

THE INFLUENCE OF OVERWEIGHT AND FATNESS ON PHYSICAL FITNESS AMONG 9 AND 10 YEAR OLD STUDENTS

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(Original scientific paper)

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Abstract

The main goal of this research is to determine the level of health-fitness among Macedonian children of both sexes aged 9 and 10 years with different values of the body mass index (BMI). The research was carried out on a sample of 862 respondents, drawn randomly from several elementary schools in the Skopje region. The sample is divided into two subsamples according to gender, namely 424 male respondents and 438 female respondents. Five anthropometric measures were taken (IBP methodology), and health-fitness was analyzed through the following parameters: physical fitness assessed through six motor tests from the MAKFIT battery; body composition determined through BIA; and aerobic capacity, assessed indirectly using the 20-meter sprint test with a progressive increase in speed. The results were statistically processed with SPSS, v.22.0 for WINDOWS (analysis of variance, analysis of covariance and χ^2 test). The percentage of overweight and obese children, classified on the basis of BMI (Cole et al.), among Macedonian children was 41.6%. Macedonian children of both sexes with a moderately increased or high BMI have: a lower percentage of muscle mass; achieve lower results in tests assessing relative strength, explosive strength, speed, agility and coordination; and have a lower aerobic capacity.

Keywords: *body mass index, motor skills, body composition, aerobic capacity*

Introduction

Obesity is mainly defined as excessive storage of body fat in the body, which in clinical practice is usually expressed through the body mass index (BMI), where the value is equal to or greater than the 95th percentile for children of the same age and gender, while overnutrition when values are in the 85th to 95th percentile range (Barlow, & Expert Committee, 2007). Obesity is a chronic non-infectious disease that occurs as a result of multiple factors, divided into two basic groups: genotype and environmental conditions. There is no complete agreement on the exact causes of the occurrence of this disease. It is thought to occur as a result of an integration of social, behavioral, cultural, physiological, metabolic and genetic factors (National Institutes of Health of USA, 2000).

Over nutrition and obesity are responsible for 80% of type 2 diabetes, 35% of myocardial ischemia and 55% of high blood pressure in adults in Europe, causing over a million deaths annually (Tsigos et al., 2008; National Institutes of Health of USA, 1998; Vukoviĥ et al., 2012; Kisiĥ- Tepavĉeviĥ et al., 2008). Obesity in early life shortens life expectancy, contributes to a high burden of disease in adulthood (Freedman, et al., 2001) and threatens the health care and insurance system.

Obese children have a high prevalence of remaining obese into adulthood (Biro, & Wien, 2010; Whitaker, et al., 1997; Serdula, et al., 1993). In addition to genetic predisposition and other biological factors (weight during birth, intrauterine development), it is considered that the child's behavior plays one of the key roles in the development of obesity (Burke, 2006). Under this group of factors is meant primarily the way of diet and level of physical activity. Lack of physical activity and excessive nutrition are some of the dominant factors in the development of obesity in the last twenty years (Lobstein, Baur, & Uauy, 2004; Roberts, Lucas, & Hirsch, 2000; Lustig, 2006).

Major research studies show a constant trend of increasing prevalence of over nourished and obese over the last 20 years worldwide with an increase of 10% to 40% in both developed and underdeveloped countries (Ford, & Mokdad, 2008).

Prevention and education of children of preschool and school age is of great importance. The most sensitive period in children in the development of over nutrition and obesity coincides with the period of onset of puberty and intensive growth and development. It is the period in which the most can be done in preventive action. In addition to regular physical activity, it is more important to inform children about the importance of proper nutrition and a healthy lifestyle.

According to the above, the main goal of this research is to determine the association of fitness with different body weight status, categorized according to the size of the BMI and the percentage of body fat in students of 9 and 10 years of age.

Materials and methods

Sample of respondents

The research was carried out on a sample of 862 respondents, drawn randomly from several elementary schools in the Skopje region. The sample is divided into two subsamples according to gender, 424 male respondents and 438 female respondents. The sample included all students whose parents gave consent to participate in the project and who were psychophysically healthy and regularly attend physical and health education classes. In addition, all students who for some reason will not do all the measurements and tests or for some other reason are excluded from the analysis. The respondents will be dealt with in accordance with the Helsinki Declaration 1961 (revision of Edinburgh 2013).

Measurement of anthropometric characteristics and body composition

The measurement of anthropometric measures was carried out according to the recommendations of the IBP international biological program (Lohman, Roche & Martorell, 1988). To assess anthropometric characteristics in this research, the following anthropometric and body composition measures will be applied: Body height, body weight, waist circumference and the body mass index (BMI) will be calculated.

The components of the body composition were determined by the method of bioelectrical impedance (measurement of electrical conductivity – Bioelectrical Impedance Analysis - BIA). The measurement will be carried out in standard school conditions during regular physical and health education classes. The measurement was carried out by experts in the field of kinesiology, who were previously trained to use the Body Composition Monitor, model "OMRON - BF511". Before starting the measurement, the gender, age and body height parameters of the subject were entered in the Body Composition Monitor. The instrument used in this study has been compared with the DXA method (which represents the gold standard) in mixed populations of children and adults and it has shown satisfactory measurement characteristics (Pietrobellietal. 2004).

To ensure better accuracy of the results obtained from the body composition assessment, the prerequisites recommended by ACSM (2005) and Heyward (2006) were met before each measurement.

The measurement of motor skills

Before the start of the study, the researchers involved in the project underwent training in order to guarantee the standardization, validation and reliability of the measurements (Morenoetal., 2003). Seven tests, which are part of the MAKFIT battery, were applied in the following order:

1. Leaning forward in a sitting position
2. Palm dynamometry
3. Long jump
4. Lying down - sit for 30 seconds
5. Shuttle run 4 x 10 meters (4 x 10 m shuttle run test)
6. Running 20 meters with a progressive increase in speed (shuttle-run)

Defining the level of nutrition

Subjects were classified based on BMI values (kg/m²) and the table (cut-off points IOTF reference) proposed by Cole et al., 2000, 2007 into three groups: normally fed (normal weight), over nourished (overweight) and obese.

Statistical analysis

Data are presented as frequencies (percentages) for dichotomous variables and arithmetic means (SD) for continuous variables. Gender differences in fitness tests and anthropometric characteristics were

analyzed by one-way analysis of variance (ANOVA). Dichotomous variables (weight status) were analyzed using the χ^2 - test. Correlation between variables was determined by Spearman's correlation. An analysis of covariance (ANCOVA) with age adjustment was used to determine differences in fitness level between groups with different weight status. Since a significant interaction was observed between weight status and gender in relation to all fitness tests ($p < 0.05$), subsequent analyses were conducted separately for boys and girls. All analyzes were performed using the Statistical Package for Social Sciences software (SPSS, v. 20.0 for Windows; SPSS Inc., Chicago, IL, USA), and values of $p < 0.05$ were considered statistically significant.

Results

Table 1 shows the characteristics of the sample used in this research. The results of the covariance analysis (table 1) show that only in the variable body height there are no statistically significant differences between boys and girls, in all other variables there are statistically significant differences in relation to gender ($p < 0.05$). The distribution of the state of normal, overweight and obesity in children, estimated through BMI, in relation to age and gender are also shown in table 1. The values of the χ^2 test ($\chi^2 = 15.480$; $p = 0.000$) indicate that there are statistically significant differences in the degree of nutrition among boys and girls of this age. From the percentage values it can be seen that a higher percentage of girls are classified as overweight (27.60% girls, against 25.50% boys) while a higher percentage of boys are classified as obese (19.80% boys, against 10, 30% girls).

Table 1. Characteristics of the sample

	Total		Boys		Girls		P*
	Mean	SD	Mean	SD	Mean	SD	
Age	9,49	0,50	9,53	0,50	9,46	0,50	0,042
Height (cm)	140,79	7,83	140,95	7,70	140,63	7,95	0,550
Weight (kg)	39,22	10,53	40,46	11,10	38,01	9,80	0,001
Waist circumference (cm)	64,23	9,79	66,37	10,25	62,13	8,84	0,000
BMI (kg/m ²)	19,58	3,94	20,16	4,18	19,02	3,62	0,000
Fat mass (%)	24,31	8,45	25,10	8,14	23,54	8,69	0,007
Fat mass (kg)	10,28	5,94	10,90	6,21	9,66	5,61	0,002
Fat-free mass (kg)	29,11	5,38	29,68	5,62	28,55	5,08	0,002
Muscular mass (%)	31,76	2,33	32,08	2,41	31,45	2,22	0,000
Muscular mass (kg)	12,48	3,32	13,00	3,57	11,97	2,98	0,000
Sit and reach (cm)	14,90	6,59	13,01	6,36	16,73	6,28	0,000
Handgrip (kg)	15,40	3,36	16,04	3,35	14,78	3,25	0,000
Standing long jump (cm)	114,61	23,18	120,08	23,07	109,33	22,06	0,000
Sit-ups 30 sek. (n)	14,39	5,14	15,42	5,15	13,38	4,94	0,000
Shuttle run 4x10 m	14,47	1,65	14,02	1,49	14,89	1,68	0,000
Stg	3,80	1,50	4,17	1,68	3,45	1,21	0,000
VO2max	47,09	3,59	47,96	3,93	46,24	3,00	0,000
Normal weight**	504	58,50%	232	54,70%	272	62,10%	
Overweight	229	26,60%	108	25,50%	121	27,60%	
Obese	129	15,00%	84	19,80%	45	10,30%	0,000

Tables 2 and 3 show the correlation coefficients between BMI and percentage of body fat and anthropometric measurements, measures for assessing body composition and tests for assessing fitness abilities in subjects of both sexes. From the review of the tables, it can be seen that all anthropometric measures and measures for assessing body composition (except the percentage of muscle mass) in both sexes show a statistically significant positive correlation (ranging from .317 to .960) with the body mass index and body fat percentage. A statistically significant negative correlation (ranging from -.165 to -.544) was found between BMI and percentage of body fat with the fitness tests long jump, 30 second body lift, 4 x 10 meter sprint and 20 meters with a progressive increase in speed (passed sections and VO2max). Only the palm dynamometry test showed a positive correlation with BMI, while a statistically significant correlation between BMI and the percentage of body fat was not determined in the deep squat test. In both genders, the highest negative correlations with BMI and percentage of body fat are shown by the fitness test running 20 meters with a progressive increase in speed (passed segments and VO2max).

Tables 4 and 5 show the mean values of the parameters for assessing anthropometric measures, body composition and fitness abilities, after age partialization. In both genders, statistically significant differences were determined in all parameters for assessing anthropometric measures, body composition and tests for assessing fitness between the groups of subjects formed on the basis of the BMI classification, except for the fitness test in which the subjects of both sexes were predisposed.

Table 2. Correlation quotients of BMI and body fat percentage with anthropometric and physical parameters (boys)

	BMI				Body fat percentage			
	T	N	O	OB	T	N	O	OB
Anthropometric parameters								
Height (cm)	,420**	,289**	,378**	,328**	,259**	-,058	,028	-,056
Weight (kg)	,910**	,640**	,735**	,708**	,793**	,420**	,358**	,216*
Waist circumference (cm)	,845**	,624**	,574**	,449**	,820**	,462**	,461**	,654**
BMI (kg/m ²)					,908**	,886**	,735**	,317**
Fat mass (%)	,908**	,886**	,735**	,317**				
Fat mass (kg)	,960**	,914**	,893**	,698**	,928**	,902**	,754**	,684**
Fat-free mass (kg)	,741**	,333**	,541**	,577**	,547**	,043	,065	-,189
Muscular mass (%)	-,277**	,055	,153	-,102	-,449**	-,275**	-,386**	-,805**
Muscular mass (kg)	,807**	,480**	,605**	,601**	,650**	,188**	,138	-,046
Physical parameters								
Sit and reach (cm)	,008	,076	-,029	,105	-0,03	,084	-,105	-,296**
Handgrip (kg)	,397**	,190**	,417**	,412**	,235**	-,049	-,019	-,093
Standing long jump (cm)	-,255**	-,078	,147	,041	-,345**	-,229**	,011	-,319**
Sit-ups 30 sek. (n)	-,196**	-,142*	,056	,101	-,276**	-,255**	-,120	-,197
Shuttle run 4x10 m	,289**	-,006	,019	,022	,335**	,067	,094	,321**
Stg	-,478**	-,249**	-,004	-,168	-,527**	-,288**	-,113	-,469**
VO2max	-,531**	-,246**	-,195*	-,316**	-,544**	-,232**	-,248**	-,426**

Table 3. Correlation quotients of BMI and body fat percentage with anthropometric and physical parameters (girls)

	BMI				Body fat percentage			
	T	N	O	OB	T	N	O	OB
Anthropometric parameters								
Height (cm)	,363**	,318**	,348**	-,003	,255**	,076	-,132	-,113
Weight (kg)	,902**	,791**	,693**	,607**	,781**	,538**	,166	,127
Waist circumference (cm)	,876**	,684**	,525**	,633**	,796**	,586**	,275**	,216
BMI (kg/m ²)					,911**	,856**	,613**	,330*
Fat mass (%)	,911**	,856**	,613**	,330*				
Fat mass (kg)	,965**	,928**	,844**	,665**	,939**	,932**	,742**	,623**
Fat-free mass (kg)	,686**	,518**	,433**	,458**	,478**	,157*	-,235*	-,250
Muscular mass (%)	-,482**	-,032	-,210*	-,153	-,642**	-,357**	-,826**	-,905**
Muscular mass (kg)	,772**	,636**	,501**	,476**	,606**	,326**	-,139	-,184
Physical parameters								
Sit and reach (cm)	-,001	,114	-,008	,235	-,042	,024	-,168	,270
Handgrip (kg)	,406**	,330**	,369**	,400**	,229**	,056	-,156	-,231
Standing long jump (cm)	-,296**	-,055	-,130	,150	-,401**	-,198**	-,440**	-,190
Sit-ups 30 sek. (n)	-,216**	,027	-,077	,019	-,297**	-,101	-,289**	-,357*
Shuttle run 4x10 m	,230**	-,047	-,065	-,154	,309**	,070	,288**	,236
Stg	-,363**	-,085	-,142	,040	-,426**	-,203**	-,256**	-,106
VO2max	-,411**	-,165**	-,263**	-,179	-,451**	-,270**	-,193*	-,131

Table 4: Significance of differences in physical fitness components in the various BMI categories in the boys

	Normal (1)		Overweight (2)		Fat (3)		F	sig	Post hoc pairwise comparisons
	Mean	SD	Mean	SD	Mean	SD			
Height (cm)	138,81	7,11	142,52	7,94	144,98	7,18	30,4	0,000	1 & 2; 1 & 3; 2 & 3
Weight (kg)	33,08	4,85	44,04	6,57	56,26	9,11	500,5	0,000	1 & 2; 1 & 3; 2 & 3
Waist circumference (cm)	59,81	5,46	70,08	6,65	80,06	8,77	308,3	0,000	1 & 2; 1 & 3; 2 & 3
BMI (kg/m ²)	17,17	1,54	21,55	1,58	26,62	2,63	867,1	0,000	1 & 2; 1 & 3; 2 & 3
Fat mass (%)	19,04	4,68	29,30	3,20	35,98	4,07	534,8	0,000	1 & 2; 1 & 3; 2 & 3
Fat mass (kg)	6,39	2,07	12,98	2,75	20,32	4,45	788,2	0,000	1 & 2; 1 & 3; 2 & 3
Fat-free mass (kg)	26,69	3,56	31,06	4,36	35,95	5,79	179,4	0,000	1 & 2; 1 & 3; 2 & 3
Muscular mass (%)	32,68	2,61	31,99	1,94	30,63	1,60	25,0	0,000	1 & 2; 1 & 3; 2 & 3
Muscular mass (kg)	10,88	2,22	14,16	2,60	17,27	3,11	249,8	0,000	1 & 2; 1 & 3; 2 & 3
Sit and reach (cm)	13,13	6,40	13,54	6,20	12,60	6,39	0,5	0,601	NS
Handgrip (kg)	15,24	3,04	16,77	3,04	17,54	3,53	21,2	0,000	1 & 2; 1 & 3
Standing long jump (cm)	125,77	23,40	118,64	18,16	109,03	21,37	17,9	0,000	1 & 2; 1 & 3; 2 & 3
Sit-ups 30 sek. (n)	16,11	5,07	16,30	4,49	12,96	5,00	13,3	0,000	1 & 3; 2 & 3
Shuttle run 4x10 m	13,64	1,34	14,24	1,48	14,90	1,42	25,3	0,000	1 & 2; 1 & 3; 2 & 3
Stg	4,83	1,68	3,83	1,29	2,88	1,00	54,3	0,000	1 & 2; 1 & 3; 2 & 3
VO2max	49,63	3,77	47,01	2,99	44,82	2,64	66,9	0,000	1 & 2; 1 & 3; 2 & 3

Table 5: Significance of differences in physical fitness components in the various BMI categories in the girls

	Normal (1)		Overweight (2)		Fat (3)		F	sig	Post hoc pairwise comparisons
	Mean	SD	Mean	SD	Mean	SD			
Height (cm)	138,72	7,47	143,76	7,72	143,75	7,72	29,7	0,000	1 & 2; 1 & 3
Weight (kg)	32,34	5,65	44,99	6,24	53,84	7,46	458,1	0,000	1 & 2; 1 & 3; 2 & 3
Waist circumference (cm)	57,01	4,47	68,46	6,63	76,86	6,35	378,8	0,000	1 & 2; 1 & 3; 2 & 3
BMI (kg/m ²)	16,72	1,67	21,66	1,33	25,98	2,38	849,3	0,000	1 & 2; 1 & 3; 2 & 3
Fat mass (%)	18,18	5,84	30,38	3,91	36,83	3,26	391,6	0,000	1 & 2; 1 & 3; 2 & 3
Fat mass (kg)	6,06	2,60	13,71	2,80	19,86	3,49	731,7	0,000	1 & 2; 1 & 3; 2 & 3
Fat-free mass (kg)	26,28	3,90	31,28	4,46	33,98	4,86	134,3	0,000	1 & 2; 1 & 3; 2 & 3
Muscular mass (%)	32,22	2,05	30,62	1,72	28,89	1,44	73,8	0,000	1 & 2; 1 & 3; 2 & 3
Muscular mass (kg)	10,47	2,21	13,81	2,30	15,58	2,43	204,5	0,000	1 & 2; 1 & 3; 2 & 3
Sit and reach (cm)	16,94	6,23	16,95	6,31	15,30	6,42	1,3	0,265	NS
Handgrip (kg)	14,10	2,92	15,69	3,39	16,75	3,38	25,6	0,000	1 & 2; 1 & 3; 2 & 3
Standing long jump (cm)	115,19	20,62	101,07	20,62	98,68	21,54	24,8	0,000	1 & 2; 1 & 3
Sit-ups 30 sek. (n)	14,40	4,54	12,59	4,98	10,23	5,53	16,5	0,000	1 & 2; 1 & 3; 2 & 3
Shuttle run 4x10 m	14,54	1,60	15,11	1,55	16,23	1,81	21,9	0,000	1 & 2; 1 & 3; 2 & 3
Stg	3,83	1,23	2,98	0,98	2,66	0,75	35,3	0,000	1 & 2; 1 & 3
VO2max	47,17	2,94	45,00	2,82	44,25	1,71	38,7	0,000	1 & 2; 1 & 3

From the values of the arithmetic means and the level of statistical significance in tables 4 and 5, it can be seen that students of both sexes with moderately overweight and overweight achieve better results in the palm dynamometry test compared to subjects with normal body weight ($p < 0.00$) and poorer results in other fitness tests. In the subjects of both sexes, in the test of deep leaning in the seat, no statistically significant differences were determined between the children classified with normal, moderate and increased BMI index. Among male subjects with normal body weight and overweight, no statistically significant differences were determined in the 30-second body lift fitness test. Also, no statistically significant differences were found in the palm dynamometry fitness test among overweight and obese subjects. Among overweight and obese female subjects, no statistically significant differences were determined in the fitness tests long jump and 20-meter run with a progressive increase in speed (passed sections and VO2max).

Discussion

Obesity in childhood and youth is becoming a global epidemic and is about to reach epidemic proportions in Macedonia. The percentage of overweight and obese children aged nine and ten, as classified based on the BMI criterion in this study, was found to be 41.6%. This figure can be compared to previous research conducted on Macedonian adolescents aged 11 to 14 years, where the percentage of overweight and obese children at ages eleven and twelve was 35%, and at ages thirteen and fourteen was 31% (Gontarev, S., & Ruzdija, K. 2014; Živkovic et al., 2014). Similar results on overweight and obesity were obtained in several international studies (Jehnet al., 2006; Ortega, 2007; Al-Nakeeb et al., 2007; Ostojic et al., 2011).

Also, the results of our study indicate that boys tend to be more overweight and obese than girls (45.3% in boys and 37.9% in girls).

Over 32% of respondents have a body fat percentage greater than 30%. Such a high percentage of body fat is associated with an increased risk of acute and chronic diseases, especially osteoarthritis, increased blood pressure, diabetes mellitus and cardiovascular disease, which can lead to a worse quality of life, increased personal and financial burden for the individual, family and society and shortening of lifespan (Williams et al., 1992; Aristimino et al., 1984; Berenson et al., 1980; 1982; Dugan, 2008).

The results of this research clearly indicate that overweight and obesity have a negative impact on health-related fitness among 4th and 5th grade students, who are nine to ten years old. The negative impact is most pronounced in tests for assessing aerobic capacity, relative strength, explosive strength, speed, agility and coordination. In most of these tests, success depends on moving the body (locomotion) in space or overcoming the resistance of one's own body or a certain part from the body, with the fat component representing ballast mass. These are motor manifestations that are influenced by the mechanisms for regulating the intensity and duration of excitation (Kurelic et al., 1975). Obviously, these mechanisms are significantly more effective in young subjects with a balanced ratio of body weight and height, i.e. lower values of BMI and body fat, which is in accordance with several international studies conducted in children aged 5 to 17 years (Baine et al., 2009; Malina et al., 1995; Minck et al., 2000; Deforche et al., 2003; Prista et al., 2003; Graf et al., 2004; Kim et al., 2005a, b; Brunet et al., 2007; Casajus et al., 2007; Haerens et al., 2007; Huang and Malina, 2007; Fogelholm et al., 2008).

In terms of flexibility, our research indicates that moderately overweight or overweight subjects achieve similar results to normal weight subjects, which has also been shown in two Taiwanese studies. However, the results obtained from research in some of the Western countries indicate that obese girls achieve better results than girls with normal weight, and this has not been established for boys (Prista et al., 2003). All motor tests (except the flexibility assessment test) are more or less correlated with BMI and body fat percentage.

Regular physical activity and a high intake of non-digestible polysaccharides reduce the risk of obesity, while a sedentary lifestyle and the intake of food with high energy value and poor in micronutrients increase the risk of obesity in children. Healthy food choices for children at home and at school reduce risk, while sugar-sweetened soft drinks and fast food advertisements increase obesity risk. Much evidence suggests that low-glycolic index and high-protein foods reduce the risk, and the large number of meals prepared outside the family and monotonous eating habits increase the risk. In any case, the diet should be based on foods with low energy value (fruits and vegetables) and whole grains (which are a good choice of dietary fiber).

The obtained results can be explained to some extent by the lack of fundamental motor movements in the teaching of physical education, as well as the expertise of the people who educate the children in the period from the beginning of preschool institutions to the sixth grade in primary school. One of the reasons related to insufficient or inadequate physical activity and incorrect habits related to nutrition can be sought in the quantity and quality of physical education teaching in preschool institutions and young school age. Certainly, "sportification" and the whole concept of teaching physical education, which is aimed exclusively at the development of motor skills, requires a thorough rethinking and change.

The obtained data refer to the scientific planning and programming of the teaching content with the aim of optimizing the relationship between the amount of subcutaneous fat and muscle mass, which will create an opportunity to maximize motor functioning in a wide range of abilities, and especially in the dimensions of strength and endurance (Katić, 2003). The aim of teaching the subject of physical and mental education in this period of life, among other things, should be aimed at reducing fat tissue and increasing muscle mass, primarily of the large muscle groups.

Conclusion

The study presents a current research on the prevalence of obesity and overweight among children in the central and eastern part of R. Macedonia based on a population approach, which puts prevention in the first place. The results indicate that more than two children out of ten are overweight, and more than one child out of ten is obese. It affects the prevalence of obesity in later life. The prevalence of overweight and obesity based on BMI among Macedonian adolescents is 41.6%. In terms of gender differences, a higher percentage of girls are classified as overweight, while a higher percentage of boys are classified as obese.

Macedonian children of both sexes with a moderately increased or high BMI have: a lower percentage of muscle mass, a higher percentage of body fat and achieve lower results in fitness assessment tests. Among male subjects with normal body weight and overweight, no statistically significant differences were determined in the fitness test lifting the body for 30 seconds. Also, no statistically significant differences were found in the palm dynamometry fitness test among overweight and obese subjects. Among overweight and obese female subjects, no statistically significant differences were determined in the fitness tests long jump and 20-meter run with a progressive increase in speed (passed sections and VO₂max).

Correlation coefficients between body fat percentage and fitness abilities are slightly higher in boys than in girls. On the other hand, the correlation coefficients between BMI and fitness abilities are somewhat higher in girls than in boys.

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