical activity, noting that they spend most of their time at moderate or high intensity aerobic physical activity, but also at least three times per week for high intensity physical activity. Bone and muscle strengthening exercises are recommended during this period, which should be included as part of a 60-minute recommended workout three times a week [60,61].

Conclusion

The results of the current study on a sample of 73 students of both sexes, chronologically aged (15 ± 0.5 years) confirmed differences between boys and girls in anthropometric characteristics with respect to RAE. Boys had higher BH and BW, while girls had higher BMI and BF values. Such results are expected if one takes into account the trend of growth and development of certain characteristics and their acceleration and deceleration. What is discouraging is that as many as 76.7% of children in the total sample are obese. Of these, 63% are girls and 13.7% boys who were born in April May and June, while the other boys 23.3% have normal nutritional values. The results of the research are more than alarming, so it is necessary to adjust the curriculum to regulate body fat relative to ERS. The main factor contributing to these indicators is today's lifestyles of children and young people, as today's development is moving towards the advancement of technology, however, the work performance and involvement of children in physical activities are minimized. Much research is needed to understand the negative impact of obesity on students' anthropological status and to express physical activity as an imperative that builds a healthy environment and population [62].

Limitations and Strength of the Study

In some further studies, certain parameters of relative age and obesity need to be complemented by external factors affecting quality of life (preferably through a questionnaire on nutritional habits or physical activity of children) to complement the results of this study.

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