Weight Status and Body Composition in Freshman Students at the College of Applied Sciences "Lavoslav Ruzicka" in Vukovar, From 2008 to 2016

Nebojša Nešić[1], Erna Davidović Cvetko[1], Vesna Šeper[1]

[1] Department for Health Studies, College of Applied Sciences Lavoslav Ruzicka in Vukovar, Vukovar, Croatia

Corresponding author: Erna Davidović Cvetko, MSc, PhD - erna.davidovic@gmail.com

Abstract

Aim: The aim of the study is to analyze the common occurrence of different weight categories among first-year students at Lavoslav Ruzicka College for Applied Sciences in the city of Vukovar, as well as to make an assessment of their body composition.

Methods: During the period from 2008 to 2016 there were 710 first-year students (461 women and 249 men) whose height and weight were measured, and body composition assessed, by bio-electric impedance analysis.

Results: Most of the subjects were of normal weight (74.5%), while the ratio between the weight status categories of men has proven to be significantly different from that of women. It was established that 8.9% of women as opposed to 2% of men were below normal weight, while there were more obese individuals among men (25.7%) than there were among women (15.4%). However, the percentage of obesity was similar in both sexes, being 5.4% in women and 5.2% in men. There was no significant difference in the ratio between the weight categories during the measurement period.

Conclusion: Most of the students at the College for Applied Sciences fall in the normal weight category. There are more obese individuals among men, while among women there are more of those with lower average body weight. The dominance of obesity and the overall ratio between the weight categories and the body composition in the category of first-year students have not changed significantly during the period between 2008 and 2016.

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Introduction

Morphological characteristics are often the subject of research due to the great impact they have on health and disease development. Obesity and fat accumulation are intertwined with hypertension, hyperlipidemia and hypercholesterolemia, as well as low levels of high-density cholesterol and hyperglycemia – all of which, among many other factors, are associated with cardiovascular problems (1). Of all the previously mentioned conditions, obesity has by far the most important influence on the quality of life (2,3).

In the USA, over one third of adults and around 17% of children are obese (4), while studies on European nations showed that around 17% of adults are obese, with some variations among countries (5). As for studies on students and younger adults, some data show that there are around 22% overweight students (6), while 50% of people aged 18-24 are subject to at least one risk factor for the development of cardiovascular diseases (7).

It has been proven that being overweight and obese during pregnancy are conditions which increase the risk for the child itself to become overweight or to develop obesity. On the other hand, girls who are overweight during their adolescence are more prone to gaining weight in pregnancy, demonstrating a vicious cycle (8).

The consequences of overweight and obesity not only affect overweight and obese persons, but society in global terms. The socioeconomic results of obesity include higher expenses for treating the diseases resulting from being obese (9-11). Finally, obesity greatly increases the risk of mortality (12,13). Therefore, preventive actions are very important, including education about diet, physical exercise and a healthy way of life.

Anthropometrical research conducted during the Croatian Adult Health Survey in 2003 (14) show that 58.5% of the adult population (over the age of 18) is overweight, whereas 20.4% is obese. Because of such widespread adult obesity, there are some predictions that by the year 2030 37%

of men and 48% of women will be obese—if the same trends towards increased obesity continue (14).

The aim of this research is to analyze the common occurrence of different weight categories among first-year students at the Lavoslav Ruzicka College of Applied Sciences in the city of Vukovar, and to assess their body constitution. Additional goals of the study are the following: (1) the analysis of the weight status and the body constitution of students who began their studies within this institution between 2008 and 2016 in order to determine if there have been some significant changes; and (2) the examination of occurring variations in the weight status and body composition between the sexes.

Methods and Materials

Study design

During the period from 2008 to 2016, 710 first year students (461 women and 249 men) volunteered to participate in the study. Every participant was measured once, during their first academic year. The average age at the time of the measurement was 19 (ranging from 18 to 26).

Measurements

The subjects' height was measured using standard techniques and equipment.

Weight and body composition were measured and assessed by bio-electric impedance analysis using the body composition analyzer GAIA 359 (Jawon Medical, Korea). This was performed in the morning hours after overnight fasting by a trained technician, following the device manufacturer's directions. Measurement results included weight, body fat mass (BFM), body fat percentage (BF%) and soft lean mass (SLM). The Body Mass Index (BMI) was calculated by the following equation: weight (in kilograms) divided by height (in square meters). WHR (Waist to Hip Ratio) was calculated by the following equation: waist circumference divided by hip circumference.

Weight status was defined following current recommendations from the WHO, according to which a BMI between 18.5 and 24.9 represents normal weight, lower values of BMI are considered being underweight, while a BMI over 25 is considered being overweight and a BMI of 30 or higher is considered obesity (15).

Statistical analysis

Statistical analysis was carried out using IBM SPSS statistics 22. Statistical significance was set at p<0.05. Since all variables failed in the Kolmogorov-Smirnov test of normal distribution, they are presented as median and 95% confidence interval (CI) for median. The ratio between the weight status categories between sexes and during the year of measurement was tested by the chi-square test. The Mann-Whitney U test was used for testing the differences in the values of measured variables between sexes. Spearman's coefficient of correlation was used to calculate the correlation between BF% and BMI, and between BF% and WHR.

Results

BMI and body composition, as well as WHR, for the total sample and by sex, are provided in Table 1. The difference between the sexes was statistically significant in all variables (Table 1). Men had a higher value of BMI compared to women, but the range of results for BMI in women was wider than in men, so that the highest BMI measured was as follows: For women, it was 44.1 kg/m2, and for men it was 36.3 kg/m2; the lowest measured BMI was similar for both sexes (Table 1). WHR was also higher in men than in women, but BF% showed that women have more fat content compared to men. The range of BF% showed that fat content in both sexes ranges from very low (4.3%) to over 37% for men and over 45% for women.

There was also a significant difference between sexes in the distribution along the weight status categories (p<0.0001). The difference between sexes in distribution along the weight status categories are shown in Figure 1. The highest predominance was in the category of normal

weight for both sexes, with around three quarters of participants (75.7% of women and 72.3% of men). In the underweight category, the women prevailed with 8.9%, whereas only 2%of men were in this category. A higher predominance of men compared to women was registered in the category of a BMI value over 25 (overweight and obese), with 25% of men vs. 15% of women. Since similar proportions of men and women were obese (5.4% of women and 5.2% of men), the difference in the proportion of subjects with a BMI higher than 25 is consequent to the predominance of overweight subjects rather than obese ones.

Distribution along the weight status categories through the years is presented in Figure 2. A chi-square test did not show any significant difference between the different measurement years (p=0.9). Distribution through the weight status categories was similar during the entire period of the study, with some small changes, mostly regarding the prevalence of terminal categories: category obese, and category underweight.

Secular trends for men and women in BMI, WHR and BF% are shown in Figures 3-5. While there were no significant differences during the years of measurements for any of the variables, distinctive differences between the sexes remained present throughout all the measurement years.

Spearman's correlation yielded a positive correlation of 0.532 (p<0.001) between BF% and BMI, and a positive correlation of 0.582 between BF% and WHR. When calculated separately by sex, the correlation between BF% and BMI for men was 0,803 (p<0.001), and for women 0.924 (p<0.001). The correlation between BF% and WHR for men was 0,983 (p<0.001) and for women 0.996 (p<0.001).

Discussion

The main finding of the present study is that the distribution across the weight status categories is significantly different between sexes (Table 2). Although there was a similar proportion for the subjects of both sexes of normal weight, there

are more overweight individuals among men, while among women there are more of those with lower average body weight. It has also been found that the prevalence of obesity among those overweighted is similar in both sexes (Table 2). The result of the similar prevalence of normal weighted among both sexes presented here complies with the results of other similar studies made throughout the student populations in India, Saudi Arabia and the USA, with the exception of the published results in listed countries showing lower portions of subjects of normal weight in their samples (16-18). The portion of subjects with normal weight was around 20% lower than in the present study. A higher prevalence of underweight women as opposed to men was also reported in the study made by Zhang et al. (19) and Sira and Pavlak (18). These results are similar to the results of studies performed at some other high schools or universities (16, 17,20). Kritsotakis et al. (21) also reported lower values of BMI in women than in men. In the paper published by Kantanista et al. (22), the authors concluded that under weighted adolescent girls are more satisfied with their body than those who are of normal weight and/or overweight. Yatsuya et al. (23) reported a higher prevalence of obesity in men than in women in Europe, which complies with the results of our study. In their study, the prevalence of obesity was assessed in different world regions, and the second highest rate was noted in Europe. The results of research done in India (16), Saudi Arabia (17), USA (18) and Brazil (20) show the prevalence of obese individuals among students of different races and ethnicities of about 6-15%, while the study of prevalence of obesity in 22 developing countries reached results similar to our study, which are 5-6% (24). Great differences in the prevalence of obesity throughout Europe were reported in comparisons made by Borsika et al.(25). They reported that the highest obesity prevalence is present in Hungary (19.5%), the Russian Federation (15.2%) and Romania (14.7%), while the lowest obesity rates are in Norway (6.2%), France (7%) and Italy (7%). Similar results were reported in the study by Van Viet Ostapchouk et al. (5). From the study by Fišter et al. (26), it could be concluded that the number of obese individuals

rises later in life, while according to Musić Milanović et al. (27) the critical years when people are starting to become obese are up to 35, when most changes from overweight to obesity are indeed recorded. Huang et al. (28) reported obesity prevalence rates at the University of Kansas to be similar to those in our results. However, some recent studies reported lower proportions of obesity among university students in Croatia of up to 3% (29-31). Similar reports of overweight/obesity predominance from neighboring countries (32-34) showed that there are great variations between and within the countries of our region: At the University of Novi Sad overweight rates reported are 33.5% in men and 7.5% in women (32), while at the University of Niš overweight prevalence is 38.18% in men and 7.95% in women (33). Rašeta et al. reported 22.4% of overweight students at the University of Banja Luka (34). It would be interesting, in our opinion, to compare the weight status and body composition of students of medical science and kinesiology as opposed to those who study social or natural sciences. Since medical students and students of kinesiology should be more aware of the risks and potential dangers of unhealthy weight, it would be interesting to see if their weight status is different in comparison to others. Something similar was done by Rašeta et al. at the University of Banja Luka (34), where obesity rates among students of three different faculties were compared: the Faculty of Physical Education and Sport, the Faculty of Economics and the Faculty of Medicine. Results showed that the students of the Faculty of Economics had the highest value of BMI and BF%, while the medical students had the highest WHR.

Other very important values for weight status assessment are WHR and BF%, which are considered more accurate measurements of body weight type and body composition than BMI, because BMI cannot distinguish between weight associated with fat and weight associated with fat-free mass (35). Most of the subjects in the present study had values of WHR and BF% within the recommended ranges for health maintenance (Figures 4 and 5). Since those measures are predictive factors for

Table 1. *Descriptive statistics.*

	Total (N=710)		Women (N=461)		Men (N=249)		
	Median (95% CI)	Min-Max	Median (95% CI)	Min-Max	Median (95% CI)	Min-Max	P*
BMI (kg/m2)	22.10 (21.9-22.5)	15.9-44.1	21.5 (21.1-21.8)	15.9-44.1	23.4 (22.9-23.9)	16.3-36.3	<0.0001
WHR	0.75 (0.74-0.76)	0.64-0.98	0.73 (0.72-0.74)	0.66-0.95	0.78 (0.78-0.80)	0.64-0.98	<0.0001
BF%	22.7 (22.2-23.5)	4.3-45.4	25.1 (24.5-25.7)	4.3-45.4	17.4 (16.5-18.4)	4.3-37.0	<0.0001

P* - p value obtained by performing Mann-Whitney test for difference between sexes
BMI - body mass index; WHR - waist to hip ratio; BF% - body fat percentage

Figure 1. *Difference between sexes in distribution along the weight status categories. Absolute frequencies in each category are presented below the graph. Chi-square test showed significant difference between men and women (p<0.0001)*

Figure 2. *Distribution along the weight status categories through the years. Absolute frequencies in categories are presented below the graph. Chi-square test did not show any significant difference between the different measurement years (p=0.9)*
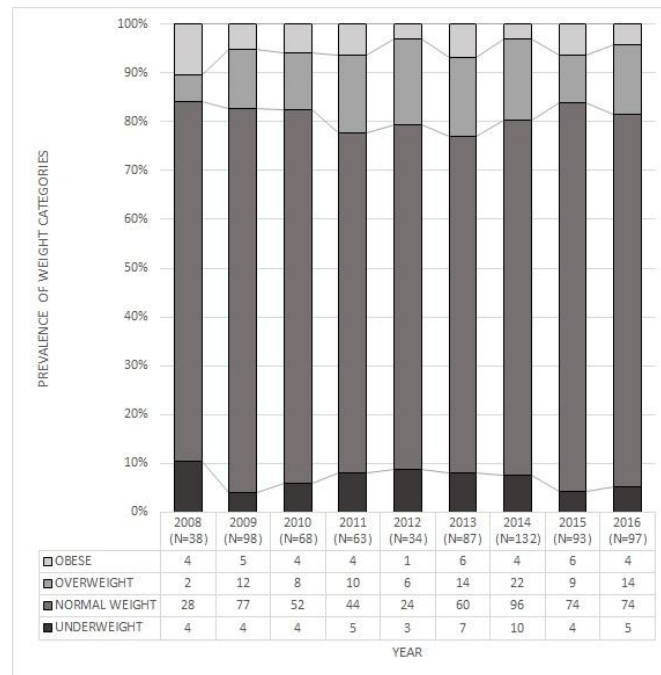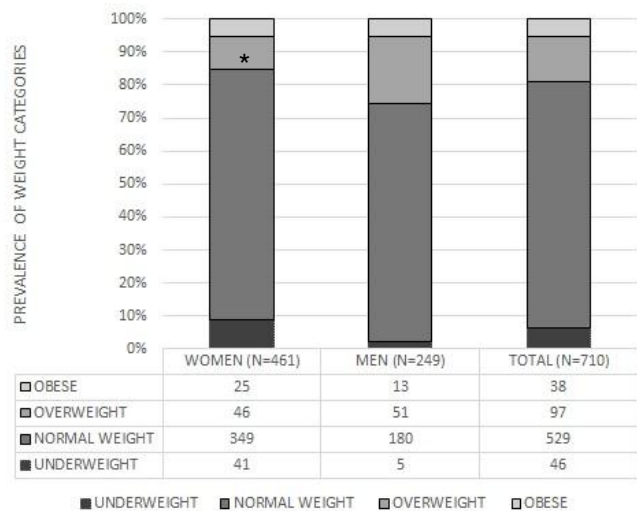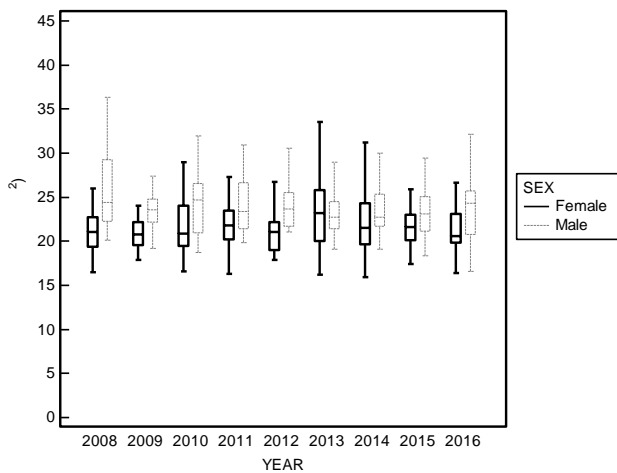

Figure 3. *Secular trend for men and women in BMI. Figure represents differences between sexes in BMI from 2008 to 2016 expressed in median (with 95% CI for median) values.*

cardiovascular problems (35), it is very important that the values were within healthy limits. Some researches show that, similar to BMI, values for PBF and WHR rise as people age (36).

The body composition (presented in Table 1) of the subjects shows that they have appropriate mass of fat and muscles, and their body composition is in accordance to weight status based on BMI value. In other words, the prevalence of obesity based on BMI distribution would probably be similar if they were distributed according to the BF% or SLM. Results reported by Grygiel-Gorniak et al. (37) show similar values of BMI, WHR and BF% with the results of the present study, as well as the similar differences between sexes. Our findings regarding differences in BMI and BF% between men and women showed that men had higher BMI, but lower BF% compared to women. This could be ascribed to the greater muscle mass in men. However, the correlation between BF% and BMI showed a statistically significant high positive value, indicating a strong connection between those two variables. Correlation was slightly lower in men than in women. There was also high correlation between BF% and WHR in both sexes. Collins et al., in their study of association of BMI and BF% among BMI-defined non-obese middle-aged individuals, found that the BMI category was not concordant with the %BF classification for 30% of the population. The greatest discordance between %BF and BMI was observed among %BF-defined overweight/obese women (38). A strong correlation of BMI and BF% in young women was reported in the study of Bakir et al. (39). They obtained correlation coefficients between BMI and BF% of 0.74 for women aged 18-30 years.

Proportions of weight categories were not significantly different over the years in which measurements were made. Students that choose to attend the College of Applied Sciences in Vukovar are similar in weight status throughout the years. This result is different compared to predictions of increase in obesity prevalence, and shows a steady state in the weight status of first-year students during the years examined, without any increase of obesity. It is possible, however, that it might have been too short a period for potential trends to reveal themselves.

Based on the presented results, the conclusion could be made that most of the freshman students at the College of Applied Sciences fall in the category of normal weight, with an overweight prevalence of around 19-20%, including around 5% obese persons among them. There are also 6.5% of those who are underweight. There is a higher tendency toward the prevalence of overweight persons among men, while among women there is a higher tendency for underweight prevalence. The prevalence of obesity and the overall distribution across the weight categories, as well as the body composition of the first-year students have not changed during the period from 2008 to 2016.

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