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Relation between Lifestyle and Body Composition among Young Females in Serbia of 18–29 Years of Age

Ćopić Nemanja, Đorđević-Nikić Marina, Rakić Slađana, Maksimović Miloš and Dopsaj Milivoj

Abstract

The aim of this study is to determine if certain lifestyle and habits influence the characteristics of body composition among young females in Serbia. The research included 248 randomly chosen females between 18 and 29 years of age. Data about physical activity were collected via validated questionnaire. In determining body composition, we relied on the instrument InBody 720, which enabled us to define the variables: body height (BH), body weight (BW), body fat mass percentage (BFM%), skeletal muscle mass percentage (SMM%), and visceral fat (VFA). In addition, we determined variables indexed for body height (BMI, FFMI, and FMI). On the basis of the results of regression analysis, we selected a mathematical model with the highest degree of prediction for body composition $(BSC) = -64.554 + (0.092 \times BW) + (-0.107 \times BMI) + (-1.001 \times FMI) + (1.353 \times SMM\%) + (-0.626 \times BFM\%) + (-0.079 \times VFA) + (4.894 \times FFMI)$. Our correspondents had normal BMI, above average % BFM, VFA—50.8 cm², FFMI in the range of normal and high and normal FMI. The score of physical activity (LSS) stood at the moderate level (9.29 ± 3.72) . LSS statistically correlated significantly with all tested variables of body composition, except with BW. The highest degree of correlation has been between LSS in relation to BFM% and SMM% (-0.408 and 0.461 , respectively).

Keywords: mathematical model, point score, questions, linear regression, index indicators

1. Introduction

Modern humans usually spend their free time with technical devices (car, computer, smartphone, remote controller, etc.) or passive entertainment such as watching television, surfing the Internet, all of which moves them away from daily activities requiring movement. Thereby, people progressively lose the need to move at all and be physically active. Be it workplace, fun or rest, contemporary humans, therefore, spend most of their time in an unhealthy environment. Such way of sedentary lifestyle faces each person with a number of risk factors, above all with hypokinesia [1]. It has been determined that most non-infectious diseases have

prevalence at either high level or constantly rising. Despite a growing advancement in the last 30 years, coronary diseases, or more precisely coronary artery disease, remains the number one cause of death in Serbia, equally present among both males and females alike [2, 3]. The lack of physical activity has been recognized as one of the main causes of these diseases, and is considered as the primary risk factor, alongside with smoking, high cholesterol, and high blood pressure (hypertension) [4].

Obesity figures as one of—if not the—consequence of such lifestyle/insufficient physical activity that represents a well-known cause of early death [5], hypertension, coronary heart disease, lower quality of life and sleeping problems [6], and the World Health Organization rightfully deals with it as a global epidemic [7]. Therefore, obesity has become one of the biggest public health problems in the world [8] and it could develop into the leading public health problem in this century [9]. Since obesity can be defined as an excessive body fat content, and overweight as an excess of body mass relative to height [10], it can be closely related to the estimation of body composition which is very important not only for the determination of nutritional status in health conditions and in disease [11], but also in various fields such as nutrition, medicine, and sports sciences [12, 13].

1.1 Contemporary lifestyle

The lifestyle of certain population groups, especially of young people, can lead to eating habits and insufficient physical activity that behave as risk factors in chronic diseases [14]. Modern societies then become characterized by the inactivity and sedentary lifestyle [15], which in turn gets reflected in the greatest amount of body fat, overweight, and obesity among the population, which are associated with a higher degree of risk of adverse health events and higher mortality [16, 17]. Young adults from 18 to 30 years of age are often in transition, graduating from high school, going to college, starting a new job, getting married, and forming a family. Often, these transitions are accompanied by potentially detrimental changes in lifestyle such as decreased physical activity, poor eating habits, increased alcohol consumption, and other unfavorable risk behaviors [18–20]. Nutrition and physical activity are of the utmost importance for health promotion. Eating habits and attitudes toward physical activity shape the lifestyle of an individual to the greatest extent, thus determining health, that is, the most common diseases of a modern man [21]. Regular physical activity has many health benefits for adults [22, 23]. But, surveillance data indicate that there is an age-related decline in physical activity and that females are less active than males [23, 24]. Only 16% of female participants of the National Health Interview Survey (NHIS) aged between 18 and 29 reported an adequate amount of vigorous physical activity [23]. Longitudinal data from young adults further attests to the decline in physical activity in this age group [25, 26]. A significant drop in physical activity and increased sedentary habits largely influence the relation between body composition factors.

1.2 Body composition

Body composition is the term that defines the phenomenon of the biological-material composition of the body, that is, the set of substances that constitute the materially manifest structure of the human body [27]. The macro-level composition of the human body is represented by four biologically measurable segments of matter:

- water, as liquid;
- the fat component, as the basic reserve of energy;
- the mineral component, as the solid body component; and,

- the protein component, as the basis for the contractile component responsible for locomotion, that is, movement [28].

In addition to these basic components of body composition, index indicators can be defined with the task of determining the relation between individual elements or even segmented relations between the same elements.

In existing research, the BMI has been presented as one of the crucial and basic parameters of obesity. The BMI presents the ratio of body high and body weight and is the simplest and most commonly used measure for determining body state of observed population and samples. Even though the BMI does not allow a detailed insight into the state and mutual relations of structural components such as the overall amount of fat or the distribution of fat in particular segments of the body, which can vary significantly within a normal values of body mass index [29], it has been shown that the values of this index had great influence on inflammatory and lipid markers (cardiovascular biomarkers) in a research that included a large number of women [30]. On the basis of results published by the Serbian Institute for Public Health, adult population in Serbia is among the highest worldwide by the number of persons and deaths from heart and blood vessels conditions, metabolic and malignant diseases, etc. [31, 32].

Owing to technological advancements, it is nowadays simple, fast, reliable, reproducible, and non-invasive to systematically follow morphological characteristic. Various methods are available to estimate or directly measure body composition. Measuring body composition with electric multichannel bioimpedance is a new generation technology that enables the direct measurement of the basic components of body composition. In addition to that, InBody 720 provides valid data in the simplest and non-invasive manner [27, 33].

Body fat, that is, the percentage of body fat, is the only component of body composition that has the tendency of increasing almost through entire lifespan [34, 35]. In addition to the biological influences related to aging [36], the change of the lifestyle of modern humans (reduced physical activity and increased energy intake) have caused an enormous increase of body fat to be one of the basic determinants of health or illness. As Gába et al. argue [37], the prevention of excessive gain in body mass-fat has become a public health priority in the developed countries, and in Serbia alike [38]. In contrast, the reduced muscle components of body composition are inevitable side effects of aging, whereby body mass remains the same or increases on the expense of fat [34, 39].

Besides the basic elements gained through a direct measurement of body composition, such as body fat, muscle mass, a very important scientific and medical role belongs to index indicators like muscle mass index and fat tissue index (SMM, FFMI, or FMI) [40].

Following the changes of body composition with different age groups is important not only for controlling the current status, but also for determining the trends of changes of the overall mass or particular parts of the given structure. At present, there is an increasing importance and need to systematically follow relevant indicators of body composition of sportspersons, persons exercising for recreational purposes or persons who do not exercise alike [41–43].

The aim of this article is to determine the influence of lifestyle and living habits to the characteristics of body composition among young females in Serbia. It is well-known that the habits one acquires from childhood to early adulthood are very important, since they present a fundamental personal foundation for a lifestyle one has in adulthood and maturity. Thus, this particular age group is a turning point for the final adoption of healthy or unhealthy life habits. Our secondary aim is defining a multidimensional model of dependence between body composition, lifestyle, and nutrition, which would enable programming of optimal patterns of behavior in both spaces, as a planned corrective measure.

2. Methodology

2.1 Subject samples

This research included 248 females aged 18–29. The group comprised professionals, students of the University of Belgrade, and secondary school students. The average age of young females was 24.40 ± 3.34 years. The research was conducted in accordance with the “Declaration of Helsinki for recommendations guiding physicians in biomedical research involving human subjects” [44] and with the permission of the Ethics Committee of the Faculty of Sport and Physical Education, University of Belgrade. Each subject was well informed about the purpose of the study, and all invitees agreed to participate.

2.2 Body composition measuring method

Body composition measurement was done by multisegmental bioelectrical impedance analysis (BIA). We relied on a professional measurement equipment—In Body 720 Tetrapolar 8-Point Tactile Electrode System (Biospace, Co., Ltd.) and DSM-BIA method (direct segmental multi-frequency bioelectrical impedance analysis). BIA is a widely used standard method for determining whole body composition and segmental lean mass measurements. InBody [45] body composition analyzer has high test-pretest reliability and accuracy (ICC 0.9995) [46]. Compared with DXA as a golden standard, the interclass correlation coefficient of BIA was between 0.96 and 0.99 in the normal-weight population [47]. All measurement had been performed between 2013 and 2016, in the morning hours. The procedure and course of analysis have been described in previous studies [33, 48].

2.3 Variables

We used a validated questionnaire [49] in order to collect data about lifestyle, living habits, and physical activity of young females. The participants were given five questions about their physical activity, with four close-ended answers to each question. Each response was validated from 0 to 3, which thus gave the maximum total score of 15. The higher scores indicated healthier behavior.

Questions:

- **do you exercise?** (0—never; 1—occasionally, 2—only seasonally; 3—regularly)
- **how often?** (0—never; 1—1–2 h per week, 2—3–4 h per week; 3—more than 4 h per week)
- **how do you spend your free time?** (0—watching TV, listening to music, using computer, reading books; 1—shopping, 2—walking; 3—practicing sport)
- **how much time do you spend behind a computer?** (0—over 6 h per day; 1—5–6 h per day, 2—2–4 h per day; 3—1–2 h per day)
- **how would you describe your daily lifestyle?** (0—too sedentary; 1—sedentary, 2—moderately active; 3—very active)

Body composition variables:

- **BH—body height**, expressed in cm;
- **BW—body weight**, expressed in kg;
- **BMI—body mass index**, expressed in kg/m^2 ;
- **BFM%—body fat mass percentage**, calculated as: $(\text{BW}/\text{BFM}) \times 100$, expressed in %;
- **SMM%—skeletal muscle mass percentage**, calculated as: $(\text{BW}/\text{SMM}) \times 100$, expressed in %;
- **VFA—visceral fat area**, expressed in cm^2 ;

Index:

- **FFMI—fat-free mass index**, presented as fat-free mass (FFM) relative to body size, calculated as: FFM/BH^2 , expressed in kg/m^2 ;
- **FMI—fat-mass index**, presented as Body Fat Mass (BFM) relative to body weight, calculated as: BFM/BH^2 , expressed in kg/m^2 ;

Point score:

- **BCS—body composition score**, a mathematical model with the highest degree of prediction has been selected on the basis of regression analysis (a more detailed description has been provided in Section 3);
- **LSS—lifestyle score**, representing the sum of points scored on the basis of the five questions, with the maximal sum of 15.

2.4 Statistical analyses

Basic descriptive statistical parameters were calculated for all results in order to define the basic measures of central tendency and level of data's dispersion (mean, SD, cV%, min, max, 95% confidence interval). The criteria variable for assessing multivariate body composition score was calculated by using factorial analysis and following statistical procedures. The relation between lifestyle and body composition variables has been determined by the Pearson's probability coefficient. The threshold of statistically significant statistical difference stood at 95% probability level, $p = 0.05$. All statistical procedures were carried out by the Microsoft® Office Excel 2007 and the SPSS for Windows, Release 17.0 (Copyright © SPSS Inc., 1989–2002).

3. Results

3.1 Results of descriptive statistics among young females

Table 1 provides the results of descriptive statistics of body composition.

Figure 1. provides the distribution of results of the correspondents' responses in relation to physical activities habits.

	Mean ± SD	%cV	Min.	Max.	95% confidence interval for mean	
					Lower bound	Upper bound
BH	169.89 ± 6.95	4.09	151.70	193.70	169.020	170.759
BW	64.44 ± 11.74	18.23	44.60	143.70	62.969	65.906
BMI	22.42 ± 4.00	17.85	17.40	48.63	21.922	22.924
BFM%	24.14 ± 8.69	36.00	5.90	55.28	23.057	25.231
SMM%	41.11 ± 4.58	11.13	24.80	50.70	40.555	41.700
VFA	51.83 ± 32.09	61.91	11.80	254.50	47.817	55.844
FFMI	16.45 ± 1.35	8.24	12.63	22.23	16.276	16.615
FMI	5.87 ± 3.28	55.91	1.93	26.40	5.463	6.284
LSS	9.29 ± 3.72	40.05	0	15	8.821	9.751
BCS	50.00 ± 16.67	33.33	−5.10	84.30	47.914	52.083

BH—body height; BW—body weight; BMI—body mass index; BFM—body fat mass; BFM%—body fat mass percentage; SMM—skeletal muscle mass; SMM%—skeletal muscle mass percentage; VFA—visceral fat area; FFMI—fat-free mass index; FMI—fat-mass index; LSS—lifestyle score; BCS—body composition score.

Table 1.
Basic descriptive indicators of body composition among young females.

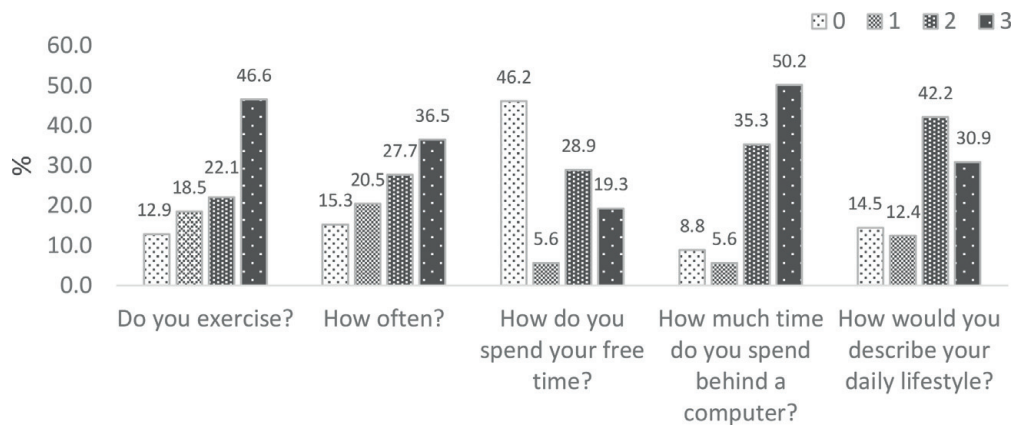


Figure 1.
Percentage of the responses given to each question from the questionnaire.

3.2 Results of regressive analysis among young females

On the basis of results gathered via multidimensional modeling and regressive analysis, we selected a mathematical model with the highest degree of prediction of the optimal model of our correspondents’ body composition. Within this model, *body composition score* (BCS) presents a criterion variable, while body composition variables (BW, BMI, FMI, SMM%, BFM%, VFA, FFMI) present the most discriminative variable of body composition that makes up a predictive part of the defined model.

Body composition score has been given quantitatively, that is, by a numerical value calculated in the following way: all body composition variables applied here were subjected to the factorial analysis, and on that basis a reduced set of singular variables that statistically best describe correspondents’ body composition has been selected. For each correspondent, BCS has been selected on the basis of specification equation that has the following form:

Body composition score (BCS) = −64.554 + (0.092 × BW)
+ (−0.107 × BMI) + (−1.001 × FMI) + (1.353 × SMM%)
+ (−0.626 × BFM%) + (−0.079 × VFA) + (4.894 × FFMI).

(1)

3.3 Results of correlation analysis among young females

Table 2 presents the results of Pearson’s coefficient of correlation between lifestyle in relation to body composition among young females.

Statistically, most prominent correlations were found between lifestyle score and body composition score ($r = 0.505$, $p < 0.01$), while the highest negative statistically relevant correlation was between the body fat mass percentage and lifestyle score ($r = 0.408^{**}$).

Figure 2 presents the relation between body composition score and lifestyle score, which is explained by applying the method of mathematical modeling. The change of trend of relation between body composition score and lifestyle score has been defined by the following ratio:

• $y = 2.26x + 28.99$

In relation to the model body composition score, we could claim that the intercept stood at 28.99, while the trend of change (curve inclination) was defined by the coefficient of regressive constant of 2.26. In other words, this means that the increase of lifestyle score by 1 point led to the increase in the value of body composition score by 2.26 points on average, that is, to its rise for as much as 2.3%.

On the basis of the value of determination coefficient ($R^2 = 0.255$), we conclude that 25.5% of the overall variability of body composition score results was determined by lifestyle score, that is, by the variability of an independent variable. The rest of variability of 74.5% has not been explained by the regression model, that is, it is influenced by other factors.

	Do you exercise?	How often?	How do you spend your free time?	How much time do you spend behind a computer?	How would you describe your daily lifestyle?	Lifestyle score
BW	−0.131*	−0.121	−0.071	−0.046	−0.117	−0.139*
BMI	−0.159*	−0.151*	−0.091	−0.036	−0.208**	−0.184**
BFM%	−0.311**	−0.322**	−0.209**	−0.204**	−0.395**	−0.408**
SMM%	0.353**	0.378**	0.252**	0.188**	0.451**	0.461**
VFA	−0.222**	−0.243**	−0.136*	−0.082	−0.306**	−0.281**
FFMI	0.144*	0.207**	0.163*	0.164**	0.174**	0.242**
FMI	−0.264**	−0.277**	−0.180**	−0.115	−0.324**	−0.331**
BCS	0.371**	0.416**	0.281**	0.235**	0.474**	0.505**

BW—body weight; BMI—body mass index; BFM%—body fat mass percentage; SMM%—skeletal muscle mass percentage; VFA—visceral fat area; FFMI—fat-free mass index; FMI—fat-mass index; BCS—body composition score.
* $p < 0.05$.
** $p < 0.01$.

Table 2.
Correlation between lifestyle and body composition among young females.

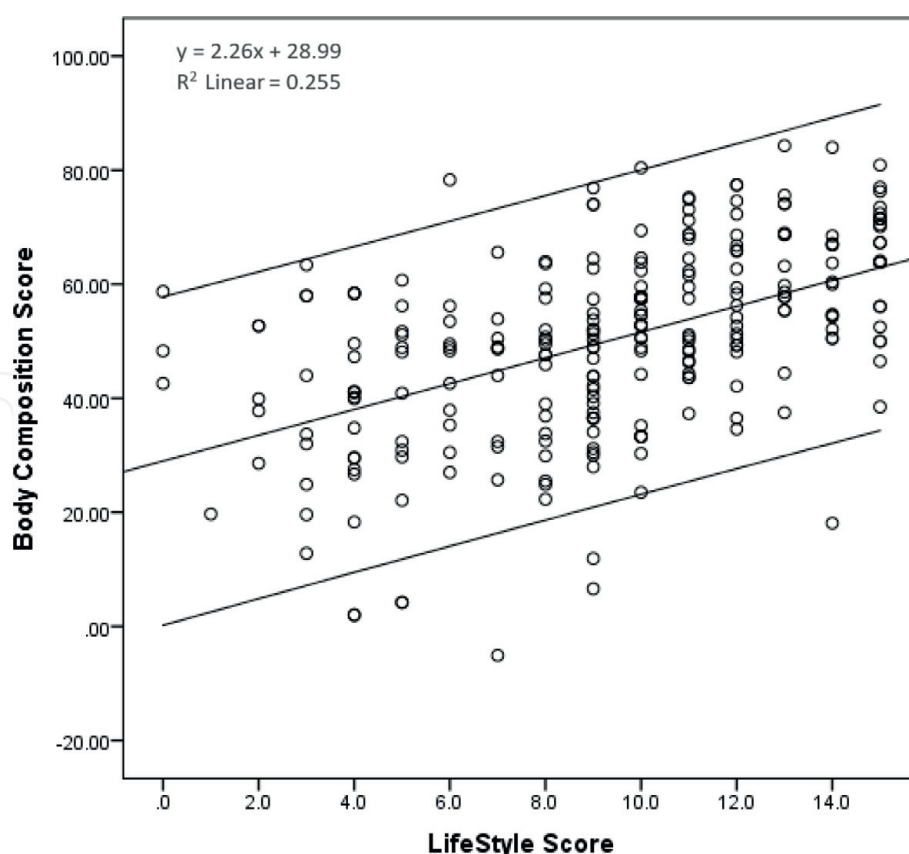


Figure 2.
Linear regression of body composition and lifestyle scores.

4. Discussion

Within this study, we aimed to explore the relationship between physical activity and body composition among young females. The results showed expected correlation. Specifically, most results (SMM%, BFM%, VFA, FMI, FFMI) showed statistically relevant correlation ($p > 0.001$) with lifestyle variables, with lifestyle score being a somewhat stronger predictor in comparison to other variables.

This cross sectional study determined the existence of correlation between physical activity and certain parameters of body composition, as well as of the constructed mathematical model of body composition score for young women.

Our correspondents had normal (some say optimal) weight according to BMI (22.42 kg/m^2). A large scale sample ($n = 1023$) of female students of the University of Belgrade aged 21.3 years on average, average BMI was 20.7 kg/m^2 [50]. This difference could be explained by the fact that our correspondence are not only older by 3 years on average, but also by the fact that our sample includes working women, women who gave birth in addition to students, which can influence their health habits related to physical activity, nutrition, etc.

According to cutoffs % fat Heyward [51], young women from our research belong to the category of above average fat occurrence, which is unfavorable considering the likely increase in body fat during aging, especially related to the menopause [52]. Gába and Přidalová [53] applied the same method of measuring body composition among Czech women of the same age group (18–30 years). The correspondents had lower values of all variables that have fat component, that is, BM, BMI, %BFM, and VFA. There is a clear correlation between excess body fat, which is a basic characteristic of obesity and increased mortality among different ethnic groups around the world. Yet, it is clinically relevant that obesity is heterogeneous, and there are individual differences in regional fat distribution, especially in

visceral adipose tissue [54]. There is a strong relation among visceral fats, metabolic syndrome, and the most common chronic non-infectious diseases of contemporary humans [55]. Enzi et al. [56] found that among lean or obese young women, subcutaneous abdominal fat dominates in relation to abdominal visceral fat, both measured by CT at the upper renal pole. There are no clearly defined standards for the visceral fat content. According to the measuring technique applied here, a VFA of 100 cm^2 [45] is considered as a risk, but this needs to be taken with caution as further studies are needed. Among our correspondents, the average value was $51.83 \pm 32.09 \text{ cm}^2$, while it was lower by 10 cm^2 in the study of Gába and Přidalová [53].

Fat-free mass index is the indicator indexed according to the body height (FFMI— kg/m^2) and is considered as not only a good indicator of the body composition of healthy, but also ill persons [57]. FFMI retains stable values among young and middle-aged women and men, and then drops after 74 years of age. Average FFMI value of our correspondents ($16.45 \pm 1.35 \text{ kg/m}^2$) corresponded to the values obtained by the research of Kyle et al. [57] (14.6 and 16.8 kg/m^2) and belonged to the category of normal and high values. According to these authors, BMI increase that comes with aging has been complemented with the increase in BF and FFM, and thereby with FFMI.

Fat-mass index (FMI) is significantly higher among sedentary than physically active men than women, and the difference rises with age [57]. Average FMI value of our correspondents ($5.87 \pm 3.28 \text{ kg/m}^2$) corresponded to the values obtained by the research of Kyle et al. [57] (3.9 – 8.1 kg/m^2) and belong to the category of normal.

4.1 Lifestyle

Out of the maximum score of 15 for physical activity, our correspondents had 9.29 ± 3.72 , which can be considered to be a moderate activity. Close to 50% of them said to be active over 4 h per week, which could be said to correspond to the recommendation of 30 min of exercising each day [58]. Still, only a third has been continuously active throughout the year, which is near to the percentage of those who described their lifestyle as very active. Half of the correspondents spend their free time in sedentary activities (using the phone, computer, watching TV, reading and the like).

With regard to the mathematical model, the results of the combined influences of individual variables of body composition showed that FFMI and SMM% (4.894 vs. 1.353) had the greatest influence on the point score of body composition, while $BW = 0.092$ had the lowest influence (please see the formula). Apparently, taken overall variability of the point score, the most influential to the optimal model of body composition were those variables that define fat-free muscle mass dependent on longitudinality (FFMI), or the percentage of muscle tissue in the organism independent of voluminosity (SMM%). As both cases apply to contractile components, that is, body components most responsible for motorical quality, that is, movement, the results clearly showed that fat-free body structure was the most sensitive body component for defining the optimal body composition within the defined optimal body model among young females from the investigated sample. In addition, the two abovementioned most sensitive variables of the model are body components that are directly developed by physical activity, regardless of that activity being endurance training or resistance or weight training. Thereby, it has been directly shown that young females were no different in relation to the occurrence of body fat in the body—as a variable directly linked to diet and sedentary lifestyle, but dominantly differed by the occurrence of contractile component—as a variable directly dependent of the amount of physical activity or exercising.

4.2 Correlation between lifestyle score and body composition score

Lifestyle score (LSS) in this research statically significantly correlated with all the tested variables of body composition, as well as with the calculated score of body composition (BCS), except with weight (**Table 2** and **Figure 2**). The correlation coefficient was the highest between LSS and BFM%, SMM%, and BCS ($r = -0.408, 0.461, \text{ and } 0.505$, respectively, **Table 2**). The vast amount of previous studies about the influence of various modalities of physical activity and exercising on BW, BMI, and the occurrence of body fat among females applied to overweight/obese women, which were either middle-aged or postmenopausal. Donnelly et al. [59] conducted a cognate research that included young, sedentary, overweight/obese women. As they persuasively showed, controlled exercising lasting 16 weeks showed significant effects on preserving the existing BW and reducing total and visceral fat among them in comparison to the physically inactive control group. An optimal exercising among women with sedentary habits, regardless of the modality (high or low intensity, aerobic, or resistance training) significantly reduces body fat [60–62]. The aerobic training was shown to be more effective than resistance training at improving visceral and liver fat and also abdominal subcutaneous fat among women and men of various age [62]. Therefore, the positive effect of aerobic exercising on reducing visceral fat among overweight/obesity subjects is connected with the improved insulin resistance and cardio-metabolic health [55, 63]. Even though our research did not involve the modality of physical activity practiced by young correspondence, the results showed statistically relevant correlation between their physical activity and VFA and FMI (**Table 2**).

Higher level of muscle mass in body composition significantly correlates with a number of health parameters [64]. It is also known that exercising, and especially resistance training, leads to an increase in muscle mass [60, 65]. Our research showed prominent correlation of SMM% with all variables of physical activity, in the first place with LSS ($r = 0.461, p < 0.05$) (**Table 2**).

Kyle et al. [57] found that physical activity increased FFMI by 0.32 kg/m^2 among men and women combined. In addition to that, the effect of age on FFMI was -0.007 kg/m^2 among physically active men and women. Our research confirmed significant correlation of physical activity and FFMI ($r = 0.242, p < 0.01$) by analyzing a general level of dependence between BCS, as an optimal modeled score of body composition, and LSS, as a score of lifestyle in relation to the level of physical activity and sedentary habits. On the basis of our results, it could be claimed that each standardized value, that is, each point more for improving lifestyle and physical activity, leads to increase in optimizing body composition of young females by 2 points, that is, it doubles (**Figure 2**).

5. Conclusions

This research set the task to investigate the correlation between lifestyle and body composition among young females. The results showed the existence of significantly relevant correlation among a large number of variables. This chiefly applies to the correlation between BFM% and SMM% in comparison with lifestyle score ($r = -0.408, p < 0.01; r = -0.461, p < 0.01$). As far as the relation between body composition and lifestyle point score is concerned, that correlation stood at the level of $r = 0.505, p < 0.05$. In addition, on a general level of correlation between BCS and LSS conducted by applying the method of mathematical modeling, it has been shown that the body score would rise by 2 points, that is, twice, if lifestyle score rises by 1 point. This is a clear evidence that a particular attention in further

research on these subjects should be given to people's lifestyle and habits, and that increase in physical activity and making it into a regular, daily part of one's lifestyle, brings serious health benefits and reduces several risks arising from the contemporary sedentary habits.

Acknowledgements

The chapter is a part of the project *Effects of applied physical activity on the locomotive, metabolic, psychosocial, and educational status of the population of Republic of Serbia*, number III47015, funded by the Ministry of Education and Science of the Republic of Serbia—Research Projects Cycle 2011–2016.

Author details

Ćopić Nemanja^{1*}, Đorđević-Nikić Marina², Rakić Slađana², Maksimović Miloš³ and Dopsaj Milivoj^{2,4}

1 Faculty of Sport, Belgrade, Serbia


2 Faculty of Sport and Physical Education, Belgrade, Serbia

3 Medical Faculty, Belgrade, Serbia

4 Institute of Sport, Tourism and Service, South Ural State University, Chelyabinsk, Russia

*Address all correspondence to: nemanjacopic@yahoo.com

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