South African Journal for Research in Sport, Physical Education and Recreation, 2017, 39(1): 111 -133.
Suid-Afrikaanse Tydskrif vir Navorsing in Sport, Liggaamlike Opvoedkunde en Ontspanning, 2017, 39(1): 111 - 133.
ISBN: 0379-9069

EFFECTIVENESS OF MARTIAL ARTS TRAINING VS. OTHER TYPES OF PHYSICAL ACTIVITY: DIFFERENCES IN BODY HEIGHT, BODY MASS, BMI AND MOTOR ABILITIES

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ABSTRACT

The aim of this study was to determine the relationships between various forms of physical activities and anthropometric parameters and motor abilities of female students. Measurements took place at the beginning and at the end of the summer semester. It involved 303 first-year full-time female students. The body height, body mass and BMI of participants were determined. Thirteen motor tests were administered to assess motor abilities. The tallest and slimmer students chose martial arts and jogging followed by sauna, whereas the shortest students opted for aerobics and swimming. Students with higher body mass and higher BMI scores were more likely to participate in golf, aerobics, general Physical Education (PE) and swimming classes. Students involved in martial arts, swimming and jogging scored highest in the majority of motor tests. The choice of physical activity (PA) correlated with body height, body mass, BMI and motor fitness. In most motor ability tests, a significant improvement in performance was observed in students who had opted for martial arts, swimming and jogging followed by sauna, which indicates that those activities had the most profound influence on the participants' motor fitness levels.

***Key words*:** Women; Motor performance; Anthropometric features; Forms of physical activity; Physical education.

INTRODUCTION

Scientific evidence clearly indicates that regular PA, exercise and physical fitness (PF) play a key role in the maintenance of health. Regular activities, in doses appropriate for the individual, benefit the physical and mental health of males and females of all ages, including disabled persons, and enable them to build more satisfactory social relationships (WHO, 2003; Rind & Jones, 2014). The health benefits of PA have been discussed in numerous studies into the prevention of metabolic diseases that lead to uncontrolled weight gain and obesity (Kahn & Williamson, 1991; Owens *et al*., 1992). Obesity increases the risk of serious medical problems, which contribute to poor health and premature death (Strenfeld *et al*., 2004; Choi *et al*., 2011). A balanced diet combined with an appropriate exercise regime seem to be most effective for maintaining healthy weight and physical fitness. In young adults, overweight and obesity is frequently associated with excessive weight in childhood (Lee *et al*., 2010). The majority of overweight and obese individuals are significantly less physically active than their peers with a healthy weight (Turconi *et al*., 2008; Simovska *et al*., 2012).

The levels of PA change with age (Van Tuyckom & Scheerder, 2010) and a significant decrease is noted during the transition from secondary school to university (Douglas *et al*., 1997; Smith *et al*., 2014) and during the first year at university (Bray & Born, 2004). In Poland, most female university students lead highly sedentary lives and their PA is generally limited to obligatory PE classes (Lisicki, 2006; Umiastowska, 2007; Podstawski *et al*., 2013a; Podstawski *et al*., 2014b). University students with high body mass and high BMI tend to select less intensive forms of PA than their peers with normal BMI (Podstawski *et al*., 2015). Low levels of PA contribute to a drop in PF (Ekelund *et al*., 2007). Individuals with higher PF are more inclined to be physically active than their peers with lower levels of motor competence (Wrotniak *et al*., 2006). People who remain physically active into old age are generally characterised by lower body weight, lower waist circumference and lower BMI (Dunsky *et al*., 2014).

Body size and body composition are determined by means of anthropometric measurements. There is evidence to suggest that basic anthropometric parameters (body mass and body height) and anthropometric indicators (such as BMI) are correlated with PA levels and motor abilities. Individuals with high body mass and high BMI are characterised by significantly lower levels of cardiorespiratory fitness, endurance abilities (Crecelius*et al*., 2008; Vanderburgh & Laubach, 2008), endurance-strength abilities (Podstawski *et al*., 2012; Podstawski *et al*., 2014a), as well as relative strength and coordination abilities (Mermier *et al*., 2000; Sands *et al*., 2000; Podstawski *et al*., 2016). High BMI compromises flexibility (Bénéfice & Ndiaye, 2005), but it is positively correlated with absolute strength (Mondal *et al*., 2011; Khalaf *et al*., 2013). The motor performance of tall individuals can also be compromised during certain strength and endurance exercises that require constant changes in body position (Podstawski *et al*., 2016).

PA programmes (aerobic and resistance training) involve various training methods (long duration, interval, continuous, high-intensity) with a different impact on the body. The influence of various training methods on the elements of PF is particularly visible in professional athletes and health training regimes are often based on professional training programmes. Health programmes are characterised by growing levels of specialisation and individualisation and they are largely inspired by the methods used in professional sport training.

Training programmes in various sport disciplines are developed to promote a particular set of skills and abilities, including strength (resistance training), speed (sprinting), endurance (marathon, triathlon) and flexibility (gymnastics). Strength training increases body mass through hypertrophy, namely the increase in the mass of the existing muscle fibres (Franchini *et al*., 2011). It also contributes to bone mineralisation and prevents osteoporosis (Mikesky *et al*., 1991). Speed abilities are more genetically based than strength, and the two are highly positively correlated (Vanderburgh & Laubach, 2008). For this reason, most sprinters have a muscular physique, which can be compared to that of bodybuilders (Toriola *et al*., 1985). Although endurance is determined mainly by maximal aerobic power (VO_{2max}) and muscle resistance to fatigue (Szopa, 1998), it should be noted that those parameters can be considerably impaired in individuals with high body mass and high body fat levels (Crecelius *et al*., 2008). The exercise regimes for sedentary individuals are generally referred to as health training (personal training), and they are part of comprehensive health programmes aiming to reduce body fat mass, increase lean body mass, improve body composition (Heyward, 1997; Osiński, 2003) and general PF levels.

The minimum required level of PA for young people is 60 minutes of moderate to vigorous exercise daily (USA Department of Health and Human Services, 1996; Brown & Summerbell, 2009). Research studies have demonstrated that many universities fail to meet this requirement (Douglas *et al*., 1997; Hilland *et al*., 2009; Smith *et al*., 2014). In Polish universities, the PE curriculum covers 60 academic hours (of 45 minutes each) during the entire study programme, and most PE classes take place in the first year in the form of 90-minute sessions (Podstawski & Sławek, 2012). During one semester of approximately five months, students have to attend 15 PE classes of 90 minutes each. Students choose their preferred type of activity and a PE instructor. The cited statistics differ between sources, but according to some researchers, Polish female university students are not engaged in sufficient amounts of PA during obligatory PE classes to stimulate adaptive physiological changes at socially expected levels (Grabowski, 2003). The contribution of PE classes in Polish universities to the students' PF levels and BMI has not been studied to date. Attempts should be made to determine the effectiveness of various types of PAs undertaken by female students during obligatory PE classes.

PURPOSE OF RESEARCH

In view of the above, the objective of this study was to determine the relationships between various types of PA (martial arts, general PE, swimming, aerobics, golf, jogging followed by sauna) undertaken by female students of the University of Warmia and Mazury in Olsztyn (UWM), Poland, on their body mass, body height, BMI and motor abilities.

METHODOLOGY

Ethics

The research was carried out with the prior consent of the Ethical Committee of the UWM. The study involved female student volunteers who signed a written statement of informed consent.

Participants

The study involved 303 first-year full-time female students, who were randomly selected from 260 groups of students attending obligatory PE classes at the UWM, Poland. Statistical tables were used for that purpose (Zieliński & Zieliński, 2001). Randomly selected students were asked whether they wished to participate in the study on a volunteer basis, and those who did, signed a volunteer form. If the chosen student did not wish to participate in the study, another potential candidate was randomly drawn. A total of 27 PE groups were randomly selected, and only those female students who were absent, for whatever reason, on the day the tests and measurements were performed, were excluded from the study. More than 95% of the students, aged 19 to 20 years, from the selected groups were examined. The vast majority of the participants resided permanently in the Region of Warmia and Mazury, Poland. The participants were selected from among volunteers who did not take any medication or nutritional supplements, were in good health, had no history of blood diseases or diseases affecting biochemical and biomechanical factors, and did not participate in any PA programmes other than the obligatory PE classes.

PA levels were evaluated in female students with the use of the Polish short version of the standardised and validated *International Physical Activity Questionnaire* (IPAQ) (Biernat *et al*., 2007). The participants declared the number of minutes dedicated to PA (minimum 10 minutes) during an average week preceding the study. The energy expenditure associated with weekly PA levels was expressed in terms of Metabolic Equivalent of Task (MET) units. The MET is the ratio of the work metabolic rate to the resting metabolic rate. One MET denotes the amount of oxygen consumed in 1 minute, which is estimated at 3.5mL/kg/min. Based on the frequency, intensity and duration of PA declared by the surveyed students, the respondents were classified into groups characterised by low (L=<600 METs-min/week), moderate (M=<1,500 METs-min/week) and high (H=≥1,500 METs-min/week) levels of activity.

Only female students with low levels of PA, a sedentary lifestyle and energy expenditure of up to 600 METs per week were chosen for the study. IPAQ was used only to select a homogenous sample of female students. These results are not presented in this article. The resulting sample can be regarded as representative of first-year students of the UWM in Olsztyn. Every student had to attend 15, 90-minute PE classes to receive credit. Students selected a PE teacher and a preferred type of activity online in the University's USOS WEB system. The evaluated students were presented with the following choice of PA: martial arts, general PE, swimming, aerobics, golf, jogging followed by sauna.

Instruments and procedures

Body mass and body height were measured using the Radwag scale and the results were used to calculate their BMI. Volunteers participated in 13 motor ability tests: standing long jump [cm], 4×10m shuttle run [s], 8s skipping with hand clapping [number of claps], zig-zag run [s], standing forward bend [cm], barbell overhead trunk rotation [cm], sit-ups in 30s [number of sit-ups], medicine ball (4 kg) forward throw [cm], medicine ball (4kg) backward throw [cm], flexed arm hang on bar [s], 1-minute and 3-minute Burpee tests [number of cycles], and 12-minute Cooper test on a rowing ergometer [m]. The accuracy and reliability of the applied motor ability tests were confirmed by numerous studies (Szopa *et al*., 1998). In each group, motor ability tests were conducted in the same order, beginning from coordination tests, through speed, agility, flexibility and strength tests, and concluding with endurance and strength tests. The instructions for each test were given during a PE class, and students were given sufficient time to practise. The participants performed an active warm up for 10 minutes before the tests (Frandkin *et al*., 2010).

Statistical analysis

The results of every trial were averaged and standard deviation was computed using descriptive statistics. Maximum and minimum values were also noted to classify the participants into the applicable ranges for every test. The differences in the motor abilities of students participating in different types of physical activities were determined by analysis of variance (ANOVA). The mean values of the "physical activity factor" were compared by Duncan's test. Mean values and significant variations between participants attending different PE classes were shown in tables. Data were processed and the results were analysed in the Statistica PL v. 10 software package (Rabiej, 2012).

Definition of the effectiveness of physical education classes

The effectiveness of PE classes for female university students is measured not only by the extent to which PA contributes to an improvement in PF and body mass reduction to healthy levels. The results scored by students are a reflection on their overall health, therefore, the effectiveness of PE classes is also measured in terms of health-related fitness (H-RF) criteria. In line with the H-RF approach, the goal of PF should be to improve physical health and minimise the risk of disease. Individuals who have successfully improved their PF levels have more energy, feel more motivated to accomplish daily tasks and derive a sense of accomplishment from participating in sports (Howley & Franks, 1997).

RESULTS

The evaluated body mass, body height, BMI and variations in the analysed parameters across different physical activity groups are presented in Tables 1 and 2. The significance of differences between the results of motor ability tests within groups at the beginning and end of the semester is shown in Table 3, and the significance of differences between the results of motor ability tests between groups at the beginning and end of the semester is presented in Table 6.

Differences in body mass, body height and BMI values between the beginning and end of the semester are shown in Table 1. The body mass and BMI of all female students (regardless of the type of chosen physical activity) increased significantly by 0.05kg (p=0.0010) and 0.02kg/m^2 (p=0.0003), respectively. A significant decrease in body mass was found in students performing martial arts (p=0.0000) and jogging followed by sauna (p=0.0000), whereas a significant increase in body mass was observed in participants attending golf (p=0.0000), general PE (p=0.0000), aerobics (p=0.0016) and swimming classes (p=0.0000). Similar correlations were generally noted in BMI values of the entire population, regardless of the type of PA. BMI increased significantly by 0.02kg/m^2, but it remained within the reference range at the beginning and end of the semester. A significant decrease in BMI was noted in students performing martial arts (p=0.0000) and jogging followed by sauna (p=0.0000), whereas a significant increase in BMI was observed in participants attending golf (p=0.0000), general PE (p=0.0000), aerobics (p=0.0014) and swimming classes (p=0.0000). Martial arts students were tallest (mean of 166.10cm) and students attending swimming classes were shortest (156.69cm) (Table 1).

The results presented in Table 2 indicate that at the end of the semester, the body mass of martial arts students (1) was significantly lower than the body mass of students attending general PE, swimming, aerobics and golf classes (2,3,4,5), whereas the body mass of joggers (6) was significantly lower than the body mass of students attending general PE and swimming classes (2,3).

Table 1. **BODY MASS, BODY HEIGHT AND BMI AT BEGINNING AND END OF SUMMER SEMESTER**

Activity	**Anthropometric parameters**	**Begin semester** Mean±SD	Min-Max	**End semester** Mean±SD	Min-Max	p-Value (Sign.)
Martial arts	Body mass [kg]	57.10±4.81	49.70-70.20	56.90±4.80	49.20-69.70	**0.0000**
n=41	Body height [cm]	166.10±8.72	149-183	166.10±8.72	149-183	*ns*
	BMI (kg/m²)	20.76±1.82	17.39-25.39	20.69±1.81	17.30-25.27	**0.0000**
PE classes	Body mass [kg]	63.37±6.91	54.10-89.30	63.48±6.89	54.20-89.50	**0.0000**
n=107	Body height [cm]	160.18±7.93	148-182	160.18±7.93	148-182	*ns*
	BMI (kg/m²)	24.88±3.73	19.19-39.69	24.92±3.72	19.32-39.78	**0.0000**
Swimming	Body mass [kg]	62.93±6.36	53.10-82.30	63.07±6.35	53.30-82.50	**0.0000**
n=68	Body height [cm]	156.69±6.60	146-176	156.69±6.60	146-176	*ns*
	BMI (kg/m²)	25.74±3.20	19.98-35.62	25.79±3.20	20.05-35.71	**0.0000**
Aerobics	Body mass [kg])	60.59±6.06	54.20-78.20	60.68±6.06	54.20-78.40	**0.0016**
n=63	Body height [cm]	157.92±7.24	149-178	157.92±7.24	149-178	*ns*
	BMI (kg/m²)	24.47±3.57	19.47-34.37	24.50±3.58	19.51-34.28	**0.0014**
Golf	Body mass [kg]	59.44±4.22	56.10-73.10	59.86±4.15	56.60-73.00	**0.0000**
n=25	Body height [cm]	158.44±5.99	149-172	158.44±5.99	149-172	*ns*
	BMI (kg/m²)	23.81±2.84	19.74-30.82	23.98±2.83	19.88-30.78	**0.0000**
Jogging	Body mass [kg]	58.86±5.91	49.90-76.30	58.47±5.83	49.50-75.60	**0.0000**
then sauna	Body height [cm]	162.30±9.53	148-182	162.30±9.53	148-182	*ns*
n=23	BMI (kg/m²)	22.41±2.09	18.11-26.85	22.27±2.08	17.96-26.64	**0.0000**
Total group	Body mass [kg]	61.28±6.49	49.70-89.30	61.33±6.51	49.20-89.50	**0.0009**
N=327	Body height [cm]	159.86±8.14	146-183	159.86±8.14	146-183	*ns*
	BMI (kg/m²)	24.16±3.56	17.39-39.69	24.18±3.58	17.30-39.78	**0.0003**

ns = No significant difference p= Probability of exceeding calculated chi-square value

Table 2. **ANTHROPOMETRIC PARAMETERS OF ACTIVITY GROUPS (END OF SEMESTER)**

Parameter	**Activity group** **1** Mean±SD(min-max)	**2** Mean±SD(min-max)	**3** Mean±SD(min-max)	**4** Mean±SD(min-max)	**5** Mean±SD(min-max)	**6** Mean±SD(min-max)	**Diffe-rence**
Body mass [kg]	56.90±4.80 (49.2-69.7)	63.48±6.89 (54.2-89.5)	63.07±6.35 (53.3-82.5)	60.68±6.06 (54.2-78.0)	59.86±4.15 (56.6-73.0)	58.47±5.83 (49.5-75.6)	2.3.4.5>1 2.3>6
Body height [cm]	166.10±8.7 (149-180)	160.18±7.9 (148-182)	156.69±6.6 (146-176)	157.92±7.2 (149-178)	158.44±6.0 (149-172)	162.30±9.5 (148-182)	1>2.5.4.3 2>3
BMI [kg/m²]	20.69±1.81 (17.3-25.3)	24.92±3.72 (19.3-39.8)	25.79±3.20 (20.1-35.7)	24.50±3.58 (19.5-34.3)	23.98±2.83 (19.9-30.8)	22.27±2.08 (18.0-26.6)	3.2.4.5>1 3.2>6

1=Martial arts, 2=General PE, 3=Swimming, 4=Aerobics, 5=Golf, 6=Jogging then sauna BMI= Body Mass Index

Martial art students (1) were significantly taller than students attending general PE, swimming, aerobics and golf classes (2,3,4,5), and students participating in general PE were significantly taller than swimmers. An analysis of BMI values at the end of the semester revealed that swimmers (3) were overweight, whereas the body mass of the remaining students was within the norm, while participants attending golf and general PE classes (2,5) occupied the upper limit of the normal range of values. The lowest BMI values were noted in the martial arts group (1), and they were significantly lower than in groups of students attending general PE, swimming, aerobics and golf classes (2,3,4,5). At the end of the semester, the BMI of joggers (6) was significantly lower in comparison with students involved in general PE classes and swimming (2,3) (Table 2).

Martial arts students significant improved their results in all motor ability tests at the end of the semester. In the group of students attending general PE classes, a significant deterioration in results at the end of the summer semester was noted in the standing long jump (p=0.0130), skipping with hand clapping (p=0.0000), barbell overhead trunk rotation (p=0.0078) and 30s sit-ups (p=0.0416). A significant improvement was observed only in the medicine ball forward throw test (p=0.0073), whereas no significant differences were found in the remaining motor ability tests (Table 3).

In the group of swimmers, a significant improvement in results was observed in the following motor ability tests: 8s skipping with hand clapping (p=0.0001), 30s sit-ups (p=0.0000), medicine ball forward and backward throw (p=0.0000 for both tests), flexed arm hang on bar (p=0.0000), 1-minute and 3-minute Burpee tests (p=0.0000 for both tests) and the 12-minute Cooper test on a rowing ergometer (p=0.0000). Their results deteriorated in the standing downward bend (p=0.0122), whereas no significant differences were observed in the remaining motor ability tests. The results scored by aerobics participants deteriorated in the following tests: standing long jump (p=0.0000), 4×10m shuttle run (shorter time is a better result, p=0.0000), 8s skipping with hand clapping (p=0.0193), zig-zag run (shorter time is a better result, p=0.0038), 30s sit-ups (p=0.0242), medicine ball backward throw (p=0.0000), 1-minute and 3-minute Burpee tests (p=0.0138 and p=0.0026, respectively) and the 12-minute Cooper test on a rowing ergometer (p=0.0000). A significant improvement in results was noted only in the standing downward bend test (p=0.0428), whereas the differences observed in the remaining tests were not significant (Table 3).

In the group of golfers, a significant deterioration in test results was observed in the 4×10m shuttle run (p=0.0280), zig-zag run (p=0.0000), medicine ball forward throw (p=0.0058) and the 3-minute Burpee test (p=0.0084). No significant differences in the remaining tests were noted in the group of golf players between the beginning and end of the summer semester. Students who jogged and used a sauna significantly improved their results in the standing long jump (p=0.0021), 4×10m shuttle run (p=0.0001), zig-zag run (p=0.0000), medicine ball forward throw (p=0.0000), medicine ball backward throw (p=0.0114), 1-minute and 3-minute Burpee test (p=0.0000 for both tests), and the 12-minute Cooper test on a rowing ergometer (p=0.0000). No significant differences in results were noted in the remaining motor ability tests: 8s skipping with hand clapping (p=0.8866), standing downward bend (p=0.5365), barbell overhead trunk rotation (p=0.6760), 30s sit-ups (p=0.0566) and flexed arm hang on bar (p=0.0779) (Table 3).

Table 3. **MOTOR ABILITY TESTS SCORED AT BEGINNING AND END OF SEMESTER ACCORDING TO ACTIVITY**

Activity	Motor ability tests	Beginning of semester Mean±SD (min-max)	End of semester Mean±SD (min-max)	Sign. Differences (p)
Martial arts	Standing long jump [cm]	179.37±11.59 (165-211)	180.41±11.43 (165-211)	**0.0032**
	4×10m shuttle run [s]	12.41±0.62 (10.81-13.45)	11.97±0.60 (10.76-12.95)	**0.0000**
	8s Skipping & hand claps [no. claps]	22.59±1.86 (18-27)	25.93±1.52 (23-29)	**0.0000**
	Zig-zag run [s]	30.56±1.19 (28.14-32.78)	28.78±0.86 (27.00-30.91)	**0.0000**
	Standing downward bend [cm]	8.34±2.24 (4-14)	11.78±2.52 (8-17)	**0.0000**
	Barbell overhead trunk rotation [cm]	71.73±6.26 (60-85)	67.27±6.42 (54-80)	**0.0000**
	30s Sit-ups [no. sit-ups]	18.93±1.94 (16-23)	22.00±1.99 (18-27)	**0.0000**
	Medicine ball backward throw [cm]	744.63±105.79 (560-940)	815.00±105.79 (620-1050)	**0.0000**
	Medicine ball forward throw [cm]	600.24±77.18 (470-780)	657.68±81.30 (530-830)	**0.0000**
	Flexed arm hang on bar [s]	9.19±9.04 (2.00-45.23)	11.76±10.64 (3.46-51.34)	**0.0000**
	1-min Burpee test [no. cycles]	16.80±2.22 (14-22)	19.37±2.50 (17-26)	**0.0000**
	3-min Burpee test [no. cycles]	52.56±4.04 (44-61)	55.51±4.31 (47-64)	**0.0000**
	12-min Cooper test, rowing ergometer [m]	1838.85±165.48 (1549-2156)	1939.95±186.86 (1620-2340)	**0.0000**
Physical education	Standing long jump [cm]	161.95±16.19 (119-205)	161.32±16.26 (120-207)	**0.0130**
	4×10m shuttle run [s]	12.52±3.68 (10.87-46.00)	12.39±0.82 (10.59-14.78)	*ns*
	8s Skipping & hand claps [no. claps]	23.19±2.61 (17-28)	21.99±2.59 (13-27)	**0.0000**
	Zig-zag run [s]	28.27±2.85 (22.53-34.99)	28.30±2.49 (23.98-34.40)	*ns*
	Standing downward bend [cm]	4.74±3.40 (-5-13)	4.54±3.90 (-6-13)	*ns*

Continued

Activity	Motor ability tests	Beginning of semester Mean±SD (min-max)	End of semester Mean±SD (min-max)	Sign. Differences (p)
Physical education	Barbell overhead trunk rotation [cm]	69.80±6.06 (54-88)	70.30±5.81 (56-85)	**0.0078**
	30s Sit-ups [no. sit-ups]	19.80±3.73 (12-27)	19.41±3.59 (12-27)	**0.0416**
	Medicine ball backward throw [cm]	646.08±118.29 (420-1000)	647.47±125.90 (380-1060)	*ns*
	Medicine ball forward throw [cm]	547.53±88.78 (380-800)	552.52±90.21 (370-820)	**0.0073**
	Flexed arm hang on bar [s]	5.03±6.65 (0.00-38.03)	4,95±6.67 (0.00-45.99)	*ns*
	1-min Burpee test [no. cycles]	18.02±7.86 (12-91)	17.44±2.39 (11-23)	*ns*
	3-min Burpee test [no. cycles]	48.98±8.45 (18-62)	49.28±8.60 (16-62)	*ns*
	12-min Cooper test, rowing ergometer [m]	1644.34±309.15 (845-2359)	1649.46±313.57 (788-2340)	*ns*
Swimming	Standing long jump [cm]	157.98±14.74 (126-188)	158.31±15.26 (127-190)	*ns*
	4×10m shuttle run [s]	12.97±0.85 (11.08-15.23)	12.94±0.80 (10.87-15.04)	*ns*
	8s Skipping & hand claps [no. claps]	24.59±2.65 (17-34)	25.55±2.91 (18-36)	**0.0001**
	Zig-zag run [s]	30.19±2.72 (24.58-35.46)	30.06±2.62 (25.69-34.87)	*ns*
	Standing downward bend [cm]	6.84±4.69 (-1- 18)	6.41±4.92 (-2- 20)	**0.0122**
	Barbell overhead trunk rotation [cm]	64.67±4.59 (55-74)	64.34±4.52 (55-74)	*ns*
	30s Sit-ups [no. sit-ups]	15.19±2.77 (11-23)	17.48±3.02 (11-25)	**0.0000**
	Medicine ball backward throw [cm]	720.63±126.68 (470-1000)	747.97±126.83 (500-1080)	**0.0000**
	Medicine ball forward throw [cm]	587.97±96.73 (400-820)	641.72±99.40 (450-890)	**0.0000**
	Flexed arm hang on bar [s]	4.34±2.49 (0.00-14.47)	5.71±2.78 (1.23-17.87)	**0.0000**
	1-min Burpee test [no. cycles]	17.39±3.12 (11-24)	18.83± 3.59 (10-28)	**0.0000**

Continued

Activity	Motor ability tests	Beginning of semester Mean±SD (min-max)	End of semester Mean±SD (min-max)	Sign. Differences (p)
Swimming	3-min Burpee test [no. cycles]	47.50±3.58 (39-54)	49.81±3.39 (42-55)	**0.0000**
	12-min Cooper test, rowing ergometer [m]	1488.67±245.35 (712-1997)	1630.31±251.63 (889-2147)	**0.0000**
Aerobics	Standing long jump [cm]	155.06±16.19 (123-193)	153.06±16.21 (120-192)	**0.0000**
	4×10m shuttle run [s]	12.77±0.84 (11.00-15.12)	13.12±0.73 (11.72-15.47)	**0.0000**
	8s Skipping & hand claps [no. claps]	23.49±2.21 (19-29)	22.70±2.22 (17-27)	**0.0193**
	Zig-zag run [s]	30.66±2.52 (24.59-37.89)	30.95±2.55 (25.28-37.03)	**0.0038**
	Standing downward bend [cm]	6.94±4.78 (-6- 23)	7.81±5.20 (-9-21)	**0.0428**
	Barbell overhead trunk rotation [cm]	69.00±5.86 (58-81)	69.34±5.41 (57-80)	*ns*
	30s Sit-ups [no. sit-ups]	16.17±4.11 (6-24)	15.62±4.00 (7-22)	**0.0242**
	Medicine ball backward throw [cm]	628.87±97.24 (370-860)	612.60±97.69 (350-840)	**0.0000**
	Medicine ball forward throw [cm]	559.15±89.76 (350-800)	561.51±91.76 (340-790)	*ns*
	Flexed arm hang on bar [s]	4.81±7.03 (0.00-45.12)	4.64±7.21 (0.00-46.06)	*ns*
	1-min Burpee test [no. cycles]	17.13±2.19 (13-22)	16.51±1.86 (11-21)	**0.0138**
	3-min Burpee test [no. cycles]	45.77±5.97 (31-58)	44.85±5.73 (29-57)	**0.0026**
	12-min Cooper test, rowing ergometer [m]	1300.13±194.07 (923-1698)	1250.02±201.67 (823-1671)	**0.0000**
Golf	Standing long jump [cm]	157.98±14.74 (126-188)	158.31±15.26 (127-190)	**0.0032**
	4×10m shuttle run [s]	12.97±0.85 (11.08-15.23)	12.94±0.80 (10.87-15.04)	**0.0000**
	8s Skipping & hand claps [no. claps]	24.59±2.65 (17-34)	25.55±2.91 (18-36)	**0.0000**

Continued

Activity	Motor ability tests	Beginning of semester Mean±SD (min-max)	End of semester Mean±SD (min-max)	Sign. Differences (p)
Golf	Zig-zag run [s]	30.19±2.72 (24.58-35.46)	30.06±2.62 (25.69-34.87)	**0.0000**
	Standing downward bend [cm]	6.84±4.69 (-1- 18)	6.41±4.92 (-2- 20)	**0.0000**
	Barbell overhead trunk rotation [cm]	64.67±4.59 (55-74)	64.34±4.52 (55-74)	**0.0000**
	30s Sit-ups [no. sit-ups]	15.19±2.77 (11-23)	17.48±3.02 (11-25)	**0.0000**
	Medicine ball backward throw [cm]	720.63±126.68 (470.00-1000)	747.97±126.83 (500-1080)	**0.0000**
	Medicine ball forward throw [cm]	587.97±96.73 (400-820)	641.72±99.40 (450-890)	**0.0000**
	Flexed arm hang on bar [s]	4.34±2.49 (0.00-14.47)	5.71±2.78 (1.23-17.87)	**0.0000**
	1-min Burpee test [no. cycles]	17.39±3.12 (11-24)	18.83±3.59 (10-28)	**0.0000**
	3-min Burpee test [no. cycles]	47.50±3.58 (39-54)	49.81±3.39 (42-55)	**0.0000**
	12-min Cooper test, rowing ergometer [m]	1488.67±245.35 (712-1997)	1630.31±251.63 (889-2147)	**0.0000**
Jogging and sauna	Standing long jump [cm]	176.22±11.48 (156-204)	177.39±11.30 (160-205)	**0.0021**
	4×10m shuttle run [s]	12.35±0.88 (10.15-13.56)	12.08±0.82 (10.28-13.52)	**0.0001**
	8s Skipping & hand claps [no. claps]	24.78±2.49 (19-28)	24.87±2.80 (17-30)	*ns*
	Zig-zag run [s]	29.39±3.17 (24.15-36.89)	28.68±3.31 (23.18-35.83)	**0.0000**
	Standing downward bend [cm]	3.43±2.39 (0-9)	3.74±2.97 (-2- 9)	*ns*
	Barbell overhead trunk rotation [cm]	69.26±5.20 (58-76)	69.43±4.05 (61-75)	*ns*
	30s Sit-ups [no. sit-ups]	19.83±3.46 (11-26)	19.00±3.57 (10-26)	*ns*
	Medicine ball backward throw [cm]	683.04±154.14 (500-1000)	702.43±154.40 (520-1030)	**0.0000**
	Medicine ball forward throw [cm]	546.96±89.35 (410-720)	556.09±85.37 (420-720)	**0.0114**

Continued

Activity	Motor ability tests	Beginning of semester Mean±SD (min-max)	End of semester Mean±SD (min-max)	Sign. Differences (p)
Jogging and sauna	Medicine ball forward throw [cm]	546.96±89.35 (410-720)	556.09±85.37 (420-720)	**0.0114**
	1-min Burpee test [no. cycles]	16.96±2.31 (13-22)	19.48±1.86 (16-24)	**0.0000**
	3-min Burpee test [no. cycles]	51.83±5.22 (41-58)	55.13±4.80 (45-62)	**0.0000**
	12-min Cooper test, rowing ergometer [m]	1411.87±166.48 (1023-1717)	1529.61±171.38 (1158-1892)	**0.0000**

ns = No significant difference p= Probability of exceeding calculated chi-square value

In the *standing long jump*, women performing martial arts (1) and jogging followed by sauna (6) scored significantly better results at the end of the semester than students attending general PE, swimming, aerobics and golf classes (2,3,4,5) (Table 4). The results scored by martial arts students (1) and joggers (6) in the *4×10m shuttle run* test were significantly better than those of swimming, aerobics and golf students (3,4,5). Women enrolled in general PE classes (2) significantly outperformed swimming and aerobics students (3,4). In the *8s skipping with hand clapping* tests, martial arts students (1) also scored the best results which were significantly higher than those reported in general PE, aerobics and golf groups (2,4,5). Golfers (5) scored significantly below students from the remaining groups (2,3,4,6). The results of students enrolled in general PE classes (2) were significantly below those noted in the group of swimmers (3), and the results of aerobics students (4) were significantly below those scored by swimmers and joggers (3,6). In the zig-zag run, martial arts students (1) significantly outperformed aerobics students (4), and students attending general PE classes scored significantly higher results than swimming, aerobics and golf students (3,4,5).

In the *standing downward bend* test, martial arts students (1) performed significantly better than women from the remaining groups (2,3,4,5,6), whereas aerobics students (4) significantly outperformed women enrolled in general PE, golf and jogging classes (2,5,6). In the *barbell overhead trunk rotation* test, swimmers (3) scored significantly higher results (achieved a greater degree of mobility at the glenohumeral joint) than women from the remaining groups (2,4,5,6), excluding martial arts students (1) whose performance was superior to that of general PE class students (2). In the *30s sit-ups*, martial arts students (1) scored significantly higher results than students from the remaining activity groups (2,3,4,5,6). Students enrolled in general PE classes (2) scored significantly higher results than swimming, aerobics and golf students (3,4,5). Joggers (6) significantly outperformed aerobics students (4).

In *medicine ball forward and* backward throw tests, martial arts students (1) performed significantly better than general PE, aerobics, golf and jogging students (2,4,5,6). In both tests, swimmers (3) scored significantly higher results than women attending general PE and aerobics (2,4) classes. Swimmers (3) significantly outperformed joggers (6) in the medicine ball forward throw. In the *flexed arm hang on bar*, martial arts students (1) scored significantly better results than general PE, swimming, aerobics and golf students (2,3,4,5). Swimmers (3) and joggers (6) significantly outperformed students attending general PE, aerobics and golf classes (2,4,5).

Table 4. **DIFFERENCES AMONG DIFFERENT ACTIVITY GROUPS: MOTOR ABILITY TESTS**

Motor ability tests	**Activity groups** **1** Mean±SD (min-max)	**2** Mean±SD (min-max)	**3** Mean±SD (min-max)	**4** Mean±SD (min-max)	**5** Mean±SD (min-max)	**6** Mean±SD (min-max)	**Difference**
Standing long jump [cm]	180.41±11.43 (165-211)	161.32±16.26 (120-207)	158.31±15.26 (127-190)	153.06±16.21 (120-192)	157.60±17.53 (111-188)	177.39±111.3 (160-205)	1.6>2.3.5.4
4×10m shuttle run [s]	11.97±0.60 (10.76-12.95)	12.39±0.82 (10.59-14.78)	12.94±0.80 (10.87-15.04)	13.12±0.73 (11.72-15.47)	13.12±1.16 (11.40-15.87)	12.08±0.82 (10.28-13.52)	5.4.3<1 5.4.3<6; 4.3<2
8s Skip & hand claps [no. claps]	25.93±1.52 (23-29)	23.19±2.61 (17-28)	25.55±2.91 (18-36)	22.70±2.22 (17-27)	19.16±1.37 (16-21)	24.87±2.80 (17-30)	1>2.4.5 3.6.2.4>5 3>2; 3.6>4
Zig-zag run [s]	28.78±0.86 (27.00-30.91)	28.30±2.49 (23.98-34.40)	30.06±2.62 (25.69-34.87)	30.95±2.55 (25.28-37.03)	30.78±3.80 (22.23-37.92)	28.68±3.31 (23.18-35.83)	4<1; 4.5.3<2 4<6.2
Standing downward bend [cm]	11.78±2.52 (8-17)	4.54±3.90 (-6- 13)	6.41±4.92 (-2- 20)	7.81±5.20 (-9- 21)	4.52±3.14 (-2- 9)	3.74±2.97 (-2- 9)	1>4.3.2.5.6 4>2.5.6
Barbell overh. trunk rotation [cm]	67.27±6.42 (54-80)	70.30±5.81 (56-85)	64.34±4.52 (55-74)	69.34±5.41 (57-80)	68.60±5.02 (58-80)	69.43±4.05 (61-75)	2.6.4.5<3 2<1
30s Sit-ups [no. sit-ups]	22.00±1.99 (18-27)	19.41±3.50 (12-27)	17.48±3.02 (11-25)	15.62±4.00 (7-22)	16.64±1.89 (13-19)	19.00±3.57 (10-26)	1>2.6.3.5.4 2>3.5.4; 6>4
Med. ball backward throw [cm]	815.00± 105.79 (620-1050)	647.47± 125.90 (380-1060)	747.97± 126.83 (500-1080)	612.60± 97.69 (350-840)	681.52± 96.43 (463-860)	702.43± 154.40 (520-1030)	1>6.5.2.4 3>2.4
Med. ball forward throw [cm]	657.68±81.30 (530-830)	552.52±90.21 (370-820)	641.72±99.40 (450-890)	561.51±91.76 (340-790)	570.60±87.87 (330-670)	546.96±89.35 (410-720)	1>5.4.2.6 3>4.2.6
Flexed arm hang on bar [s]	11.76±10.64 (3.46-51.34)	4.95±6.67 (0.00-45.99)	5.71±2.78 (1.23-17.87)	4.64±7.21 (0.00-46.06)	2.23±2.00 (0.00-5.45)	7.76±5.10 (1.01-18.98)	1>3.2.4.5 6.3>2.4.5
1-min Burpee test [no. cycles]	19.37±2.50 (17-26)	17.44±2.39 (11-23)	18.83± 3.59 (10-28)	16.51±1.86 (11-21)	15.32±1.84 (12-18)	19.48±1.86 (16-24)	1>2.4.5; 6.3.2>5 6>2; 6.3>4
3-min Burpee test [no. cycles]	55.51±4.31 (47-64)	49.28±8.60 (16-62)	49.81±3.39 (42-55)	44.85±5.73 (29-57)	37.60±7.98 (22-49)	55.13±4.80 (45-62)	1>3.2.4.5 6.3.2>5; 6>2.4.3; 2>4; 3>4
12-min row ergometer [m]	1939.95± 186.86 (1620-2340)	1649.46± 313.57 (788-2340)	1630.31± 251.63 (889-2147)	1250.02± 201.67 (823-1671)	1409.40± 187.04 (980-1680)	1529.61± 171.38 (1158-1892)	1>2.3.6.5.4 2.3>5; 2.3.6>4

1=Martial arts, 2=General PE, 3=Swimming, 4=Aerobics, 5=Golf, 6=Jogging then sauna

In 1- and 3-minute Burpee tests, significant differences in results were observed between the evaluated activity groups. In the *1-minute Burpee test*, martial arts students (1) significantly outperformed women enrolled in general PE, aerobics and golf classes (2,4,5), whereas golfers (5) scored significantly lower results than students participating in general PE, swimming and jogging classes (2,3,6). Significant differences were also noted between joggers (6), general PE students (2), between swimmers (3) and joggers (6), and aerobics students (4). In the *3-minute Burpee test*, martial arts students (1) significantly outperformed women from the remaining activity groups (2,3,4,5), excluding joggers (6). Golfers (5) scored significantly lower results than students attending general PE, swimming and jogging classes (2,3,6). Other relationships between the analysed activity groups were also noted: jogging followed by sauna (6), general PE, swimming and aerobics (2,3,4), general PE and swimming (2,3) and aerobics (4). In the 12-minute Cooper test on a rowing ergometer, martial arts students (1) significantly outperformed women from the remaining groups (2,3,4,5,6). General PE students (2) and swimmers (3) scored significantly higher results than golfers (5) and aerobics students (4) and joggers (6) significantly outperformed aerobics students (4) (Table 4).

DISCUSSION

According to experts, an improvement in PF levels and a periodic reduction in body fat due to physical training are relatively easier to accomplish than permanent changes in eating habits combined with regular exercise. For this reason, many individuals participating in voluntary PA programmes are able to improve their PF and reduce their body mass within a relatively short time, but those who give up training after two to three months return to their baseline weight or are even heavier (the yo-yo effect) (King, 2001). Not all individuals are able to achieve the set goals with equal determination and their efforts are influenced by lifestyle, habits, PA levels, gender, health status, overall fitness levels and traits of character, such as motivation, willpower and temperament. Goal achievement is also influenced by environmental factors and the type of undertaken PA (Podstawski *et al*., 2013b), but 30 to 50% of individuals who enrol in a health programme quit after two to three months, whereas more than 50% of individuals quit after approximately six months (Neupert *et al*., 2009). The highest quit rates are noted among people with a sedentary life style. The female students investigated in the current study fell into this category. Nevertheless, a regular exercise regimen as part of obligatory PE classes over a period of five months could be expected to bring positive results. Studies of HR-F (Health Related Fitness) programmes revealed that participants who do not quit in the first 6 months are more likely to continue their training (Dishman & Salis, 1994; Neupert *et al*., 2009).

An analysis of the results scored in various groups indicated that body height, body mass and BMI scores influenced the students' choice of PA. The slimmest and tallest women preferred more intense PAs (martial arts, jogging followed by sauna), whereas students characterised by lower body height and higher body mass opted for the least intense forms of PA (golf, general PE and aerobics). Highly similar results were also reported in a study of male university students where participants with significantly higher body mass and BMI were more likely to choose strength exercises involving several repetitions with relatively long breaks in between sets, Nordic walking and golf. Martial arts, team sports and jogging were more frequently selected by leaner students with higher PF levels. Taller students were more inclined to choose volleyball (Podstawski *et al*., 2015).

The observed correlations were validated by other authors who demonstrated that excessive body mass and obesity have a negative influence of PA levels regardless of age and gender (Janssen *et al*., 2005). Similar trends were noted among pre-school and early primary school students (D'Hondt *et al*., 2009; Krombkolz, 2011). The only exception was reported in a study of underweight female students from south-western Saudi Arabia whose PA levels were significantly lower in comparison with their obese peers. The authors of the cited study attributed those findings to socioeconomic and cultural factors (Khalaf *et al*., 2013). In the current study, the only exception to the above rule were overweight students (BMI=25.74 to 25.79kg/m^2) who were involved in swimming, a relatively intense form of PA. It should be noted, however, that apparent body mass in water is quite low due to high water displacement, therefore, resistance levels are low in high-intensity water exercises. The above theory was confirmed by Gwinup (1987) and Jang *et al*. (1987), who investigated obesity in athletes and regular swimmers. The cited authors noted that swimmers were characterised by higher fat tissue levels (men=12%, women=20%) in comparison with runners (men=7%, women=15%) who burned similar amounts of energy during training (Flynn *et al*., 1990). According to Jang *et al*. (1987), swimmers were also sleepier and less active during daytime.

Various types of PA involve different forms of movement (Angyán *et al*., 2003; McGawley & Bishop, 2006) and lead to different changes in anthropometric parameters and PF levels (Almeida *et al*., 2013). A reduction in body mass and BMI and an improvement in PF (1-mile run, trunk flexion test, curl-ups, grasping force (Rt), grasping force (Lr) and long-jump) was observed among obese children performing aerobic training and combined (aerobic/resistance) training as part of a 10-week PA programme (Lee *et al*., 2010). In a group of male university students engaged in various types of PA, a significant increase in body mass and BMI was reported only in bodybuilders, significant changes in the above parameters were not noted in respondents who chose martial arts, jogging followed by sauna, golf and general PE classes, whereas a significant decrease was observed in volleyball players (Podstawski *et al*., 2015). Kayihan (2014) studied 236 volunteers, including 84 martial arts athletes, 72 team sport athletes and 80 non-sport participants, and observed significant differences in body mass, BMI, body height, body fat and skinfold thickness between the analysed subjects. Martial arts athletes were significantly shorter than team sport athletes. Martial arts athletes were also characterised by significantly lower body fat and skinfold thickness than non-sport participants (Kayihan, 2014).

Changes in somatotype and motor fitness are most visible in professional athletes whose somatic type and constitutional physiognomy are characteristic of a given discipline (Thorland *et al*., 1981). Our study evaluated university students with a sedentary lifestyle, but the noted anthropometric parameters, BMI values and the results of motor ability tests validate the above assumption. Female students attending swimming, general PE, aerobics and golf classes were characterised by the highest BMI values at the beginning of the semester, their fat tissue levels increased significantly during the study and were highest at the end of the semester. By contrast, body mass and BMI values decreased significantly in martial arts students and joggers.

A comparison of motor ability test results between the beginning and end of the semester revealed that certain activities have a more pronounced and stimulating effect on PF levels than other exercises. The vast majority of students performing high-intensity PAs significantly improved their results at the end of the semester. The most striking improvement was noted in the group of martial arts students who scored higher results in all motor ability tests, swimmers who scored higher results in nine tests, and joggers who scored higher results in eight tests. Female students attending martial arts, swimming and jogging classes represented the most developed and well-rounded groups of participants in terms of the assessed motor abilities at the end of the semester. At the end of the semester, martial arts students outperformed the participants from the remaining activity groups in the highest number of motor ability tests. In another study, male students practising martial arts were also more physically fit than those attending bodybuilding/fitness, volleyball, jogging, golf and general PE classes (Podstawski *et al*., 2013b; Podstawski *et al*., 2015). Kayihan (2014) compared individuals engaged in various types of PA and demonstrated that although martial arts performers were characterised by significantly higher muscular endurance and flexibility than team sport and non-sport participants, martial arts athletes had significantly lower aerobic capacity than team sports athletes. According to some researchers, martial arts deliver a host of physiological benefits for young adults (Shaw & Deutsch, 1982, Douris *et al*., 2004), medium-aged subjects (Heller *et al*., 1998; Fong & Ng, 2011) and the elderly (Lan *et al*., 1998; Hong *et al*., 2000), including an improvement in health-related fitness indicators.

The improvement in the results of selected motor ability tests at the end of the semester could also be attributed to the specific features of a given sports discipline relating to the frequency of targeted exercises. Aerobics involves a significant number of flexibility exercises, which is why aerobics students were able to improve their sagittal spinal flexibility (standing downward bend). Swimmers significantly improved their performance in strength tests (medicine ball forward and backward throw, 30s sit-ups, flexed arm hang), endurance-strength tests (1- and 3-minute Burpee test), endurance tests (12-minute Cooper test on a rowing ergometer) and coordination tests (8s skipping with hand clapping). Swimmers were able to improve their results in the above tests, because the majority of swimming exercises are high-intensity activities that engage nearly all locomotive muscles and promote strength, endurance and coordination (Hall *et al*., 1996). There is evidence to suggest that the apparent loss of body mass in water improves nerve and muscle coordination due to considerable muscle relaxation (Westby, 2001; Bartles *et al*., 2007) and that regular activities in water contribute to an overall improvement in cardiovascular efficiency (Chase *et al*., 2008). Other authors have demonstrated that ball games and free play (soccer, basketball and football) increase the heart rate more significantly than gymnastics (MacFarlane & Kwong, 2003). Research studies indicate that students participating in team sport spend more time in the high-intensity exercise zone (characterised by higher mean heart rate) than students performing other sport (Klausen *et al*., 1986; Kulinna *et al*., 2003).

In the current study, female students who participated in less intense PAs improved their results in selected motor ability tests, but in the remaining tests, their scores did not change or even deteriorated significantly. The above was observed in the group of aerobics students whose results deteriorated in nine motor ability tests, followed by golf and general PE students whose results deteriorated in four tests. The observed deterioration in the results of selected motor ability tests could result from negligence on behalf of the teachers who focused on technical and tactical aspects of a given sports discipline, but disregarded general health and development goals. The deterioration in sagittal spinal flexibility could have resulted from the teachers' failure to incorporate flexibility exercises during swimming classes (during warm-up or at the end of the class). Despite an absence of significant changes in results, swimmers were characterised by the highest mobility in the region of the shoulder girdle (barbell overhead trunk rotation), which could be attributed to dolphin and front crawl strokes that improve shoulder joint mobility. The deterioration noted in the results of speed tests (4×10m shuttle run, zig-zag run), strength tests (standing long jump, 30s sit-ups, medicine ball backward throw), endurance-strength tests (1- and 3-minute Burpee test), endurance tests (12-minute Cooper test on a rowing ergometer) and coordination tests (8s skipping with hand clapping), and the lowest motor fitness levels in the aerobics group can be undoubtedly attributed to teachers' negligence.

During the summer semester, female students attended only 15, 90-minute classes conducted once a week, which suggests that their PA levels were low. The number of PE classes was insufficient to promote a significant improvement in test results, but other research demonstrated that rowing for 500m on an ergometer only once a week delivered numerous benefits for sedentary students (Podstawski *et al*., 2009). Interestingly, the cited study demonstrated that the participants were able to improve their rowing times only up to a certain level (5 to 6 training sessions), after which their results ceased to improve.

PRACTICAL APPLICATION

This study revealed that despite a limited number of PE classes during the academic year, female university students are presented with a wide variety of PA options. Certain types of activities improve motor ability, others have weak or no effects, whereas some activities can even lead to a deterioration in motor abilities. PE teachers can improve the students' fitness levels by encouraging them to participate in high-intensity exercise routines. The results of the current study can be used to design a new PE programme with emphasis on health training. Despite the allocated number of class hours in the academic curriculum, the rigid system of 15, 90-minute weekly classes can be replaced with more flexible options. Subject to technical possibility, high-intensity activities could be divided into 30- to 60-minute training sessions held more than once a week.

LIMITATIONS

International classification standards have not been developed for several tests in the applied battery of 13 motor ability trials, therefore, the students' average fitness levels in all tests (total T-score) or selected drills could not be evaluated. An extended number of tests was designed for a more reliable assessment of specific motor abilities. The study was performed on the assumption that 15, 90-minute PE classes per semester (five months) are not sufficient to induce not only a significant improvement but any improvement in the students' fitness levels. Coordination skills were evaluated in only one test, skipping with hand clapping (Mynarski, 2000). Additional coordination trials could not be incorporated into the study due to time constraints. The study was performed only in the UWM in Olsztyn, and the evaluated population included only female students performing six types of PAs because the instructors teaching bodybuilding/fitness, Nordic walking and yoga classes refused to participate in the study.

CONCLUSIONS

Body height, body mass and BMI scores influenced young and sedentary women's choices of PA. The tallest women had a preference for martial arts and jogging followed by sauna, whereas the shortest participants were more likely to choose aerobics and swimming. Students characterised by higher body mass and higher BMI opted for less intense forms of PA (golf, aerobics and general PE), whereas slimmer participants chose more intense activities (martial arts, jogging followed by sauna). The only exception to the above rule was swimming, a high-intensity activity, which was selected by overweight women. Disciplines, such as martial arts and jogging, had the most profound and extensive influence on motor fitness levels. Students involved in those types of activities improved their results in a greater number of the motor ability tests.

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(Subject Editor: Dr Paola Wood)