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DIFFERENCES IN MORPHOLOGICAL CHARACTERISTICS BETWEEN FEMALE STUDENTS OF UNIVERSITY OF ZAGREB

RAZLIKE U MORFOLOŠKIM OBILJEŽJIMA IZMEĐU STUDENTICA SVEUČILIŠTA U ZAGREBU

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SUMMARY

The aim of this study was to establish differences in morphological characteristics among female students of the Faculty of Kinesiology, Faculty of Medicine and Faculty of Teacher Education. The sample consisted of 255 female students, 78 students of Kinesiology, 84 students of Teacher Education and 93 students of Medicine. The sample of variables was comprised of eleven morphological characteristics. Central and dispersion parameters were calculated for all the variables and for each group. The normal distribution of variables was tested by the Kolmogorov-Smirnov test. The significance of differences between the groups was determined with the univariate analysis of variance (ANOVA) and the discriminant analysis. The Kolmogorov-Smirnov test showed a normal distribution of all variables. The ANOVA and discriminate analyses showed statistically significant differences in morphological characteristics between the groups of examinees. The variable for assessing the risk of obesity and the variables for estimating body fat contributed the most to the formation of global differences and the defining of the latent content of discriminant functions. Kinesiology students who engage in systematic daily physical activities have significantly lower body fat and more muscle mass while the Teacher Education and Medical students have higher levels of body fat because of their inclination to a sedentary lifestyle. It was concluded that there are statistically significant differences in morphological characteristics between female students from the Faculty of Kinesiology, Faculty of Medicine and the Faculty of Teacher Education.

Key words: anthropometric characteristics, body fat, physical activity, health.

SAŽETAK

Cilj ovog istraživanja bio je utvrditi razlike u morfološkim obilježjima studentica Kineziološkog, Medicinskog i Učiteljskog fakulteta. Uzorak ispitanika sastojao se od 255 studentica, od čega 78 studentica Kineziološkog, 84 studentice Učiteljskog i 93 studentice Medicinskog fakulteta. Uzorak varijabli činilo je jedanaest morfoloških obilježja. Za sve varijable izračunati su centralni i disperzivni parametri svake skupine. Normalnost distribucije varijabli testirana je Kolmogorov-Smirnovljevim testom. Značajnost razlika između skupina utvrđena je univarijatnom analizom varijance (ANOVA) i diskriminacijskom analizom. Kolmogorov-Smirnovljev test pokazao je normalnu distribuciju svih varijabli. ANOV-om i diskriminacijskom analizom utvrđene su statistički značajne razlike između skupina ispitanica u morfološkim obilježjima. Varijabla za procjenu rizičnosti tipa pretilosti i varijable za procjenu potkožnog masnog tkiva najviše su pridonijele nastajanju globalnih razlika i definiranju latentnog sadržaja diskriminacijskih funkcija.Studentice Kineziološkog fakulteta, koje provode svakodnevne sustavne tjelesne aktivnosti imaju značajno manje potkožnog masnog tkiva te više mišićne mase dok studentice Učiteljskog i Medicinskog fakulteta imaju veću razinu potkožnog masnog tkiva zbog sedentarnog načina života. Zaključuje se da postoje statistički značajne razlike u morfološkim obilježjima između studentica Kineziološkog, Učiteljskog i Medicinskog fakulteta.

Ključne riječi: antropometrijske karakteristike, potkožno masno tkivo, tjelesna aktivnost, zdravlje.

INTRODUCTION

The current rapid development and lifestyle provides a variety of benefits, but at the same time it results in less often implementation of physical activities. The worldwide trend of hypokinesia is a risk to the human health, so the opposition to hypokinesy contributes to improving and maintaining of human health and the health of the entire community (27). Experts in the field of health and education are in the ideal position to raise awareness about the importance of physical activity in the society. The link between health care professionals and those in educational institutions is the human life and taking care of the human health from various aspects. Teachers and professors as well as physicians should be instructors of health (10) for both children and adults. In the near future faculty students, who were in the focus of this study (Faculty of Kinesiology, Teacher Education and Medicine), will have a leading role in the society as representatives of health and which is connected to physical activity. This was the primary reason for selecting students from the aforementioned faculties for this research so as to highlight the characteristics of educated young women in the modern society. Kinesiologists should put emphasis on the pleasure of movement and enjoyment of physical activity because such an approach is effective when it comes to making exercise habits and an active lifestyle for the entire life span (1). Primary school teacher is the first person whom the children meet when arriving at school, and are the most responsible factor of quality in the educational process (28). One of their primary tasks is to convey to the children the love and the habit of conducting physical activity by means of a professional and systematic guidance through physical exercise. Global problems associated with hypokinesia, the cause of various diseases, are problems connected to public health and must involve health professionals in promoting physical activity. Personal habits of physicians are consistent and significant predictors of their habits of counselling patients on preventive exercise and through their example they strongly motivate the adoption of healthy habits among patients (4,5).

Regular physical activity causes significant changes in anthropometric characteristics of both men and women. They differ in features, but respond similarly given the anthropological changes. There is a larger number of research conducted on this subject among male students (13,30) than among female students (12,18,21), and that is one of the reasons for selecting the female student population in this study to increase the extent of knowledge about the effects of physical activity in young women. Some studies included morphological characteristics of students of both genders (14,19). There are also studies on women of all ages, including young women (6,16,20).

Due to the assumption that the selected sample from three faculties has different volume of physical activity morphological characteristics of female students were established.

Accordingly, the aim of this study was to determine the morphological characteristics of students from the Faculty of Kinesiology, Faculty of Medicine and Faculty of Teacher Education, and the differences in morphological characteristics between student groups were measured.

SUBJECTS AND METHODS

The sample of subjects was drawn from the population of female students at the University of Zagreb. Three faculties were chosen from which a convenient sample of 255 students in total was selected. The first group consisted of 78 students from the Faculty of Kinesiology, another group of 84 students from Faculty of Teacher Education, and the third group of 93 students from the Faculty of Medicine, between the ages of 19 and 23 years (mean age of the total sample of examinees 20.46 ± 0.84 years, body height 167.27 ± 5.67 cm, body weight 62.72 ± 9.28 kg).

The following anthropometric characteristics were measured: body height (cm), body mass (kg), forearm circumference (cm), abdominal circumference II (cm), hip circumference (cm), triceps skinfold (mm), abdominal skinfold (mm), and suprailiac skinfold (mm). The measured anthropometric variables were used to calculate the body mass index (BMI), waist-to-hip ratio (WHR) (2), and the percentage of body fat (8). The measurement method of morphological characteristics was used according to the International Biological Programme (IBP) (17) with some modifications in the method for measuring the skinfolds (8).

Data processing was carried out in several phases. The software package Statistica for Windows, ver. 7.1. was used. For all anthropometric variables central and dispersion parameters were calculated with all three groups of students. Normality of distribution was tested by the Kolmogorov-Smirnov test. The univariate analysis of variance (ANOVA) was used to determine the difference between the groups. The significance of differences between the groups at the global level was analyzed using the discriminant analysis. The significance of the discrimination function was tested with the chi-square test.

RESULTS

Results of the Kolmogorov-Smirnov test show that the distribution of the results of anthropometric variables does not significantly deviate from the normal one. Central and dispersion parameters of morphological characteristics (Table 1) demonstrate the largest differences between the groups in all variables of the subcutaneous adipose tissue, whereby students of the Faculty of Kinesiology (FK) have the least amount of body fat, then students of the Faculty of Teacher Education (FTE), and students of the Faculty of Medicine (FM) have the most skinfold values and percentage of body fat. The variability of the results of FK students is smaller, which indicates a greater homogeneity of this group, while the highest variability was observed among the students of FM

Descriptive parameters show somewhat smaller differences between the groups in circular measurements. The largest were observed in hips circumference, the highest score among FTE students, and the smallest among the FM students. Abdominal circumference is the largest among FM students and the lowest among FK students. The greatest variability was observed among FTE students while the FK students show the highest homogeneity in circular measurements. The arithmetic mean of the waist-to-hip ratio shows that the FM group stands out from the FTE and FK groups with higher index values (Table 1).

Table 1. Central and dispersion parameters and results of ANOVA of morphological variables of female students from the Faculty of Kinesiology, Teacher Education and Medicine, level of significance p<0,05

Tablica 1. Centralni i disperzivni parametri i rezultati ANOV-e morfoloških varijabli studentica Kineziološkog, Učiteljskog i Medicinskog fakulteta, nivo značajnosti p<0,05

	FK	N	AM	SD	F	P
Body height (cm)	FK	78	168,47	5,69	3,74	**0,03**
	FTE	84	166,06	5,27		
	FM	93	167,36	5,84		
Body mass (kg)	FK	78	62,80	7,32	1,45	0,24
	FTE	84	63,93	11,48		
	FM	93	61,55	8,43		
Body mass indeks (BMI)	FK	78	22,09	2,02	4,42	**0,01**
	FTE	84	23,12	3,58		
	FM	93	21,95	2,60		
Forearm circumference (cm)	FK	78	23,99	1,36	4,01	**0,02**
	FTE	84	23,62	1,84		
	FM	93	23,33	1,36		
Abdominal circumference (cm)	FK	78	69,55	4,70	1,92	0,15
	FTE	84	70,66	7,58		
	FM	93	71,48	6,53		
Hip circumference (cm)	FK	78	97,09	5,38	22,55	**0,00**
	FTE	84	98,57	7,33		
	FM	93	92,30	6,59		
Waist-to-hip ratio (WHR)	FK	78	0,72	0,04	61,68	**0,00**
	FTE	84	0,72	0,04		
	FM	93	0,77	0,04		
Triceps skinfold (mm)	FK	78	14,27	3,78	36,68	**0,00**
	FTE	84	18,52	5,79		
	FM	93	22,09	7,39		
Abdominal skinfold (mm)	FK	78	14,45	4,90	29,80	**0,00**
	FTE	84	18,58	6,75		
	FM	93	22,17	7,42		
Suprailiac skinfold (mm)	FK	78	8,26	2,83	22,24	**0,00**
	FTE	84	11,50	4,94		
	FM	93	12,52	4,64		
Body fat (%)	FK	78	18,26	3,34	37,62	**0,00**
	FTE	84	21,79	4,72		
	FM	93	24,16	4,96		

Faculty (FC), number of entities (N), arithmetic mean (AM), standard deviation (SD), F-test, p-level of significance, Faculty of Kinesiology (FK), Faculty of Teacher Education (FTE), Faculty of Medicine (FM)

Fakultet (FK), broj entiteta (N), aritmetička sredina (AS), standardna devijacija (SD), F-test, p-nivo značajnosti, Kineziološki fakultet (KIF), Učiteljski fakultet (UF), Medicinski fakultet (MEF)

Kinesiology students are the tallest while there are no specific differences between the groups in body weight. The body mass index (BMI) is the highest in the FTE group and the lowest in the FM group. Also, the FK and FM groups are more homogeneous than the students of FTE.

ANOVA showed statistically significant differences in all skinfold variables, percentage of body fat, **waist-to-hip ratio** and body mass, as well as in some variables to for the estimation of the body volume and body height (Table 1).

The discriminant analysis revealed two significant discriminant functions which were used to determine the existence of differences between the groups in their morphological variables (Table 2).

Table 2. Discriminant analysis of morphological variables of female students groups
Tablica 2. Diskriminacijska analiza morfoloških varijabli skupina studentica

DF	λ	Rc	Wλ	χ^2	df	p
1	2,09	0,82	0,25	341,61	22,00	0,00
2	0,29	0,47	0,78	62,85	10,00	0,00

Discriminant functions (DF), eigenvalue (λ), canonical correlation coefficient (Rc), Wilks' Lambda (Wλ), Chi-square test (χ^2), degrees of freedom (df), level of significance (p)

Diskriminacijske funkcije (DF), svojstvena vrijednost (λ), koeficijent kanoničke korelacije (Rc), Wilksova Lambda (Wλ), Hi-kvadrat test (χ^2), stupnjevi slobode (df), razina značajnosti (p)

The extent of the differences between the groups was defined on the basis of the groups' centroid value and their position on the discriminant functions (Table 3, Figure 1).

Table 3. Group centroids of morphological variables
Tablica 3. Centroidi skupina morfoloških

	DF1	DF2
FK ○	-1,47	-0,59
FTE □	-0,69	0,72
FM △	1,85	-0,15

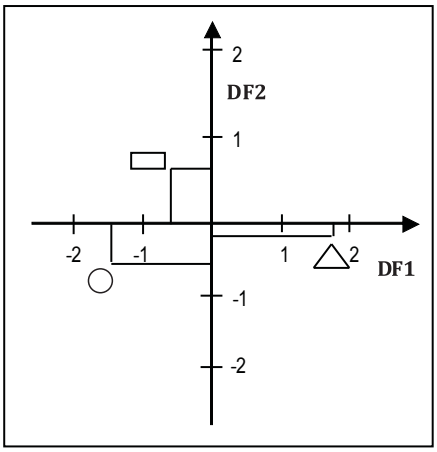

Figure 1. Group centroids of morphological variables
Graf 1. Centroidi skupina morfoloških varijabli

Table 4. Discriminant functions structure of morphological variables of female students
Tablica 4. Struktura diskriminacijskih funkcija morfoloških varijabli studentica

	DF1	DF2
Body height	-0,02	-0,32
Body mass	-0,06	0,13
Body mass indeks	-0,06	0,31
Forearm circumference	-0,12	-0,12
Abdominal circumference	0,08	0,08
Hip circumference	-0,27	0,33
Waist-to-hip ratio	0,47	-0,29
Triceps skinfold	0,35	0,34
Abdominal skinfold	0,32	0,29
Suprailiac skinfold	0,24	0,43
Percentage of body fat	0,35	0,40

Structure of the first discriminant function (DF1), structure of the second discriminant function (DF2)
Struktura prve diskriminacijske funkcije (DF1), struktura druge diskriminacijske funkcije (DF2)

Table 4 shows that the variable for assessing the risk of obesity and the variables for estimating body fat have the highest correlations with DF1 therefore these variables contributed the most to the formation of global differences and the defining of the latent content of the first discriminant function. The DF2 structure is best defined by variables for the estimation of body fat and circumference of the hips.

DISCUSSION

Basic descriptive parameters show differences between all three groups of respondents in the majority of morphological variables, with the most noticeable differences in body composition, an almost equal body height, body weight and body mass index, and some measurements of body volume. ANOVA showed statistically significant differences between the groups in all morphological variables except in the weight and waist circumference. Differences between the groups are best confirmed by the discriminant analysis whereby the highest correlations with discriminant functions are indicators of fat content which separate the groups well. The highest correlation with the first discriminant function has the waist-to-hip ratio, triceps skinfold and body fat percentage.

Some volume measures are larger among FK students (forearm circumference and hip circumference) while the values of all skinfolds were lower than those of students of FM and FTE. It can be concluded that the muscle mass of FK students is significantly higher. Certainly, their higher degree of physical activity is responsible for these results and less physical activity increases the amount of the subcutaneous fat among the students of the two other faculties. Circumference of the hips was the lowest among the FM students, while their abdominal circumference was the highest, so the index for the risk assessment of the obesity type (WHR) was the highest. This index defines obesity with regards to the distribution of the subcutaneous fat, however, none of the

groups enter the obesity risk (2) although the students of FM have a higher index than the FK and the FTE groups, which can be linked to the fact that the group of FM students are the least physically active and that they spend most of their time in the sedentary position. According to the Eurofit system's normative values of the measurements of the of the Croatian working population for the group of young women under 35 years of age (6), students of FK and FTE are below the average risk associated with obesity, and FM students hit the average risk value. Compared with the population of young women under 30 years in Croatia (22), FM students have a slightly higher **waist-to-hip ratio** than physically inactive young women in Croatia, while the results of the FK and the FTE students are identical to those of active young Croatian women under 30 years of age.

Differences between the groups of women are highest in the skinfold measurements. FK students have a significantly lower average of the subcutaneous fat thickness in all the measured points when compared to the other two groups, while primarily students of FM, and then students of FTE, contribute to these differences with significantly higher thickness values of all the measured skinfolds. Mišigoj-Duraković and Ivanek (1995) observed that already upon enrollment students of the Faculty of Kinesiology have significantly lower average values of the subcutaneous adipose tissue than the female students from other faculties. When compared to previous research (14,18,19) Kinesiology students are within the boundaries of their colleagues' results from previous generations in the upper arm skinfolds, but have somewhat larger values of abdomen and lower suprailiac skinfold. According to the student results of other faculties from previous studies (3,14,18,19), FTE students have larger values of the skinfold thickness and abdomen and almost equal suprailiac skinfolds. It is interesting that in the results of the skinfold, this group of students was more similar to some previous generations of students of Teacher Education faculties in Croatia (15,23,31). Students of FM exhibit high values of skinfolds, especially those of the upper arm and abdomen. This can be compared with students who also do not carry out systematic physical exercise (23,32). It is considered that the amount of subcutaneous fat in the abdomen is under the significant influence of exogenous factors (physical activity, diet and other) unlike some other skinfolds. What is really worrying is that without a significant difference between the groups in body weight and an almost equal body height, a visible big difference is observable in the relationship between the amount of muscle mass and body fat between the groups of students.

In the body content of the FK students there is significantly less body fat and they can be identified with active young women (22) as well as with previous generations of students at the Faculty of Kinesiology (19). Students of FTE have more body fat as well as students from other faculties from previous studies (19) and young Croatian women under the age of 35 (6). Body fat percentage is the highest among the FM students and the apparent similarity with the results of some research conducted by foreign authors on female students (29) and young women (7,24). On the other hand, although all groups of women are within the values of the normal body mass index (BMI) (17), students of FM have the lowest BMI which could be yet another proof that the body mass index should be interpreted with caution (25,26) because a normal BMI does not serve as a guarantee of fitness in students who lead a sedentary lifestyle (11) and an extremely muscular population may have a higher BMI (9,21). This index should therefore be observed along with other parameters such as the body fat percentage. Students of FTE have the highest BMI, with equal index values as inactive young women in Croatia (22) suggesting a negative effect of a sedentary lifestyle in both cases.

According to the average values of the body fat percentage in the age range between 18 and 22 (17), FTE and FM students are within the average values. However, according to the normative values of the Eurofit measurement system for the group of young women under the age of 35 (6) FK students are below the average percentage of body fat which is the result of increased physical activity while the FTE students are within the range of average values, but the FM students are on the border between the average and above average percentage of body fat as a result of the sedentary lifestyle and the neglect of physical activity.

CONCLUSIONS

Values of the results obtained in this study indicate that there are significant differences between the groups of examinees, so according to the aim, it was concluded that there are significant differences in the morphological characteristics between the students of Kinesiology, Teacher Education and Medicine. No significant differences were noticed in the body mass and the values of body height were almost equal while visible big difference were noticed in the relationship between the amount of muscle mass and subcutaneous body fat. Kinesiology students who engage in systematic daily physical activity have significantly less body fat and more muscle mass while the Teacher Education and Medical students have higher levels of body fat because of their inclination to a sedentary lifestyle. The study indicates the student population's need for organized physical activities that would thoroughly influence their lifestyle and the awareness of the importance of physical activity. Such an approach could influence the attitude of future teachers, physicians and professors in the direction of more frequent recommendations and implementations of physical activity for children and adults.

Literature

1. Borms J. Organisational and methodological aspects of health-related physical activity. Kinesiology 2000; 32(1): 94-100.
2. Bray GA, Gray, DS. Obesitiy: Part I - Pathogenesis. West J Med 1988; 149(4): 429-41.
3. Caput-Jogunica R. Prilog antropometrijskim istraživanjima studentica Sveučilišta u Zagrebu. U: Milanović D, ur. Zbornik radova 2. konferencije Kineziologija, Dubrovnik, Fakultet za fizičku kulturu Sveučilišta u Zagrebu, 1999; 430-3.
4. Frank E, Breyan J, Elon L. Physician disclosure of healthy personal behaviors improves credibility and ability to motivate. Arch Fam Med 2000; 9(3): 287-90.
5. Frank E, Rothenberg R, Lewis C et al. Correlates of physicians' prevention-related practices: findings from the Women Physicians' Health Study. Arch Fam Med 2000; 9(4): 359-67.
6. Heimer S, Mišigoj-Duraković M, Ružić L et al. Fitness level of adult population in the Republic of Croatia estimated by EUROFIT system. Coll Antropol 2004; 28(1): 223-33.
7. Jackson AS, Pollock ML. Generalized equations for predicting body density of women. Med Sci Sports Exerc 1980; 12(3): 175-82.
8. Jackson AS, Pollock ML. Practical Assessment of Body Composition. Phys SportsMed 1985; 13(5): 76-90.
9. Kaštelan D, Kraljević I, Kardum I et al. The effects of the level of physical activity on calcaneal ultrasound measurements: bone properties of medical students and physical education students. Coll Antropol 2007; 31(3): 701-4.
10. Krawański A. Intellectual challenges of physical education. SPCT 2009; 16(3): 281-90.
11. Maaroos J, Landor A. Anthropometric indices and physical fitness in university undergraduates with different physical activity. Tartu, Faculty of Medicine, Department of Sports Medicine and Rehabilitation, 2001.
12. Matković BR, Malez V, Matković B. Aerobni kapacitet studentica zagrebačkoga Sveučilišta. U: Milanović D, ur. Zbornik radova 1. konferencije Kineziologija, Dubrovnik, Fakultet za fizičku kulturu Sveučilišta u Zagrebu, 1997; 49-52.
13. Medved R, Janković S, Ivanek M. Morfološke osobitosti studenata kineziologije (muškog spola). Kinesiology 1992; 24(1-2): 24-6.
14. Medved R, Janković S, Ivanek M et al. Morfološke osobitosti studenata kineziologije. HŠMV 1992; 7(3): 54-7.
15. Mesarić I, Boutlas G. Neke dimenzije antropološkog statusa studentica prve godine Visoke učiteljske škole u Čakovcu i studentica Technological Education institute of Larisa. U: Findak V, ur. Zbornik radova 14. ljetne škole kineziologa RH, Rovinj, Hrvatski kineziološki savez, 2005; 319-22.
16. Metikoš D, Mišigoj-Duraković M, Heimer S. Povezanost morfoloških karakteristika i motoričkih sposobnosti u žena. HŠMV 1994; 9: 63-9.
17. Mišigoj-Duraković M. Kinantropologija. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu, 2008.
18. Mišigoj-Duraković M, Heimer S, Matković BR. Neke somatometrijske karakteristike studentica-četverogodišnja longitudinalna studija. HŠMV 1995; 11(2-3): 47-52.
19. Mišigoj-Duraković M, Heimer S, Matković BR. Morfološke i funkcionalne karakteristike studentske populacije Sveučilišta u Zagrebu. Kinesiology 1998; 30(2): 31-7.
20. Mišigoj-Duraković M, Heimer S, Matković BR et al. Physical activity of urban adult population: questionnaire study. Croat Med J 2000; 41(4): 428-32.
21. Mišigoj-Duraković M, Ivanek M. Udio masti u strukturi tijela studentica Fakulteta za fizičku kulturu. Kinesiology 1995; 27(1): 73-6.
22. Mišigoj-Duraković M, Ružić L, Heimer S et al. Active vs. inactive population according to body size, body composition and functional abilities. In: Bartoluci M, Heimer S, Ružić L, Eds. Proceedings of the 2nd CESS Conference, Poreč, Faculty of Kinesiology University of Zagreb, 2001; 148-52.
23. Mraković S, Horvat V, Brčić K. Razlike u nekim morfološkim karakteristikama dvije skupine studentica Učiteljskog fakulteta u Zagrebu. U: Findak V, ur. Zbornik radova 15. ljetne škole kineziologa RH, Rovinj, Hrvatski kineziološki savez, 2006; 197-201.
24. Nassis GP, Geladas ND. Age-related pattern in body composition changes for 18-69 year old women. J Sports Med Phys Fitness 2003; 43(3): 327-33.
25. Nevill A, Stewart A, Olds T et al. Relationship between adiposity and body size reveals limitations of BMI. Am J Phys Anthropol 2006; 129(1): 151-56.
26. Ode JJ, Pivarnik JM, Reeves MJ et al. Body mass index as a predictor of percent fat in college athletes and nonathletes. Med Sci Sports Exerc 2007; 39(3): 403-9.
27. Oja P. Health-enhancing physical activity: evidence, potential and population strategies for public health. Kinesiology 2000; 32(1): 85-93.
28. Prskalo I, Tokić P, Sekulić V. Učitelj razredne nastave-čimbenik kvalitete u tjelesno-zdravstvenom odgojno-obrazovnom području. U: Rosić V, ur. Zbornik radova 2. međunarodni znanstveni kolokvij, Rijeka, Filozofski fakultet Sveučilišta u Rijeci, 1999; 630-34.
29. Roy JLP, Hunter GR, Blaudeau TE. Percent body fat is related to body shape perception and dissatisfaction in students attending an all women's college. Percept Mot Skills 2006; 103: 677-84.
30. Sporiš G, Tomić V, Ujević B. Razlike u nekim antropometrijskim varijablama između redovnih studenata Kineziološkog fakulteta i izvanrednih studenata Više trenerske škole usmjerenja fitness. HŠMV 2004; 19(1-2): 51-5.
31. Tomljenović B, Tomljenović F, Radošević I. Antropološke pretpostavke rada na Učiteljskom studiju u Gospiću. U: Findak V, ur. Zbornik radova 16. ljetne škole kineziologa RH, Poreč, Hrvatski kineziološki savez, 2007; 251-6.
32. Zerbo D, Fležar M, Štefančić M. BMI and Heath-Carter somatotypes od female students in Ljubljana. Coll Antropol 1998; 22(2): 451-63.