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# The Correlation between Body Composition and Physical Fitness Parameters in High Theological School Students

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**Abstract**

Previous research findings support the claim that physical activity (PA) and maturation result in changes in physical fitness (PF) and body composition (BC) parameters. Fitness assessment tests are especially important for monitoring the health of adolescents. The purpose of this study was to find the correlation between BC and PF parameters in studnts enrolled in High Theological School in Niš. Thirty-seven male students living in boarding schools were included in the participant sample. The average age of the participants was 17.48±1.48 years. The body composition analyser Omron BF 511 (Omron, Tokyo, Japan), was used to measure the BC values. A modified Eufitmos testing protocol was determined to evaluate PF parameters such as: Progressive aerobic cardiovascular endurance run (Pacer), 1-Mile run (1MR), Push-ups (PU), Handgrip (HG), Standing broad jump (SBJ), 20-Meter run (20mR), Back-saver sit and reach (BSR), and Body mass index (BMI). The results showed that the weight status parameters were highly correlated with each other. Regarding PF parameters, they correlated moderately with each other. The correlation analysis between BC and PF parameters showed that BMI, Fat%, and Muscle% achieved moderate correlations with PACER, VO2max, PU, SBJ, and 20mR, while BW had a significant correlation only with HG and PU. Also, BH had a moderate correlation with VO2max, PACER, SBJ, and HG. The findings indicate a correlation between body composition and physical fitness parameters among theology students. However, a suggestion for further research is to conduct multiple regression analysis, which would reveal the relationship between the overall body composition composite and the fitness of the students, rather than just individually determined parameters.

***Keywords:*** *physical fitness, anthropometric characteristics, adolescents, Eufitmos testing protocol*

## Introduction

As an important health indicator, physical fitness (PF) is a set of measures that demonstrate how effectively the body can carry out exercises and physical activities (PA) (Oja & Pixsööt, 2022). PA is defined by the World Health Organization (WHO, 2020) as any movement of the body caused by the activation of skeletal muscles, including the expenditure of energy and being able to be performed at different intensities. PF is a term used to describe an assortment of characteristics that people have or develop throughout their lives that are associated with their capacity for exercise and PA. It indicates an integrated measurement of the body systems and functions that are engaged in their performance (Kolb et al., 2021; Landry & Driscoll, 2012; Ortega, Ruiz, Castillo, & Sjöström, 2008; WHO, 2020). An assortment of motor abilities, including muscle strength and endurance, movement speed, agility, joint flexibility, coordination, and balance, are included in this concept. A few authors also incorporate body composition (BC) as another aspect of PF (Ortega, Ruiz, & Castillo, 2013). Anthropometric characteristics, including body mass index (BMI) and BC, have an impact on the PF parameters that are associated with health (Hyska, Mersini, Mone, & Burazeri, 2014; Rakic, Bozic-Krstic, & Pavlica, 2011).

The findings of earlier research support the idea that changes

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in BC and PF indices are also caused by the maturing process (Malina, 2005). Country-specific epidemiological data on BC, the prevalence of overweight or underweight, and PF parameters are essential for creating public health policies that work and apply to practice for PA (Ried-Larsen, Grøntved, Kristensen, Froberg, & Andersen, 2015). Body fluids, bones, muscle, and adipose tissue are the basic components of BC. The distribution of muscle and fat mass within the body can be assessed and understood with the aid of this information (Heymsfield & Waki, 1991). PA is the most effective strategy to prevent overweight and obesity in children and adolescents (Hills, Okely, & Baur, 2010).

Standardized test batteries can be used to reliably measure PF parameters in children and adolescents. There are currently over fifteen test groups available worldwide to evaluate PF parameters (Cvejic, Pejovic, & Ostojic, 2013). The test batteries that are most frequently used are Unifittest, FitnessGram, and Eurofit (Bruggeman et al., 2020; Mekota & Kovar, 1995; Pluim & Gard, 2018). The goal of the European Fitness Monitoring System (EUFITMOS) is to create a system across Europe for measuring adolescents' physical fitness. The authors found an existing test battery used in the EUFITMOS project to assess physical fitness based on a review of all prior research (Marques et al., 2021). The tests that were chosen were: Progressive aerobic cardiovascular endurance run (Pacer), 1-Mile run (1MR), Push-ups (PU), Handgrip (HG), Standing broad jump (SBJ), 20-meter run (20mR), Back-saver sit and reach (BSR), and Body mass index (BMI).

Although some studies have examined the relationship between BC and PF among students (Ivanyshyn et al., 2021; Ortega et al., 2007; Yohannes, Östenberg, & Alricsson, 2020), they have used only one parameter of weight status in relation to certain PF parameters. Additionally, to our knowledge, there are no studies that have examined this relationship among theology students. In this regard, our study includes multiple BC parameters, as well as a complete battery of PF tests to assess the fitness status of the participants. Therefore, the study aims to explore the correlation between physical fitness parameters and body composition in adolescents participating in the High Theological School.

## Methods

*Sample Participants*

Thirty-seven male students from the High Theological School in Niš, Serbia made up the sample of participants. The average age of the male participants was 17.48±1.48 years. The exclusion criteria were: the participants' or parents' lack of consent to participate in the research; missing one measurement session; lower extremity injuries excluding physical activity; poor health; diagnosed chronic or noncomunicable diseases; incorrectly performed physical fitness tests; and abandonment from conducting tests during the research. Every adult participant has read the informed consent, understood the aim of the research, given written consent to take part, and is free to terminate participation at any moment without facing negative consequences. Consent was signed by parents or legal guardians for underage participants. Participants had to fulfill certain criteria to be included in the research: they had to be in good general health and not have any long-term medical conditions that might interfere with their ability to participate in all anthropometric and motor assessments at the scheduled times. The study took place at the Faculty of Sports and Physical Education in Niš. The research was conducted in accordance with the Declaration of Helsinki, and the protocol received approval from the Ethics Committee of the Faculty (Approval Document No. 04-504/2).

*Study procedure*

The researchers received instructions on how to conduct physical fitness tests correctly, code data, and maintain test results confidential. They prepared all the required equipment before the measurements started. The study was carried out in the Faculty of Sport and Physical Education hall between 2 and 4 p.m. The researchers consciously and voluntarily decided to take part in the study. The study's goal and the confidentiality of the results were explained to participants, their parents, the school administration, and the teachers. Teachers and the school administration were always consulted while organizing the planned measurements.

## Measurements

*Body composition*

Trained evaluators conducted anthropometric measurements. All participants received instructions to avoid food or liquids for three hours before the measures, starting on the day of the appointment. The Martin Anthropometer was used to measure participants' body height (BH) with 0.5 cm precision. The Omron BF 511 device (Omron, Tokyo, Japan), which offered information on body weight (BW), percentage of body fat (Fat%), and percentage of muscle (Muscle%), was used to measure body composition parameters. Body Mass Index (BMI) is calculated using the following formula: BMI=BW(kg)/BH(m)2.

*Physical fitness parameters*

A modified EUFITMOS protocol (Marques et al., 2021) for evaluating PF parameters was chosen for this research, taking into account the participant sample. Pacer, HG, PU, SBJ, 20mR, BSR, and BMI were the tests that were selected. EUFITMOS was proposed by authors from six different countries, creating a test battery from valid motor tests that cover the entire physical fitness of a person. Thus, a reliable and valid test for measuring cardiorespiratory fitness is the Pacer (Meredith & Welk, 2010). The maximal oxygen consumption (VO2max) is then calculated from the lap count that was recorded (Saint-Maurice, Welk, Finn & Kaj, 2015). To evaluate resistance and strength in the upper body, a PU test is used (Baumgartner, Oh, Chung & Hales, 2002). The valid measure of maximum isometric strength is HG (Wind, Takken, Helders, & Engelbert, 2010). According to España-Romero et al. (2010), HG has acceptable reliability despite differences in dynamometer brands. A valid field-based test to assess lower-body muscular power is the SBJ (Fernandez-Santos, Ruiz, Cohen, Gonzalez-Montesinos & Castro-Piñero, 2015). For measuring linear speed, 20mR is used. BSR has low validity for lumbar flexibility but moderate validity for hamstring flexibility (Mayorga-Vega, Merino-Marban & Viciana, 2014).

*Statistical data analysis*

To determine whether the data distribution was normal, the Kolmogorov-Smirnov test (K-S test) was used. The data are presented as mean values with a standard deviation (SD). To determine the relationship between BC variables and PF, the Pearson correlation coefficient was used with correlation intensity ranging from 0.01 to 0.39 (weak), 0.4 to 0.69 (moderate), and 0.7 to 1.0 (strong). For the statistical analysis, SPSS software version 21 (IBM, Chicago, IL, USA) was used, with a significance level of p=0.05.

## Results

The results of the descriptive statistics used to measure the characteristics of BC are shown in Table 1. The average BH is 179.35±7.36 cm, and BW is 83.70±17.92 kg. The BMI average was very high (26.05±5.52). The results of the descriptive statistics for the assessment of PF measures are also included in the same table.

The K-S test indicated that all variables have a normal distribution at a significance level of $p<0.05$. Therefore, the Pearson correlation coefficient was used to determine the associations.

When it comes to anthropometric characteristics (table 2), all parameters were highly intercorrelated (.797-.971), except for BH, which had a low correlation with other anthropometric parameters.

**Table 1.** Descriptive Statistics Results

| Variables | Mean | SD | Min | Max | Skew | Kurt | K-S | p |
|---|---|---|---|---|---|---|---|---|
| BH | 179.35 | 7.36 | 161.00 | 192.00 | -.210 | -.181 | .615 | .844 |
| BW | 83.70 | 17.92 | 61.00 | 132.30 | .788 | .001 | .829 | .498 |
| BMI | 26.05 | 5.52 | 18.20 | 41.30 | .737 | .153 | .730 | .661 |
| Fat% | 22.90 | 9.45 | 5.80 | 39.30 | -.021 | -1.018 | .558 | .914 |
| Muscle% | 38.31 | 4.81 | 29.70 | 46.60 | -.001 | -.968 | .618 | .840 |
| Pacer | 4.81 | 1.81 | 2 | 9 | .239 | -.730 | 1.010 | .259 |
| VO2max | 30.42 | 6.19 | 20.40 | 44.90 | .250 | -.559 | .672 | .757 |
| PU | 12.86 | 8.54 | 0 | 38 | 1.020 | 1.197 | .855 | .458 |
| HG | 408.57 | 84.02 | 228 | 566 | .194 | -.676 | .794 | .554 |
| SBJ | 181.00 | 26.69 | 118 | 238 | -.106 | -.336 | .644 | .801 |
| 20mR | 3.80 | .311 | 3.25 | 4.45 | .430 | -.418 | .480 | .975 |
| Back saver | 26.65 | 9.47 | 0 | 47 | -.474 | 1.323 | .727 | .666 |

Note. BH-Body height; BW-Body weight; BMI-Body mass index; Fat%-Percentage of body fat; Muscle%-percentage of muscle; Pacer-Progressive aerobic cardiovascular endurance run; VO2max-maximal oxygen consumption; PU-Resistance and strength in the upper body; HG-Maximum isometric strength; SBJ-Lower-body muscular power; 20mR-Linear speed test; BSR-Back-saver sit and reach

**Table 2.** Correlations Between Body Composition Variables And Physical Fitness

| Variables | BH | BW | BMI | Fat% | Muscle% | Pacer | $VO_2$ max | PU | HG | SBJ | 20mR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BW | .220 | | | | | | | | | | |
| | .191 | | | | | | | | | | |
| BMI | -.177 | .919** | | | | | | | | | |
| | .295 | .000 | | | | | | | | | |
| Fat% | -.300 | .797** | .923** | | | | | | | | |
| | .071 | .000 | .000 | | | | | | | | |
| Muscle% | .225 | -.810** | -.904** | -.971** | | | | | | | |
| | .180 | .000 | .000 | .000 | | | | | | | |
| Pacer | .402* | -.296 | -.458** | -.571** | .549** | | | | | | |
| | .014 | .076 | .004 | .000 | .000 | | | | | | |
| $VO_2$max | .397* | -.308 | -.470** | -.580** | .548** | .990** | | | | | |
| | .015 | .064 | .003 | .000 | .000 | .000 | | | | | |
| PU | .269 | -.477** | -.584** | -.687** | .688** | .693** | .713** | | | | |
| | .108 | .003 | .000 | .000 | .000 | .000 | .000 | | | | |
| HGP | .636** | .361* | .101 | -.023 | .027 | .312 | .315 | .076 | | | |
| | .000 | .028 | .551 | .893 | .874 | .060 | .058 | .654 | | | |
| SBJ | .564** | .002 | -.226 | -411* | .399* | .668** | .666** | .501** | .588** | | |
| | .000 | .992 | .178 | .012 | .015 | .000 | .000 | .002 | .000 | | |
| 20mR | -.309 | .215 | .355* | .483** | -.482** | -.680** | -.670** | -.453** | -.385* | -.649** | |
| | .063 | .201 | .031 | .002 | .003 | .000 | .000 | .005 | .018 | .000 | |
| BSR | .259 | .141 | .020 | -.006 | -.044 | .087 | .076 | .015 | .288 | .339* | -.257 |
| | .122 | .405 | .908 | .973 | .794 | .609 | .655 | .932 | .084 | .040 | .125 |

Note: BH-Body height; BW-Body weight; BMI-Body mass index; Fat%-Percentage of body fat; Muscle%-percentage of muscle; Pacer-Progressive aerobic cardiovascular endurance run; VO2max-maximal oxygen consumption; PU-Resistance and strength in the upper body; HG-Maximum isometric strength; SBJ-lower-body muscular power; 20mR-linear speed test; BSR-Back-saver sit and reach; *-Correlation is significant at the 0.05 level (2-tailed); **-Correlation is significant at the 0.01 level (2-tailed).

The correlation analysis between physical fitness parameters showed that PACER and VO2 max were highly correlated with each other, as well as with the tests SBJ, 20mR, and PU. There was a moderate correlation between PU, HG, SBJ, and 20mR, while BSR had a weak correlation with the PF tests.

Regarding the relationship between body composition parameters and physical fitness (table 2), BH achieved a moderate correlation with VO2max, PACER, SBJ, and HG, with weak correlations for the rest. BW had a significant correlation only with HG and PU. While BMI, Fat%, and Muscle% achieved moderate correlations with PACER, VO2max, PU, SBJ, and 20mR.

## Discussion

This is the first study of its kind that has been carried out among Serbian theological high school students, as far as we are informed. Main findings of the study are: a) All anthropometric parameters, except for BH, were highly intercorrelated; b) The correlation analysis between physical fitness parameters showed that PACER and VO2max were highly correlated with each other, as well as with the tests SBJ, 20mR, and PU. There was a moderate correlation between PU, HG, SBJ, and 20mR; c) BMI, Fat%, and Muscle% achieved moderate correlations with PACER, VO2max, PU, SBJ, and 20mR, while BW had a significant correlation only with HG and PU. BH had a moderate correlation with VO2max, PACER, SBJ, and HG; d) The students had high average BMI values of over 25 and are classified as overweight.

Since there isn't much information in the literature about using the Eufitmos test battery on a sample of adolescents, the outcomes were compared to test batteries that are more widely used, including the Fitnessgram, EuroFit, or their modifications. Eufitmos is regarded as valid, reliable, relevant, health-related, and specially designed for adolescents (Marques et al., 2021). Our outcomes can be contrasted with those of adolescent participants from seven European countries who completed the Eufitmos assessment battery and submitted information for 2022 (Marques et al., 2024). The methodology used in our research, has been applied in several studies (Marques et al., 2021; Marques et al., 2024; Masanovic et al., 2020).

In this study, a high mutual correlation between anthropometric parameters was established, consistent with previous studies that examined the correlation, especially of weight status parameters, which showed high intercorrelation (Katanic et al., 2023; Kavak, Pilmane, & Kazoka, 2014; Ranasinghe et al., 2013). This is expected since these parameters are used to assess weight status and obesity prevalence in adolescents (Kavak et al., 2014).

When it comes to the interrelationship of PF parameters, our results show a moderate mutual correlation. These findings are in line with previous findings that have generally confirmed a moderate correlation between fitness parameters (Batez et al., 2021). This is somewhat understandable since the given parameters are selected to assess the same component of PF.

Our research findings are consistent with evidence from other studies showing that PF is impacted by BW (Huotari, Nupponen, Laakso, & Kujala, 2009; Johansson Brissman, Morinder, Westerståhl & Marcus, 2020). As evidenced by trends in China (Bi, Zhang, Gu, Song, & Cai, 2020), Sweden (Westerstahl, Barnekow-Bergkvist, Hedberg, & Jansson, 2003), and New Zealand (Albon, Hamlin, & Ross, 2008), increased BW also related to higher values of BMI. Moreover, our study's outcomes align with those of Yohannes et al. (2020), which found a relationship between a sample of Swedish adolescents' PF measures and their BMI. Mak et al. (2010) suggest that results should be interpreted carefully because lifting a larger BMI may need more energy in people who are obese or have extra BW. BMI and Fat% negatively correlate with parameters PACER and VO2max, which are direct indicators of cardiorespiratory endurance. These findings are consistent with previous studies (Ivanyshyn et al., 2021; Ortega et al., 2007), which also found a negative association between BMI, BW, and Fat% with measured cardiorespiratory fitness.

This understanding supports previous research (Chen, Cui, Zhang, & Peng, 2020; Huang & Malina, 2010) and our study's findings, indicating adolescents with normal weights typically have greater levels of PF than those who are overweight or obese. Some authors have evaluated PF parameters related to strength and flexibility (Chen et al., 2020; Joshi, Bryan & Howat, 2012; Zar, Karan, & Ahmadi, 2017). Consistent with our research findings, these studies have also determined that individuals of normal weight perform better in endurance tests as well as strength and flexibility tests. In adolescents between the ages of 12 and 18, a nonlinear association was found between BMI and the outcomes of PF tests in the study by authors Dewi, Rimawati and Purbodjati (2021). They confirmed that obese or underweight participants performed worse on PF tests than participants whith normal nutritional state. Conversely, in healthy adolescents, developing more muscle mass has a significant impact on improving PF. Furthermore, these results generally correspond with the results of our study. A study conducted in our region (Leskošek, Strel & Kovač, 2007) looked at the morphological characteristics and motor abilities of students from different high schools who were 16, 17, and 18 years old. The authors concluded that most variables get better with age. Similar outcomes were seen in the study conducted by Glavač et al. (2015), which looked into variations in students' morphological characteristics and motor abilities over four years at a military high school. Although morphological parameters, or parameters of weight status, are generally observed for assessing obesity (Kavak et al., 2014), preference should be given to body composition analysis using precise measuring devices with defined measurement protocols for these purposes (Đorđević et al., 2024).

These results indicate the importance of promoting physical activity among students to increase their aerobic conditioning and physical fitness (Oforka et al., 2023). When compared to the recommended weekly level of 60 minutes of moderate to vigorous PA per day, five days a week, the level of PA among children and adolescents is not sufficient in many countries (WHO, 2020). Students in high theological schools require PA even when physical education PE sessions are not feasible to organize in practice. This is especially due to the specific conditions of boarding life. The Serbian church community has been significantly engaged in the matter of reforming theological education throughout the last two decades of the 20th century and the beginning of the 21st (Мићић, 2009; Сандо, 2012). Consequently, any prospective reform in the future must endorse the effort to include regular PE as a subject in high theological schools (Bogdanović, 2019). Studies of this nature aim to influence policies to promote physical activity and healthy lifestyles among children and adolescents (Peulić, Katanic, Jovanović, & Bjelica, 2024). Therefore, this should be just the first step in highlighting the significance of physical fitness for the population's health, calling for collective involvement in taking necessary further steps in that direction.

Practical implications suggest that these findings can be useful in designing appropriate interventions to curb the high rates of overweight and obesity and to improve PF test outcomes among adolescents, especially those who lack access to organized physical activity and live in tightly controlled environments.

Like any study, this one has certain limitations, primarily concerning the relatively small sample size. Additionally, guidelines for further research should thoroughly examine the body composition of the subjects and include the level of physical activity, which is an important parameter in this relationship. From a methodological standpoint, conducting multiple regression analyses would be beneficial to examine the relationship between entire body composition, PF, and PA, rather than just their individual parameters.

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**Conflict of interest**
The authors declare that there are no conflict of interest.

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