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Differences in Motor and Functional Abilities between Female Students of the University of Zagreb

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ABSTRACT The aim of this paper was to determine the differences in motor and functional abilities of female students of the Faculty of Kinesiology (FK), Faculty of Medicine (FM), and Faculty of Teacher Education (FTE). The sample consisted of 255 female students (78 FK, 84 FTE, 93 FM), tested by six motor tests and Astrand test. Statistical analyses showed significant differences between groups. The best results were achieved by the FK students. FM students were better in strength, more flexible and had a better aerobic capacity than FTE, who had faster movement and better coordination. Students FK, who conducted systematic physical activity, had a significantly better motor-functional status, while FTE and FM students, as a result of more sedentary lifestyle, showed a lower status. This research points to the need of the student population for organized and systematic physical exercise during the entire educational period.

INTRODUCTION

Human movement is one of the fundamental biotic needs of the human body which sustains life (Malina et al. 2004; Abernethy 2005). Physical activities have a positive effect on the cardiovascular (Iwasaki et al. 2003; Cunha et al. 2011) and respiratory systems (Farinatti and Monteiro 2010). However, health includes functional abilities which means that measures of functional abilities also contributes to the assessment of the health level (Pate 1988). Also, research on students showed that the reduced cardiovascular risk is associated with the aerobic fitness (Hoyos et al. 2011).

Ever since childhood and throughout the entire school education, physical activity is reduced, and this direction is continued after the end of the education process (Pavon and Moreno 2006), especially among women (Kristjansdottir and Vilhjamsson 2001). Results of the cohort study over the 15-yr period indicated the decline in aerobic fitness, strength and flexibility in both genders (Wetter et al. 2013). Similar recent findings support that physical fitness among students is declining (Pribis et al. 2010). Also, Ekblom et al. (2011) reported that aerobic fitness in Swedish young people declined across a 20-yr period. After the graduation, it is important that young people are well prepared during the transition period in their lives. From the kinesiological standpoint, this is a transition period of individuals from organized physical activity during the schooling process to a working environment which does not provide this. Then, it is important to maintain the stability of physical activity (Sallis et al. 1992). Consequently, it is necessary to have as many practical and theoretical information about physical activity, and to accept it as a culture of life. Longer and better organisation of the implementation of kinesiological activities will contribute to the development and maintenance of an optimal level of anthropological characteristics, as well as to the maintenance of high levels of work ability.

The students' habit of regular physical activity in Croatia is not at the satisfactory level (Matkovic et al. 2010; Mrakovic et al. 2014). The most common excuse is the lack of time, which occurs due to the university's obligations and study area. While these are the primary tasks of every student, they should not be an obstacle to the implementation of regular physical activity and the quality improvement of a healthy lifestyle. Physical education class is the only form of organized physical activity for most students. The faculty is also the final stage of systematic physical exercise during the educational process. Therefore, it is important to optimize the previously mentioned transition period. Occupations which make human health one of their primary tasks are certainly kinesiologists, physicians, and teachers. In this paper, three groups of female students from the Faculty of Kinesiology, Med-

icine, and Teacher Education were examined. In addition, physical activity in different volume, intensity, and duration were conducted. Withal, the differentiation of the implementation of physical activity on chosen faculties was one of the reasons for conducting this research. Faculties as institutions are responsible, among all other, for the improvement of the quality of life. The special roles at the University have the selected faculties as presenters of the healthy lifestyle and health prevention. Research provides the insight to the motor and functional abilities of female students. The reason for selecting female students of these faculties was to point out those characteristics of educated young women in the modern society. The collected data could contribute to the realization of organized and systematic physical exercise during the entire educational period. Subsequently, great responsibility of spreading awareness about the need for physical activity as an integral part of the culture of life lies in the future occupations of selected students. If already as students they do not possess this awareness, they will not be able to transfer it to children and adults.

A review of available research, points to a larger number of papers that determines the motor-functional status of male students (Heimer et al. 1992; Sporiš et al. 2005; Razak et al. 2013) than female students (Matkovic et al. 1997; Hraski et al. 2011; Konczos et al. 2012). Nevertheless, others include the anthropological characteristics of students of both genders (Matkovic and Ivanek 1993; Mišigoj-Durakovic et al. 1998; Radu et al. 2014; Agopyan 2015). Furthermore, there are papers on selected samples of students involved in collegiate sports (Morrow et al. 1980) and on the unselected student population (Bale et al. 1985; Hraski et al. 2009). Some papers compare students with the norms of the final year of high school (Jeras and Kondric 2002; Mihevc and Kondric 2002), and some follow the transformation processes of students during a certain period under the influence of a kinesiological treatment (Bla•evic 1997; Horvat and Delija 1999). Researches were also conducted on women of all ages, including young women (Metikoš et al. 1994; Heimer et al. 2004b).

Aim of this Research

The aim of this paper was to determine whether there are differences in the motor and functional abilities of female students from the Faculty of Kinesiology, Faculty of Medicine, and the Faculty of Teacher Education.

METHODOLOGY

Sample of Subjects

The sample of subjects was convenient and consisted of 255 female students from three faculties of the University of Zagreb. Thus, 78 students were from the Faculty of Kinesiology, 84 students were from the Faculty of Teacher Education, and 93 students were from the Faculty of Medicine, between the ages of 19 and 23 years (mean age of the total sample of subjects 20.46 ± 0.84 years, body height 167.27 ± 5.67 cm, body weight 62.72 ± 9.28 kg).

Sample of Variables

The sample of variables for the assessment of motor abilities of the subject sample covered the basic motor abilities. However, they were selected according to the standard measures used in our educational system (Findak et al. 1996). Motor abilities were measured with six motor tests for the assessment of latent dimensions of speed of movement frequency, explosive strength, flexibility, coordination, static strength of arms and shoulders, and repetitive strength of the trunk. However, the following variables were measured:

Speed of Movement

Hand tapping (MTR) - From a sitting position, subject places the non-dominant hand in the middle of the tapping board. Thus, the dominant hand is placed crosswise over the first hand on the board. In 15 seconds, subject with his dominant hand alternately touches the board as fast as possible. Every alternate touch of both boards is counted as one point. Test was performed three times.

Explosive Strength

Standing long jump (MSD) - From the standing position, subject jumps with maximal take off with both feet from the end of the opposite side of the springboard. With both feet, he lands on the mat to the marked centimeter scale. The result is read in cm. Test was performed three times.

Flexibility

Sit and reach (MPR) - Subject is sitting on the floor, leaning his back and head on the wall. Extended legs are placed on two marked line on the floor which are at an angle of 45°. With extended arms, he puts the palm of his right hand on the back of his left hand and places them on the floor in front of him without moving. Measurer sets a zero position of the wooden meter where the subject touches the floor with his fingertips. The task is to perform a long bend forward, but that fingertips glide along the meter without twitching. The result is read in cm. Test was performed three times.

Coordination

Polygon backwards (MPN) - The goal of the subject is to move backward on all fours in the space of 10 meters (start and finish line distance), crossing over the first barrier (Swedish vaulting box, height 50 cm, 3 m from the start), and then passing through the frame of the Swedish vaulting box (6 m from the start). During the task, subject can look through his legs to follow direction, but cannot turn his head. The task is completed when the subject crosses the finish line with both hands. The result is recording in tenths of seconds. Test was performed three times.

Static Strength

Flexed arm hang (MIV) - Task is performed on the horizontal bar, height 1.5 m, under which is the mat. From a standing position, subject catches horizontal bar from below at the shoulder width. The measuring starts when the subject's chin is in a position above the bar, while the body stands still. The task is to hold this position as long as possible. The task is stopped if the subject touches the bar with his chin or if twitching of the body is highlighted. If the subject holds this position for more than 120 sec, the task is stopped and that time is recorded. The result is recorded in tenths of seconds. Test was performed once.

Repetitive Strength

Sit-ups (MPT) - The result is the number of correct trunk lifting from the lying to the sitting position in 60 seconds, with the knees flexed at the angle of 90°, feet apart in hip width and arms crossed on the chests with hands on opposite shoulders. Partner fixes the subject's feet, and on the sign subject starts lifting as fast as he can into the sitting position, with his elbows touching the thigh, and then back to the starting position. Test was performed once.

Astrand Test

Functional abilities were estimated by the method according to Astrand (Astrand and Ryhming 1954) on the bicycle ergometer (Monark Ergomedic 828E). The Astrand test estimates maximal oxygen uptake on the basis of the heart rate in a steady state during submaximal load. Thus, the relative value of the maximal oxygen uptake was calculated by dividing the absolute value with the body mass of the subject.

Statistical Analysis

Central and dispersion parameters were calculated for all variables. Normality of distribution was tested by the Kolmogorov-Smirnov test. The discriminant analysis and the univariate analysis of variance (ANOVA) were used to determine the differences between the groups for the set of motor variables. The significance of the discrimination functions was tested with the chi-square test. To determine the differences between groups in functional abilities, the univariate analysis of variance (ANOVA) was used. The software package Statistical for Windows, ver. 7.1 was used.

RESULTS

Results of the Kolmogorov-Smirnov test showed that the results distribution of motor and functional variables statistically did not significantly differ from normal. Central and dispersion parameters showed differences between the groups on all motor variables (Table 1). In six tests of motor skills, female students from the Faculty of Kinesiology (FK) achieved the best results. By comparing the results of arithmetic means of female students from the Faculty of Medicine (FM) and the Faculty of Teacher Education (FTE), it is observable that there were differences between the two groups, whereby the FM female students achieved better results in four motor variables (FM:FTE in MSD 1.5 cm; MPR 2.99 cm; MIV 6.7 sec; MPT 1.84 sit-ups),

Table 1: Central and dispersion parameters and ANOVA results of motor variables of female students from the Faculty of Kinesiology, Teacher Education and Medicine, level of significance p<0.05

	FC	*N*	*M*	*SD*	*MIN*	*MAX*	*F*	*p*
Hand tapping (MTR)	FK	78	39.95	3.36	33.00	48.00	56.22	0.00
	FTE	84	38.29	3.58	31.00	45.00		
	FM	93	34.04	4.28	25.00	46.00		
Standing long jump (MSD)	FK	78	208.06	13.50	170.00	236.00	155.67	0.00
	FTE	84	163.25	17.36	128.00	206.00		
	FM	93	164.75	22.36	100.00	215.00		
Sit and reach (MPR)	FK	78	78.45	9.50	58.00	101.00	12.89	0.00
	FTE	84	69.75	11.18	45.00	95.00		
	FM	93	72.74	12.07	42.00	96.00		
Polygon backwards (MPN)	FK	78	10.08	1.47	7.00	14.40	33.26	0.00
	FTE	84	11.89	2.14	8.00	18.20		
	FM	93	12.61	2.39	8.50	18.30		
Flexed arm hang(MIV)	FK	78	40.67	14.37	22.00	82.00	55.43	0.00
	FTE	84	16.76	15.83	1.00	60.30		
	FM	93	23.46	14.36	1.15	54.29		
Sit-ups (MPT)	FK	78	52.87	5.81	41.00	68.00	76.50	0.00
	FTE	84	39.46	9.01	15.00	54.00		
	FM	93	41.30	7.16	17.00	53.00		

Legend: faculty (FC), number of subjects (N), arithmetic mean (M), standard deviation (SD), minimal (MIN) and maximal (MAX) result, F-test, p-level of significance, Faculty of Kinesiology (FK), Faculty of Teacher Education (FTE), Faculty of Medicine (FM)

and the FTE female students in two motor variables (FM:FTE in MTR 4.25 hand tapping; MPN 0.72 sec).

ANOVA showed statistically significant differences between the groups in all motor variables (Table 1): on variables for the estimation of speed of movement frequency (F=56,22; p=0,00), explosive strength (F=155.67; p=0.00), flexibility (F=12.89; p=0.00), coordination (F=33.26; p=0.00), static strength (F=55.43; p=0.00), and repetitive strength (F=76.5; p=0.00).

With the discriminant analysis obtained, there were two significant discriminant functions, as evidenced by the low values of Wilks' lambda, the high values of the Chi-square test, and the p values (DF1 p = 0.00; DF2 p = 0.00) (Table 2). By testing the significance of discriminant functions, the differences between groups were determined in motor variables.

Size differences between the groups were determined based on the values of the group centroids and their position on the discriminant functions (Table 3). The greatest distance of the group centroids on the first discriminant function (DF1) was between the FK (-1.86 SD) and the FTE (0.94 SD) female student groups, and is the value of 2.8 SD. The distance of the group centroids on DF1 between groups FK (-1.86 SD) and FM (SD 0.72) was 2.58 SD, which also proves a big difference between these groups. The smallest difference was between the groups FTE (SD 0.94) and FM (SD 0.72), where the distance of the centroids on DF1 is 0.22 SD.

On the second discriminant function (DF2), the greatest distance between the group centroid was between the groups FM (-0.7 SD) and FTE (SD 0.72), and is 1.42 SD. The distances of the group centroids on DF2 between the groups FK (SD 0.07) and FTE (0.72 SD), of 0.65 SD, and between the groups FK (SD 0.07) and FM (-0.7 SD), of 0.77 SD are similar (Table 3).

The DF1 separates the group FK from FM and FTE, while DF2 differentiates the FM group of female students. Centroids of the groups FTE

Table 2: Discriminant analysis of motor variables of female student groups

DF	*Ë*	*Rc*	*Wë*	χ^2	*df*	*p*
1	1.55	0.78	0.29	309.35	12.00	0.00
2	0.35	0.51	0.74	75.69	5.00	0.00

Legend: discriminant functions (DF), eigenvalue (ë), canonical correlation coefficient (Rc), Wilks' Lambda (Wë), Chi-square test (χ^2) degrees of freedom (df), level of significance (p)

and FM were on the positive pole of DF1, while the centroid of the group FK was on the negative pole of DF1. Centroids of groups FK and FTE were on the positive pole of DF2, and the centroid of the group FM was on the negative pole of DF2 (Table 3).

Table 3: Group centroids of motor variables

	DF1	*DF2*
FK	-1.86	0.07
FTE	0.94	0.72
FM	0.72	-0.70

Legend: structure of the first (DF1) and second (DF2) discriminant function

Based on the Mahalanobis distances of the centroids of groups, statistically significant differences were observed between the female students of the three faculties: FK and FTE (d^2=8.24; f=54.44; p=0.00), FK and FM (d^2=7.22; f=50.02; p=0.00), and FTE and FM (d^2=2.06; f=14.86; p=0.00), wherein d^2 is the square value of the Mahalanobis distance, f-values of the difference size, and p is the level of error. Group FK showed the greatest distances when compared to groups FTE and FM.

The structure of discrimination functions was interpreted (Table 4) in order to establish with certainty to which extent and which variables contributed the most to the differentiation of the groups. The variable for the assessment of explosive strength had the highest correlation with DF1 (MSD -0.89). Variables for the assessment of repetitive (MPT -0.63) and static strength (MIV -0.52), as well as coordination, (MPN 0.39) had high correlations with DF1. Thus, this means that these variables contributed the most to the global differences and the defining of the latent content of DF1. Less projected were variables for the assessment of the speed of movement frequency (MTR -0.35) and flexibility (MPR -0.25).

The DF2 structure was best defined by a variable for the assessment of the speed of movement frequency (MTR 0.84). The variable for the assessment of coordination (MPN -0.31) had an effect also with smaller projections on the DF2. Other variables had low correlations with the DF2 (MSD 0.08; MPR -0.15; MIV -0.24; MPT -0.08) (Table 4).

Table 4: Discriminant function structure of motor variables

	DF1	*DF2*
Hand tapping (MTR)	-0.35	0.84
Standing long jump (MSD)	-0.89	0.08
Sit and reach (MPR)	-0.25	-0.15
Polygon backwards (MPN)	0.39	-0.31
Flexed arm hang (MIV)	-0.52	-0.24
Sit-ups (MPT)	-0.63	-0.08

Legend: structure of the first (DF1) and second (DF2) discriminant function

The central and dispersion parameters of the Astrand test results showed differences between the groups of female students in functional variables (Table 5). The FK group (2.57±0.54) achieved the highest, and the FTE group (1.96±0.45) the lowest results in the absolute maximal oxygen uptake (VO_2max) expressed in l/min. However, the differences were most obvious between those two groups of subjects (FK:FTE 0.61 l/min). Somewhat, smaller difference was found between the FM (2.04±0.42) and FK (FK:FM 0.53 l/min) groups, while a very small difference was observed in the FTE and FM groups (FTE:FM 0.08 l/min).

Values of the group of subjects in the relative maximal oxygen uptake (VO_2rel), expressed in milliliters per kilogram of body weight per

Table 5: Central and dispersion parameters and ANOVA results of functional variables of female students from the Faculty of Kinesiology, Teacher Education and Medicine, level of significance p<0.05

	FC	*N*	*M*	*SD*	*MIN*	*MAX*	*F*	*p*
Maximal oxygen uptake (VO_2max)	FK	78	2.57	0.54	1.60	3.80	40.39	0.00
	FTE	84	1.96	0.45	1.60	3.20		
	FM	93	2.04	0.42	1.60	3.20		
Relative maximal oxygen uptake (VO_2rel)	FK	78	41.12	8.17	24.69	63.55	40.58	0.00
	FTE	84	31.26	7.28	16.05	51.09		
	FM	93	33.47	6.49	19.65	51.38		

Legend: faculty (FC), number of subjects (N), arithmetic mean (M), standard deviation (SD), minimal (MIN) and maximal (MAX) result, F-test, p-level of significance, Faculty of Kinesiology (FK), Faculty of Teacher Education (FTE), Faculty of Medicine (FM)

minute (ml/kg/min), showed the same group relationships as in VO_2max. Therefore, the FK group had the highest results (41.12±8.17), the FM group (33.47±6.49), while the lowest score was achieved by the FTE group (31.26±7.28). Variability was greater in VO_2rel than in VO_2max, which could be the reason for the involvement of body weight in the calculation of VO_2rel.

Differences between the groups of subjects in the variables of functional abilities were determined with the univariate analysis of variance (ANOVA). ANOVA showed statistically significant differences in both variables: VO_2max ($F=40.39$; $p=0.00$) and VO_2rel ($F=40.58$; $p=0.00$) (Table 5).

DISCUSSION

A statistically significant differences were determined between the groups on all motor variables whereby the most noticeable differences were in the tests for the assessment of strength and speed. The structure of the first discriminant function showed that strength is the general motor factor (primarily explosive power, then repetitive and static strengths). However, female students from the Faculty of Kinesiology (FK) achieved better results in all motor tests, which was expected due to their active lifestyle. Groups of female students from the Faculty of Teacher Education (FTE) and the Faculty of Medicine (FM) had lower motor abilities than the FK female students.

Explosive strength is considered to be a more genetically determined motor ability. Therefore, physical activity will not bring major changes in that form of strength at a later age, although some studies indicate that adequate programs can somewhat transform this motor ability (Kravitz et al. 1997; Tkalcic 1997). FK students' explosive strength can be compared with active female students with an above average motor status (Vlašic et al. 2007; Zorec 1999), while the FTE and FM female students showed a lower explosive strength than some students' below average results in similar studies (Mesaric and Boutlas 2005; Srhoj et al. 2006). A muscularity of FK students certainly had an impact on their much greater explosive strength, since the results of motor abilities tests also depends on the structure of morphological characteristics, especially the subcutaneous adipose tissue (Mrakovic et al. 2014).

Static and repetitive strength are the least inherent of all primary motor abilities, on which the greatest impact of physical activity is possible throughout life. Thus, this was supported by the results of the FK female students, who were regularly physically active. This increases muscle development and reduces the level of subcutaneous fat tissue in the body composition which is reflected in their motor abilities. Similar results were found in for example the Police Academy female students since it is the nature of their profession to be more physically active (Zorec 1999). FTE and FM female students showed a low level of static strength as well as students of similar study programs from earlier research (Horvat and Delija 1999; Mesaric and Boutlas 2005; Hraski et al. 2009). Thus, the results of these two groups were not satisfactory in sit-ups, considering how much physical activity can affect the repetitive strength. The data suggested that physical activity should be implemented more frequently at higher education institutions.

Hand tapping test had the highest projection to the second discriminatory function. Also, it differentiated the FM female students with the lowest frequency of movement. Speed has a high inherent coefficient, but it is certain that systematic physical activity will maintain an optimal body condition without a decrease in the abilities, including speed. FK female students' better results can also be attributed to the selection on the entrance exam. Of course, their athletic body provides an additional advantage in solving motor tasks. Thus, this case involves fast movements at a given time. Results of the FM female students were within the results of students from other faculties where physical activity is also not a part of their everyday life (Mesaric and Boutlas 2005; Srhoj et al. 2006).

Significant differences between the groups of female students were also found in aerobic capacity. The maximal oxygen uptake in absolute and relative values, were the highest in FK female students. The reason for this is their systematic physical activity which has a positive effect on aerobic capacity, as also was confirmed by the results of other research which established that more active students had higher values of both relative and absolute oxygen uptake (Maaroos and Landor 2001; Astrand et al. 2003; Hoyos et al. 2011; Hoehn et al. 2015). By comparing the results of the FK female students with their colleagues from previous generations, it can be

noticed that they were somewhat better than female students from earlier research (Matkovic and Ivanek 1993; Mišigoj-Durakovic et al. 1998). The maximal oxygen uptake of the FTE and FM female students was significantly lower than that of the FK female students, whereby the FM students had a somewhat better aerobic capacity. Hence, these differences were insignificant. Their oxygen uptake can be compared with the values of female students from similar study programs in terms of their physical activity (Mišigoj-Durakovic et al. 1998) as well as with young Croatian women under 30 (Mišigoj-Durakovic et al. 2001) and under 35 years (Heimer et al. 2004b). Research by foreign authors conducted on female students showed similar results (Bale et al. 1985). Some research showed higher results of a maximal oxygen uptake among female students of similar or the same study program as the FTE and FM female students (Tongprasert and Wattanapan 2007; Milczarczyk and Czarkowska-Paczek 2008).

It is important to mention that in relation to research where the direct measurement method was applied, the results of aerobic capacity estimated by indirect Astrand procedure are 10-15 percent lower than the direct measurement (Nieman 1990 as cited in Mišigoj-Durakovic et al. 1998).

Based on Eurofit for adults, the European Project of the Council of Europe targets the levels of the maximum oxygen uptake (Oja and Tuxworth 1995). With the project, Eurofit for adults in Croatia (Heimer et al. 2004a) norms were set for the maximal oxygen uptake measured with the Astrand test, and expressed in relative values. According to these norms, the FK female students were in the excellent category, and the groups of the FTE and FM students were in the category of the average values of maximal oxygen uptake of the adult Croatian population. Different habitual physical activities of female students certainly significantly contributed to this difference and point to a well-known fact that physical activity will result in better functional abilities.

This is supported by research on kinesiology students (Astrand et al. 1997), measured in a 33-year study, who had high scores of the maximal oxygen uptake as students, which was later regardless of the drop in the value with age (Toth et al. 1994). They were considerably above the average for their age, which the authors related to the habit of conducting physical activity throughout life. Lifelong conduction of physical activities will certainly create a healthier generations. Physicians, teachers, and kinesiologists can greatly contribute to the promotion of such an optimal lifestyle, since they have a direct impact on children and adults, and their opinion will be more readily accepted based on the very status to which they belong in the society. In order for the aforementioned experts to work properly, they must acquire as many practical and theoretical information as possible on the importance of physical activity for health already as students at universities.

CONCLUSION

In conclusion, the best motor-functional status showed the FK female students. The FM female students were better in the general strength factor (explosive, static, and repetitive strength), and more flexible than the FTE female students, who had faster movement and better coordination. The FM female students had a better aerobic capacity than the FTE students. It was concluded that there were significant differences in motor and functional abilities between the female students of the Faculties of Kinesiology, Teacher Education, and Medicine. Female students of the Faculty of Kinesiology, who conducted systematic daily physical activity, had a significantly better motor and functional status, while the female students of the Faculty of Teacher Education and the Faculty of Medicine, as a result of lifestyle that does not include or insufficiently includes systematic physical activity, showed a lower motor and functional status.

RECOMMENDATIONS

The selected study programs are closely related to human health. Thus, it is important for future professionals to have the awareness about the positive effects of physical activity. This research points to the need of the student population for organized and systematic physical exercise during the entire educational period, in the order of thorough impact on their lifestyle. Therefore, this would also influence the attitudes of future physicians, teachers, and kinesiologists in the direction of more common recommendations and implementations of physical activity.

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