Differences in aerobic capacity among students with regard to their level of nutritional status[1]

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Abstract

Due to contemporary lifestyle, nutritional status of students is poorer and therefore it negatively affects the aerobic capacity. The purpose of this study was to determine the differences in aerobic capacity among female students of Faculty of Teacher Education with regard to their level of nutritional status. The study included 281 female students of the Faculty of Teacher Education, University of Zagreb. The sample of variables consisted of anthropometric measures: body height, body weight, sub-scapular and triceps skinfolds. Aerobic capacity was measured by 20 meter shuttle run test and nutritional status was determined by the body mass index (BMI). The subjects were divided into four groups according to their nutritional status: underweight, normal body weight, overweight and obese. Mean values of the BMI place the students into normal weight group, however, mean values of aerobic capacity show that students achieved poor results. Kruskal Wallis test and its post-hoc test (multiple comparisons for all groups with Bonferroni adjustment) for determining the difference between subsamples according to the level of nutritional status among students show that the subsamples differ in four of the five variables that describe the morphological characteristics (body weight, BMI, sub-scapular skinfold, triceps skinfold) as well as in aerobic capacity. The results obtained in this study show that the increased body mass have extremely high impact on the aerobic capacity results. It can be concluded that the tested students' aerobic capacity is poor and students with normal body weight have better aerobic capacity than overweight or obese students.

Keywords: body mass index; faculty students; functional capacity; 20 m shuttle run test; VO2 max

Introduction

Aerobic capacity (VO2 max) is the "maximal amount of oxygen that human body can utilize per minute of activity or physical workout" (Dhara & Chatterjee, 2015, p. 9). It is the most frequently used measure of cardiorespiratory fitness (Grant, Corbett, Amjad, Wilson, & Aitchison,

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1995), which shows cardiorespiratory durability of an individual (Dhara & Chatterjee, 2015). Furthermore, VO2 max is affected by many factors, such as physical training, genetics, age, gender and body composition (Hoeger, W.W.K & Hoeger S.A., 2014).

The VO2 max can be measured using submaximal and maximal tests, by methods which can be direct or indirect (Nabi, Rafiq, & Qayoom, 2015). Considering that the direct measurement of VO2 max is expensive, multistage progressive shuttle run test (MST) is the most commonly used measure. MST can at the same time include a large number of participants, but it is a maximal test which has potential health risk and participants have to be highly motivated to invest truly maximal effort (Grant et al., 1995).

Research studies have established that VO2 max is a crucial physiological factor and has an important role in the determination of fitness and capacity of physical work under aerobic conditions (Ribisl & Kachadorian, 1969). For women aged 13-19 years VO2 max under 25 ml/kg/min, and for women aged 20-29 years under 23.6 ml/kg/min have been taken as the normative for very poor fitness (The Physical Fitness Specialist Certification Manual, 1998).

International standard of physical activity is maximal oxygen uptake expressed as millilitre/kg/minutes because the absolute value is highly affected by body weight (Shete, Bute, & Deshmukh, 2014). It has been established that low level of physical activity affects body composition and the correlation between body composition and cardiovascular fitness is inversely proportional (Brooks, 2002).

Many cross-sectional studies prove that a low level of aerobic capacity is a feature of overweight adolescents and youth (Lee & Arslanian, 2007; Ward et al., 1997). Ferreira (2013) as well as Pate, Wang, Dowda, Farrell, and O'Neill (2006) have proven that overweight and obese adolescents have lower cardiorespiratory fitness level than normal weight adolescents. Low level of cardiorespiratory fitness and adiposity in adolescence are both correlated with higher risk of mortality in adulthood (Apor, 2011), and it is well known that cardiorespiratory fitness is an independent determinant of a healthy lifestyle (Ferreira, Twisk, van Mechelen, Kemper, & Stehouwer, 2005). Thus, the aim of this study was to determine differences in aerobic capacity among the Faculty of Teacher Education students with regard to their level of nutritional status.

Methods

The study included 281 first and second year students of the Faculty of Teacher Education, University of Zagreb. The measurement was conducted in the academic year 2014/15. All the participants were healthy and willing to participate in research. The sample of variables consisted of anthropometric measures: body height, body weight, sub-scapular and triceps skinfolds. All anthropometric measurements were performed according to the International Biological Program-IBP instructions (Weiner & Lourie, 1969). Body height was measured by using anthropometry and body weight with the help of digital scales. Skinfolds were measured by Lange skinfold calliper. Aerobic capacity was measured by multi-stage 20 meters - shuttle run test (Leger & Lambert, 1982). Body mass index was calculated on the basis of the formula BMI (kg/m2=weight (kg)/(height (m))^2 (Garow & Webster, 1985). Based on the calculated body mass index and the International Classification (WHO, 1997), the subjects were divided into four groups according to their nutritional status: underweight (below 18.50), normal body weight (18.50-24.99), overweight (25.00-29.99) and obese (above 30.00).

Statistical analysis

Data analysis was performed with the program STATISTICA (data analysis software system), version 7.1. For all variables, basic descriptive parameters: arithmetic mean (M), standard

deviation (SD), minimum (MIN) and maximum (MAX), Skewness and Kurtosis were calculated. The normality of the distribution of variables was tested by Kolmogorov-Smirnov test and the homogeneity of variance by Levene's Test. Since the results of these two tests were statistically significant, for establishing differences according to the level of nutrition status, nonparametric Kruskal Wallis test and its post-hoc test (multiple comparisons for all groups with Bonferroni adjustment) were used. Statistical significance was tested at a significance level of $p < 0.05$.

Results

Table 1

Descriptive parameters for students' anthropometric measures and maximal oxygen

	N= 281						
	Mean	SD	Min	Max	Skew	Kurt	K-S test
Height-cm	167.31	6.74	150.00	189.00	0.32	0.00	p < .10
Weight-kg	61.53	11.45	41.00	135.50	2.32	10.01	**p < .01**
BMI	22.15	3.64	16.63	50.81	2.95	15.84	**p < .01**
Sub-scapular skinfold	15.72	6.61	5.80	46.00	1.25	2.21	**p < .01**
Triceps skinfold	21.06	6.41	8.40	50.00	0.97	2.16	p < .10
V02 max	28.80	6.08	18.50	50.80	0.72	0.21	p < .01

Table 1 shows the basic descriptive parameters for the studied sample of participants. It can be seen in that students' average body height is 167.31 cm and body weight 61.53 kg. BMI values are generally at comfortable levels of 22.15, placing them in the group of normal weight adults according to the standards of the International Classifications (WHO, 1997). The values of skinfolds are in accordance with the norms (Mišigoj-Duraković, 2008). Results of maximum oxygen consumption (VO2 max) with the value of 28.80 ml/kg/min show a poor level (The Physical Fitness Specialist Certification Manual, 1998).

Table 2

Results of the Kruskal Wallis test for determining the difference between subsamples defined by the degree of nutritional status (p <0.05)

	Underweight 4%	Normal weight 81%	Overweight 10%	Obese 4%	Kruskal-Wallis test	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	H	P
Height-cm	164.29±4.87	167.47±6.82	166.12±5.81	170.29±8.06	4.467	0.21
Weight-kg	47.32±3.08	59.03±6.35	73.03±6.77	98.80±17.82	108.475	**0.00**
BMI	17.61±0.54	21.22±1.58	26.67±1.14	34.53±6.18	127.827	**0.00**
Sub-scapular skinfold	12.87±4.40	14.60±5.60	20.54±5.97	29.35±8.76	47.314	**0.00**
Triceps skinfold	16.02±3.95	20.07±5.43	26.01±4.13	34.07±10.14	54.216	**0.00**
V02 max	30.41±4.61	29.41±6.12	26.08±4.68	21.51±2.32	29.224	**0.00**

M-mean result; H= h- value; p= level of significance (p< 0.05)

Table 2 shows that 81% of the tested students had normal nutritional status, while 10% of students are in the group of overweight and 4% of students are in the group of obese students. On the other hand, 4% of students belong to an underweight group. The arithmetic means of

subsamples according to the level of nutritional status are also given in Table 2. It is obvious that the students who belong to the group of obese are over 6 and 3 cm higher than underweight and normal weight students respectively. Another obvious difference is evident in body mass where the normal weight students have 40 kilograms less than obese students. Also, nominal differences in both skinfolds are also evident, with overweight and obese students having almost twice as bigger skinfold than underweight and normal weight students. Aerobic capacity results were lower in students with increased body mass, although it is evident that all four sub-samples have a very low level of aerobic capacity.

Kruskal Wallis test results for determining the difference between subsamples according to the level of nutritional status among 1st and 2nd year students of the Faculty of Teacher Education show that the subsamples differ in four of the five variables that describe students' morphological characteristics. Significant differences between subsamples defined according to the level of nutritional status appear in the variables body weight, BMI, sub-scapular skinfold and triceps skinfold (p=0.00). Also, significant differences appear in the variables for estimating the maximum oxygen consumption (p=0.00).

Table 3

Post hoc for the variable "body weight" according to the level of nutritional status

Body weight	Underweight	Normal weight	Overweight	Obese
Underweight				
Normal weight	0.00			
Overweight	0.00	0.00		
Obese	0.00	0.00	1.00	

Table 4

Post hoc for the variable "BMI" according to the level of nutritional status

BMI	Underweight	Normal weight	Overweight	Obese
Underweight				
Normal weight	0.00			
Overweight	0.00	0.00		
Obese	0.00	0.00	1.00	

Table 5

Post hoc for the variable "sub-scapular skinfold" according to the level of nutritional status

Sub-scapular skinfold	Underweight	Normal weight	Overweight	Obese
Underweight				
Normal weight	1.00			
Overweight	0.00	0.00		
Obese	0.00	0.00	0.40	

Table 6
Post hoc for the variable "triceps skinfold" according to the level of nutritional status

Triceps skinfold	Underweight	Normal weight	Overweight	Obese
Underweight				
Normal weight	0.09			
Overweight	0.00	0.00		
Obese	0.00	0.00	1.00	

Table 7
Post hoc for the variable "VO2 max" according to the level of nutritional status

V02 max	Underweight	Normal weight	Overweight	Obese
Underweight				
Normal weight	1.00			
Overweight	0.09	0.02		
Obese	0.00	0.00	0.10	

Results of post-hoc test (multiple comparisons for all groups (Siegel & Castellan, 1988)) for determining the difference between the groups according to the level of nutritional status) are shown in Tables 3-7. It was determined that for the variable *body weight* students of normal weight and those who are underweight (p=0.00) have lower body weight than students who are overweight or obese. Identical differences appear with variable *BMI*. With variables for estimating both *skinfolds*, the differences are not observed between underweight and normal weight students, or between obese and overweight students. The differences are, however, apparent between students of normal weight (p=0.00) and obese and those who are overweight. For the variable *VO2 max* it can be seen that students of normal weight had significantly better results (p=0.00) than students who are obese or overweight. Likewise, no significant differences were observed between obese and overweight students (p=0.10).

Discussion

The aim of this study was to determine the differences in aerobic capacity among students with regard to their level of nutritional status, which was determined by BMI according to WHO classification (1998). Mean value of BMI (22.15) places students into the group of normal weight. Similar results were obtained with participants from Saudi Arabia whose mean BMI value was 22.9 (El-Qudah, Al-Omran, Abu-Alsoud, & Al-Shek Yousef, 2012), but 17.6% of students from Saudi Arabia were underweight, 20.3% were overweight and 6.7% obese. In this research 10% of students from Zagreb belong to the group of overweight and 4% to the group of obese and underweight. Abdull, Muniandy, and Ajan (2012) showed in their research that 10% of students from Malaysia were overweight and 17.8% were underweight. In the research by Farreda, Hussein, and Helmy (2012), 29.5% participants from Kuwait were overweight and 12.8% were obese. It can be concluded that students from Zagreb have much better nutritional status than students from the reported studies.

Mean value of VO2 max of students in this research was 28.8 ml/kg/min which is a poor result. Better results in aerobic capacity (37.85 ml/kg/min) were achieved by students from India

(Nabi et al, 2015) as well as students from Libya (44.8 ml/kg/min) and Malaysia (45.5 ml/kg/min) (Razak, Maizi, & Muhamad, 2013). Students in the research by Pribis, Burtnack, McKenzie, and Thayer (2010) had higher BMI (24), body weight (65.6 kg) and better VO2 max (43.2 ml/kg/min) than students from Zagreb.

Even though students' aerobic capacity is poor, significant differences between groups according to nutritional status were obtained. That is, students who are underweight and normal weight have better aerobic capacity than overweight and obese students. Similar results were obtained in other studies, i.e. non-obese students had higher VO2 max values than the obese (Nabi et al, 2015; Chouhan, Trigotra, Dashora, & Mangat, 2014).

Although there was significant difference in VO2 max according to nutritional status, Moraes Ferrari, Bracco, Matsudo, & Fisberg (2013) have proven in their longitudinal study that a decline in VO2 max is greater in normal weight individuals than in those who are overweight.

Limitations of this research are reflected in the sample, which represents only one faculty and therefore the results of this study cannot be generalized to the entire population. In some future field research with students of this age it is necessary to sample participants from several faculties. Also, the obtained conclusions of this study may be useful in future studies of aerobic capacity in young people.

Conclusion

The results obtained in this study show that the increased body mass has extremely high impact on the aerobic capacity results. Students who have an increased body mass index have a lower aerobic capacity. Daily physical exercise, especially the exercise in the aerobic mode, may contribute to progress in the development of aerobic capacity of young people.

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