Journal of Combat Sports and Martial Arts
© MEDSPORTPRESS, 2013; 2(2); Vol. 4, 197-205
DOI: 10.5604/20815735.1090744

ORIGINAL ARTICLE

Maximizing university students' motor fitness by implementing a physical education program incorporating martial arts – implicational study

Robert Podstawski[1], Antti Honkanen[2], Dariusz Choszcz[3], Michał Boraczyński[4]

[1] Department of Physical Education and Sport, University of Warmia & Mazury in Olsztyn, Poland
[2] University of Eastern Finland, Centre for Tourism Studies, P.O. Box 86, 57101 Savonlinna, Finland
[3] Faculty of Technical Sciences, University of Warmia & Mazury in Olsztyn, Poland
[4] Department of Physical Education, Jozef Rusiecki Olsztyn University College in Olsztyn, Poland

Key words: Level of motor abilities, forms of P.E. lessons, male students, martial arts

Summary

Introduction. Various forms of martial arts are gaining the interest of university students. The aim of the studies presented in this article was to assess the differences in the level of motor abilities of the students taking part in diverse forms of physical education with a special focus on those practicing martial arts.

Material and methods. The research was conducted in 2010 with 1st year university male students aged 19-20, enrolled at the University of Warmia & Mazury in Olsztyn. A total of 330 students selected from 23 physical education classes were included in the studies. In order to accurately assess the level of individual motor abilities, 13 motor tests were applied.

Results. The research revealed that the level of students' motor abilities depended on the type of the P.E. classes in which they participated including: martial arts, body-building/fitness, volleyball, jogging with sauna, golf, general PE classes. The highest level of motor abilities in the majority of individual tests was observed in those students who attended martial arts classes.

Conclusions. Participation in martial arts promotes significantly stronger all-round development of motor abilities in comparison to other forms of physical activity analyzed in this work.

Introduction

Martial arts are ancient forms of combat, modified for modern sport and exercise. Participation in martial arts classes is growing in popularity, particularly among young people of both sexes, which was confirmed by the research conducted over the last two decades [1,2,3]. Martial arts provide health-promoting and meaningful exercise for millions of practitioners. Training martial arts can increase self-reliance and lead to better overall health and balance as well as an improved sense of mental well-being and numerous benefits to the autonomic nervous and immune systems [4]. Martial arts do not promote aggression and may be used as a treatment modality for young people who are prone to violent behavior [3]. Skills gained when practicing martial arts are very useful in everyday life and should not be associated only with self-defense. Many aspects of combat sports are used in other forms of health training or as an indicator of an individual's ability to survive in a given environment (such as the ability to fall when losing balance) [5,6]. There are only few studies that have been conducted to gain an understanding of why people participate in martial arts [7,8]. Findings indicate that practitioners of martial arts are motivated differently across the types of martial arts disciplines, competition orientation and past experiences [9].

Self-defense courses, which have been organized for students at the University of Warmia & Mazury in Olsztyn (UWM) since 2005 as a substitute of P.E. lessons, reflect the popularity of such a form of physical activity among young adults. The fact that these classes are of a recreational and voluntary kind attracts a large group of university students who, apart from fulfilling the physical education requirements, are given an opportunity to gain self-defense and combat skills. Although women have been known to train martial arts longer than commonly believed, in the case of the classes held at UWM men constituted an overwhelming majority, which

seems to correspond to the global tendency in this respect [10]. The fact that males are more interested in combat sports is largely connected with psychological-social factors, which can be illustrated for instance by males' heightened willingness to compete against each other [11,12].

Increasing attractiveness of PE lessons to students plays a very important role in improving the motor fitness of future role models of society. University and college graduates achieve managerial position in the work force, become involved in opinion-forming bodies and owing to the knowledge they possess can influence the attitudes of politicians and even society as a whole [13]. It is, therefore, safe to assume that these people will be largely responsible for the scale of progress in shaping social needs and public health standards [14].

Despite the above expectations, research conducted in numerous countries has unanimously indicated that university students are characterized by a very low level of physical activity and PE lessons are frequently their only form of exercise, and more often than not – their final [15,16,17]. Researchers worldwide have come to the conclusion that people today seem to have forgotten that their bodies are programmed for an active lifestyle [18]. The chronic lack of physical activity, inappropriate nutrition and other negative social factors result in increasing rates of so called civilization diseases such as: cardiovascular diseases (heart attack, heart failure, stroke), respiratory diseases (sleep apnoea), problems with joints (degeneration, spinal deformations, flat-footedness), metabolic changes (diabetes), some types of cancer (breast, colon), mental disorders (depression, apathy), infertility and even death [19,20,21,22]. It has been determined that the highest increase in weight occurred between the ages of 18 and 29 [23]. Weight gain among college students has been mainly attributed to a decrease in physical activity and an increase in caloric intake [17,24,25].

Multi-activity physical education programs (consisting of multiple sports and physical activities) have been dominant in the United States for many years; as a result today's American students are becoming increasingly aware of the importance of healthy lifestyles, and thus they tend to be more motivated and interested in programs that emphasize health-related fitness (H-RF) [7]. Unfortunately, this tendency has not been observed among Polish students [26]. It is possible that this negative attitude can be reversed by taking advantage of the popularity of martial arts and incorporating them into the university P.E. program. During martial arts trainings much emphasis is placed on increasing the level of motor fitness in people who in general can be considered physically inactive [27]. Another reason behind the necessity of increasing the attractiveness and intensity of physical education classes is the fact that the P.E. minimum at Polish tertiary institutions has dramatically decreased from 240 45-min-lesson units in 1999 to 60 in 2012 [28]. The hours are given as „academic hours"; in Poland, one academic hour lasts 45 min. The current scope involves 30 90-min-classes, which students must complete over a period of two semesters during the first year of their studies. A similar tendency has been observed nationwide, as many public and private schools and universities reduced the number of P.E. classes or, worse still, excluded them completely from their curriculums [29]. Such actions plainly signify that this branch of higher education has become greatly marginalized by authorities [16,30]. In addition, it is worth speculating whether 90 minutes of physical activity per week, regardless of its form, is sufficient to promote and maintain health-related fitness (H-R F) among healthy young adults.

According to the guidelines published by the American College of Sports Medicine (ACSM) and the Center for Disease Control and Prevention in 1995 healthy adults aged 18 to 65 need aerobic (endurance) physical activity of moderate-intensity for a minimum of 30 min. five days per week or vigorous intensity aerobic physical activity for a minimum of 20 min. three days a week [31]. Based on the above, the current number of PE lessons, although significantly reduced, allows to provide an intense physical exercise. During such P.E. lessons held at the UWM, participants are offered an opportunity to learn various techniques of the most popular martial arts styles such as: tae-kwon-do, ju-jitsu, boxing, kickboxing, krav maga or kung fu. All disciplines of martial arts are considered to be highly demanding for most muscle groups and require well-developed skills, muscular performance, agility and higher reaction time [32,33,34,35]. Apart from this, UWM students are offered a range of other forms of P.E. classes depending on their interest and individual preferences. These include: general P.E. classes, body-building and fitness, volleyball, jogging followed by sauna treatment, and even golf. The wide scope of activities organized by the Department of Physical Education and Sport enabled us to assess which form of physical activity had the most positive effect on increasing the level of UWM students' motor fitness.

The aim of the assumed research was the assessment of the usefulness of martial arts classes included in the UWM P.E. curriculum in increasing the level of first-year students' motor fitness. A more in-depth evaluation pertained to changes in terms of individual motor abilities induced by the above mentioned classes as compared to other forms of physical activity realized during the obligatory P.E. courses. Based on the reviewed literature, it was hypothesized that out of the analyzed forms of physical activity, martial arts had the most significant positive effect on increasing the level of individual motor abilities and, in consequence, students' motor fitness.

Material and methods

Ethics

The study was conducted in accordance with the Helsinki Charter of Human Rights and was approved by the Ethics Committee of the University of Warmia & Mazury in Olsztyn. Each participant expressed a willingness to voluntarily participate in the study, and was informed about the aim of the studies, methodology and the possibility to resign at any state without providing a reason. The performed motor tests did not pose a risk to the participants' health. The exclusion criteria

were contraindications for physical activity and lack of approval for participation in the research.

Subjects

The research lasted two weeks and was completed in the second part of May 2010. It was conducted with first-year, full-time students enrolled at the University of Warmia and Mazury in Olsztyn (UWM). Twenty-three groups of students, totaling 330 men, were chosen using random selection tables [36] from a total of 250 groups attending PE lessons. The participants were students of various faculties, 96% of whom were males aged 19-20. This number was determined based on the technical possibilities of surveying the study participants during a single week. Those students who, for whatever reasons, were absent on any day of the studies and therefore did not complete the full set of motor tests were excluded from the research. The study subjects were all male students since very few female students chose to participate in martial arts and those who did were not taken into account. In order to eliminate gender as variable only male students were also selected from the other forms of P.E. classes.

All the participants were permanent residents of the Warmia and Mazury voivodeship. Their level of physical activity was restricted only to the obligatory P.E. classes held at the university once a week for 90 min. As a result of the above and based on the Polish version of the standardized and validated International Physical Activity Questionnaire (IPAQ) [37], it was concluded that the analyzed students represent low intensity level of physical activity. Therefore, the study group can be considered homogenous and appropriate for these kinds of studies. Table 1 presents the percentages of students taking part in the individual types of physical activity such as: martial arts (no 1), body-building and fitness (no 2), volleyball (no 3), jogging followed by sauna treatment (no 4), golf (nr 5), and general PE classes (no 6).

As can be seen from the table, the highest and similar percentage of the analyzed male students participated in martial arts classes and general PE classes (23.94%, and 23.64% respectively). Golf (10.91%) and jogging combined with sauna (11.21%) were found to be least popular among the study participants.

Experimental design and testing schedule

Basic anthropometric parameters (body mass and height) were measured for all participants. Based on this data, the percentage of body FAT was calculated in the form of BMI. Body height was measured using a professional medical scale equipped with the stadiometer – WB-150 (ZPU Tryb– Wag, Poland), with the precision of 1 millimeter [mm]. The level of motor abilities was analyzed by a set of tests which consisted of the following 13 motor tests: the standing long jump [cm], the 4x10 m shuttle run [s], the skipping with clapping of hands – 8 s [number of claps], the sit-ups – 30 s [number of sit-ups], the medicine ball (4 kg) forward throw [cm], the medicine ball (4 kg) backward throw [cm], the bent-arm hang on bar [s], the downward bend from standing position [cm], the sit and reach [cm], Burpee test – 1 and 3 min. [number of cycles], and the forward-backward arm rotation overhead holding a bar [cm]. A large number of the applied motor tests allowed assessing given motor abilities as accurately as possible. All the tests applied have been scientifically confirmed as accurate and valid [38, 39]. Each of the students was instructed on the proper technique of executing every motor task during the lessons preceding the actual test dates and given ample time to practice them. Prior to performing the actual tests, the participants took part in a 10-minute warm-up. In the assessment of physical activity, a short version of the standardized and validated International Physical Activity Questionnaire (IPAQ) was used [40]. The level of weekly physical activity (measured in units MET min/wk), which was described as high, moderate and low intensity, was determined by multiplying the number of days in which the activity was done in a week, the average duration of the activity in one day, and metabolic equivalent of the task (1 MET – metabolic equivalent of work – a resting energy expenditure assuming oxygen consumption of 3.5 mL-min/kg weight). The subjects completed the IPAQ alone in the presence of a trained interviewer, who explained all the queries about the interpretation of the questions included in the questionnaire. Since people who are actively involved in sport and other forms of physical activity are characterized by a higher level of motor fitness and skills than those who are physically inactive [39], their participation in the studies could have significantly distorted the results regarding the differences in the individual types of motor abilities. For this reason, such individuals who constituted a marginal percentage were excluded from the study group.

Statistical procedures

Using the descriptive statistics, the average values of results obtained in the individual trials were calculated as well as standard deviation. Maximum and minimum values were also given in order to indicate the range into which the students fell in the individual trials. Variance analysis was performed in order to determine the differences in the assessed levels of motor abilities between students taking part in various forms of physical education. Item means of the "form of

Table 1. Total number and percentage of students taking part in a given form of P.E. classes held at UWM

Forms of P.E. classes													
1		2		3		4		5		6		7	
Martial arts		Body-building and fitness		Volleyball		Jogging followed by sauna		Golf		General P.E. classes		Total	
N	%	N	%	N	%	N	%	N	%	N	%	N	%
79	23.94	53	16.06	47	14.24	37	11.21	36	10.91	78	23.64	330	100

the physical education factor" were compared by the Duncan test. The results of the studies have been compiled into tables containing, among others, mean values and information on statistically significant differences between the individual forms of PE lessons. Statistical calculations were performed and results presented using the WINSTAT and STATISTICA PL. v. 10. Software packages.

Results

Anthropometric parameters and the average results obtained by the students in the individual motor tests have been presented in Table 2.

Differences in the values of basic anthropometric parameters as well as the results obtained in the individual motor tests in relation to the assumed PE form have been presented in Tables 3-4.

It was observed that students who participated in body building and fitness were characterized by the highest body mass, which was significantly higher than that of students who took part in the jogging and sauna program. Along with the students who practiced volleyball during the obligatory PE lessons, those involved in body building and fitness were also characterized by the highest height, which was found to be significantly higher than in the case of the students attending general PE classes. What is more, the highest percentage of body fat was noted in the students of bodybuilding and fitness as well as golf. In the case of these students, BMI was significantly higher than that calculated for their martial arts and jogging with sauna counterparts. The BMI of the students participating in martial arts, volleyball, jogging with sauna, golf, and general PE classes fell into the normal range, whereas those attending body building and fitness classes were found to be overweight (Tab. 3).

Judging from table 4 it can be said that volleyball students obtained the best results in the standing long jump trial. These were significantly higher than the results of the males participating in general PE classes and golf. The students who took part in the jogging with sauna course performed best in the 4x10 m shuttle run (the shortest time – 10.42 s). In

Table 2. Basic anthropometric and motor parameters characterizing the analyzed study group

Anthropometric parameters and motor tests	Descriptive statistics: $\overline{X}$ ± S (min ÷ max)
Body mass [kg]	78.20 ± 7.78 (60.00 ÷ 121)
Body height [cm]	180.39 ± 5.87 (164.00 ÷ 196.00)
Body Mass Index [kg/m^2]	24.06 ± 2.41 (18.99 ÷ 36.57)
Standing long jump [cm]	217.60 ± 21.21 (156÷270)
Sit-ups 30s [number of sits]	23.35 ± 3.89 (9 ÷ 34)
4x10 m shuttle run [s]	10.90 ± 0.95 (9 ÷ 15)
Skipping with clapping of hands 8s [number of claps]	26.15 ± 3.40 (13 ÷ 38)
Zig-zag run [s]	25.71±1.78 (21 ÷ 31)
Standing downward bend [cm]	5.18 ± 5.69 (-15 – 26)
Forward-backward rotation of bar over head held in both hands [cm] [cm]	87.26 ± 10.66 (60 ÷ 120)
1 min Burpee test [number of cycles]	23.88 ± 3.79 (11 ÷ 34)
3 min Burpee test [number of cycles]	48.70 ± 8.19 (30 ÷ 67)
Medicine ball backward throw [cm]	1036.18 ± 172.87 (550÷ 1750)
Medicine ball forward throw [cm]	856.15 ± 144.14 (510 ÷ 1360)
Pulling-up on bar [number of pull-ups]	4.06 ± 3.18 (0 ÷ 18)
Cooper test on rowing ergometer 12 min [m]	2325.12 ± 338.41 (1400 ÷ 3100)

Explanations: $\overline{X}$ – arithmetic mean, S – standard deviation, min – minimum value, max – maximum value.

Table 3. Mean values of anthropometric parameters of the students practicing a selected physical activity

Parameters	Forms of P.E. classes						Differences
	1	2	3	4	5	6	
Body mass [kg]	76.66±6.92 (63÷103)	83.36±8.99 (72÷121)	75.73±6.72 (63÷93)	71.15±4.13 (60÷81)	80.60±4.88 (73÷93)	78.72±7.33 (63÷110)	2>4
Body height [cm]	180.29±5.12 (168÷193)	181.51±7.05 (167÷196)	182.60±6.09 (168÷195)	179.68±4.03 (174÷192)	180.56±5.89 (165÷189)	178.67±5.63 (164÷194)	2,3>6
Body Mass Index [kg/m^2]	23.62±2.40 (18.70÷36.49)	25.37±2.99 (20.78÷37.22)	22.73±1.89 (18.99÷27.47)	22.03±0.93 (19.37÷24.45)	24.75±1.55 (21.84÷29.38)	24.68±2.17 (19.44÷33.77)	2,6>1,4

Explanations: 1 - martial arts, 2 - body-building and fitness, 3 - volleyball, 4 - jogging followed by sauna treatment, 5 - golf, 6 - general P.E. classes

Table 4. Level of students' motor abilities in the individual motor tests in relation to the form of P.E. assumed

Motor test	Form of P.E. classes						Differences
	1	2	3	4	5	6	
Standing long jump [cm]	221.49±18.33 (180 ÷ 270)	216.54±15.20 (161 ÷ 245)	226.49±15.11 (193 ÷ 260)	219.24±25.13 (171 ÷ 268)	211.60±17.60 (176 ÷ 245)	212.55±24.87 (156 ÷ 270)	3>6,5
4x10 m shuttle run [s]	10.65±0.71 (9.28 ÷ 12.84)	11.49±0.98 (9.78 ÷ 14.52)	10.70±0.67 (9.61 ÷ 12.87)	10.42±0.80 (9.02 ÷ 12.06)	11.52±1.01 (10.12 ÷ 13.79)	10.86±1.00 (9.32 ÷ 14.58)	2,5>4,1,3,6*
Skipping with clapping of hands 8s [number of claps]	27.80±2.86 (20 ÷ 34)	25.54±2.31 (20 ÷ 30)	27.00±2.01 (20 ÷ 32)	25.53±4.14 (16 ÷ 38)	23.22±3.81 (13 ÷ 30)	26.66±3.38 (16 ÷ 38)	1>4,2,5 2>5
Zig zag test [s]	25.34±1.48 (21.20 ÷ 28.60)	25.92±1.30 (23.22 ÷ 30.28)	25.66±1.50 (21.12 ÷ 28.70)	25.31±2.19 (21.53 ÷ 30.80)	26.44±1.49 (23.97 ÷ 31.15)	25.86±2.13 (21.00 ÷ 30.10)	5>4,1*
Standing downward bend [cm]	10.07±5.92 (-2 ÷ 26)	3.11±3.98 (-6 ÷ 11)	4.47±3.19 (-5 ÷ 11)	3.80±3.66 (-3 ÷ 10)	3.89±2.77 (-2 ÷ 10)	4.00±5.41 (-15 ÷ 17)	1>2,4,5,6,3
Forward-backward rotation of bar over head [cm]	85.64±10.87 (60 ÷ 112)	93.94±8.67 (78 ÷ 112)	87.66±7.54 (74 ÷ 102)	82.78±6.46 (70 ÷ 99)	87.81±11.54 (60 ÷ 110)	86.84±12.57 (60 ÷ 127)	2>4,1,6,5,3*
Sit-ups 30s [number of sits]	25.13±2.67 (19 ÷ 34)	24.05±3.62 (14 ÷ 32)	22.66±3.2 (13 ÷ 30)	24.12±4.55 (10 ÷ 31)	22.17±3.68 (16 ÷ 31)	22.45±4.28 (9 ÷ 30)	1>3,6,5
Medicine ball backward throw [cm]	1038.67±163.87 (700 ÷ 1600)	1122.03±181.19 (100 ÷ 1610)	1046.28±158.50 (630 ÷ 1750)	998.24±162.26 (580 ÷ 1260)	997.99±165.85 (100 ÷ 1270)	1004.04±176.21 (550 ÷ 1430)	2>4,6,5,3,1
Medicine ball forward throw [cm]	854.46±142.41 (550 ÷ 1200)	928.02±145.57 (600 ÷ 1360)	836.97±110.44 (590 ÷ 1100)	861.08±153.95 (520 ÷ 1220)	875.69±107.14 (640 ÷ 1110)	834.10±141.01 (510 ÷ 1310)	2>3,6,1
Pulling-up on bar [number of pull-ups]	5.95±3.51 (0 ÷ 18)	4.08±2.21 (0 ÷ 11)	3.12±1.84 (0 ÷ 7)	4.36±2.50 (-1 ÷ 10)	2.07±1.87 (0 ÷ 8)	4.42±3.36 (0 ÷ 14)	1>3,2,6,5
1 min Burpee test [number of cycles]	25.68±2.78 (19 ÷ 34)	23.42±3.28 (11 ÷ 29)	24.79±3.00 (18 ÷ 34)	26.07±3.24 (18 ÷ 30)	22.42±3.39 (16 ÷ 30)	23.53±4.29 (13 ÷ 31)	1,4>2,5
3 min Burpee test [number of cycles]	53.87±5.75 (43 ÷ 69)	44.16±5.07 (33 ÷ 58)	50.93±6.62 (32 ÷ 67)	56.34±6.80 (28 ÷ 66)	43.33±4.25 (32 ÷ 51)	46.47±8.74 (30 ÷ 62)	4>3,6,2 3>6,2 6>2
Cooper test on rowing ergometer 12 min [m]	2487.28±231.58 (1900 ÷ 2950)	2117.45±218.27 (1550 ÷ 2500)	2302.77±259.54 (1800 ÷ 3000)	2637.16±224.79 (2150 ÷ 3150)	2144.31±259.69 (1550 ÷ 2650)	2271.47±412.67 (1350 ÷ 2900)	1,4>6,3,2 6,3>2

Explanations: 1 - martial arts, 2 - body-building and fitness, 3 - volleyball, 4 - jogging followed by sauna treatment, 5 - golf, 6 - general P.E. classes, the shorter the time the better result

the same trial the results of the students practicing martial arts, volleyball, jogging with sauna, and general PE classes were significantly higher than the results of those involved in bodybuilding/fitness and golf. Martial arts participants did best in the skipping with clapping of hands – 8 s (27.80 claps in 8 s), and their results were significantly higher than amateur golfers, joggers and body builders. Significant differences in this trial also occurred between the students of body building/fitness and golf, with the former performing much better. As could be expected, the shortest times in the zig-zag run were those of the students taking jogging/sauna PE classes (25.31 s) but also martial arts (25.34 s). Their results were considerably higher than those of golfers (26.44 s).

Martial arts students also fared best in flexibility trials, such as: the downward bend from standing position and the forward-backward rotation of a bar over the head, which tested trunk flexibility in the sagittal plane (10.07 cm), and the range of movement of the shoulder joint (85.62 cm) respectively. In the case of the first trial, the results of the martial arts students were significantly higher than the students taking part in all other analyzed forms of physical education. On the other hand, the second flexibility trial was performed the worst by bodybuilding/fitness students, whose results were significantly lower than those of all others. Moreover, martial arts students were able to perform the highest number of sit-ups in the time allotted. Their results (25.13 sit-ups/30 s) were significantly higher than those of golf, general PE classes, and volleyball participants.

It is not surprising that students of body building/fitness performed best in the medicine ball backward throw trial. The distance within which they were able to throw the ball (1122.03 cm) was extensively higher than that of other types of PE participants. A similar phenomenon was observed in the case of the medicine ball forward throw in which bodybuilding/fitness stu-

dents obtained the best results (928.02 cm), much higher than the distances achieved by the students of volleyball, general PE, and martial arts classes. In the case of another strength trial, namely pull-ups on bar, the biggest number of repetitions was observed in the men taking part in martial arts classes. Their results were noticeably better than those of golf, volleyball, body building/fitness, and general PE participants. The results of the 1 minute Burpee test were found to be the highest in the case of the students who chose jogging-sauna and martial arts as their preferred form of physical education (26.07 cycles/minute, and 25.68 cycles/minute respectively). These results were significantly higher than those in the case of body building/fitness and golf students. As far as the 3 minute Burpee test is concerned, numerous dependences were observed. The results of the PE students who jogged and used the sauna were significantly higher than those of volleyball, general PE, and bodybuilding/fitness participants. Moreover, volleyball players achieved significantly higher results than their general PE and bodybuilding/fitness counterparts. A similar dependency was also observed between general PE and body building/fitness students in favor of the former.

In the 12 min. Cooper test on a rowing ergometer, the students who took part in jogging/sauna and martial arts classes were characterized by the best results (2637.16 m/12 min., and 2487.28 m/12 min. respectively), which were significantly higher than the results of general PE, volleyball, and bodybuilding/fitness students. Finally, the distances covered by general PE and volleyball participants were significantly higher than the distances completed by the students of bodybuilding/fitness.

Discussion

The conducted research provides valuable information which has led to several interesting conclusions. They pertain to, among others, the phenomenon of limited human somatic and motor development which is the result of the restricted requirement of anthropometric parameters as well as motor abilities and skills stemming from specialization in certain sports. Each sport or type of physical activity is characterized by different specifics [41,42]. These specifics of different forms of movement result in changes regarding anthropometric indicators and the level of motor fitness, which depending on the intensity of stimuli is higher or lower in the scope of given motor skills and abilities [43]. This phenomenon is typical of sports performers at the professional level, who are characterized by the somatic type and body composition specific to the given discipline [44]. Our studies confirmed the above assumption as supported by the values of anthropometric parameters and BMI, and the results achieved in the individual motor tests. It was observed that the students participating in bodybuilding/fitness activities were marked by the highest BMI. The values of the BMI are not relevant for people who practice bodybuilding, i.e. whose muscle mass is significantly developed [45]. This is due to the fact that the BMI does not account for the proportion between the different components of the body tissue (muscle tissue and adipose tissue). It should be noted, however, that men who attend strength training once a week cannot be treated as professional bodybuilders, and therefore the BMI values based on their parameters are reliable and relevant for this group of athletes.

The results of the men training volleyball and bodybuilding/fitness perfectly illustrate this relation. Significantly better results achieved by volleyball students in the standing long jump trial could have been caused by the fact that students practicing volleyball perform relatively more jumps as compared to those involved in other forms of physical activity. Another striking example are body bodybuilding/fitness students who were characterized by the highest level of strength abilities (in the tests such as: the medicine ball backward throw and the medicine ball forward throw), along with the lowest level of flexibility as demonstrated by the downward bend from standing position and forward-backward rotation of bar over head trials and also endurance abilities (Cooper test on a rowing ergometer 12 min). As supported by the studies of other authors, ball games and free play (e.g., soccer, basketball, and football) were found to increase heart rate more significantly than gymnastics [46]. Other research also confirmed that students participating in team sports spent more time in their HR Zone (have higher mean heart rates) than those participating in other types of activities [47,48].

Based on the presented research it was observed that certain forms of physical activity have a stronger and more stimulating effect on human body as compared to others. A good illustration of this are the students taking part in martial arts classes as they represented the best developed and well-rounded group of students in terms of the assessed motor abilities. The men training martial arts obtained the best results in the following trials: sit-ups 30 s, the skipping with clapping of hands - 8 s, the standing downward bend, and the pulling-up on bar. Moreover, in the tests such as: the 4 x 10 m shuttle run, the zig zag test, the forward-backward rotation of bar overhead, 1 and 3 min. Burpee tests, and the Cooper test on a rowing ergometer 12 min, their results did not differ significantly from the highest achieved in those tests.

The study participants took part in a limited number of 15 90-min-lessons held once a week over the course of a semester, which might point to the students' low level of physical activity. Although the scope of PE lessons did not seem to be sufficient, it was observed in other studies that there are numerous benefits of training on a rowing ergometer only once a week over the distance of 500 meters by physically inactive male [49] and female students [50]. Interestingly, the research in question revealed gradual improvement discerned by the ability to cover a given distance within a faster time up to a certain level (5-6 trainings) after which the results ceased to improve.

Taking the above as well as the results of the present work into consideration, it can be assumed that the specificity of the given form of physical activity can significantly affect the level of individual motor abilities even when performed at a relatively low frequency. Thus, it could be interesting to pose a question what makes martial arts more effective than

other forms of physical activity. There are many factors that exert an influence on the students' willingness to participate in PE programs. One of them is the nature of the activity itself [51]. In the case of our research the students who chose this PE form entered the trial with a specific goal in mind, namely learning the techniques of self-defense which could be used later on in sparring sessions as well as potential real-life situations. By this, their concentration was more focused and maximum effort dedicated. It has been indicated by the studies of other authors that students are more likely to be physically active and eager to devote greater effort providing they believe they can actually accomplish something during PE lessons (in our case it was to learn a new practical technique). The authors of this study believe that physical educators should adopt effective strategies to raise students' motivation by promoting individualized and ability-oriented tasks that enhance success [7].

Moreover, the type of physical activity performed would influence the time spent while performing moderate-to-vigorous physical activity (MVPA) [48]. Research conducted by Strand & Reeder [52] revealed that students spent 50% of the class time in their target heart zone, which they were able to attain by participating in nine different activities, although the time spent in the target rate zone varied. At the end of the main part of the martial arts lesson, a sparring session usually took place compelling the practitioners to the highest psycho-physical effort. It has been confirmed by the studies that sport activities tend to produce equal or greater time in MVPA than other activities [53,54]. Proper execution of combat techniques requires from the practitioner an adequate level of general motor fitness. Therefore, in addition to specialized techniques, the students in self-defense classes completed a set of specially designed exercises such as agility tests, aimed at improving general motor fitness. This stems directly from the fact that without an adequate level of general motor fitness a practitioner will not be able to properly perform specific techniques (for example a high leg kick from the jump). In consequence, this would make them more involved in the exercise [55, 56]. As a result of the increased motivation to participate in martial arts, evolving into a more intense exercise, a greater improvement of motor abilities than in other cases was observed in the students.

This was achieved by the martial PE classes held at the UWM. It can be argued that other forms of physical education analyzed in our study also provide the students with specific tasks and goals, with the exception of general PE classes. Those taking up bodybuilding aimed at increasing strength and developing muscles, whereas volleyball and golf players learned the rules and techniques of the games. Joggers, on the other hand, aspired to cover longer distances so as to improve endurance and lose weight. However, none of these aims has as strong practical applications as learning martial arts.

Conclusions

Based on the conducted studies it can be stated that the level of students' motor abilities depends on the form of physical activity undertaken. The study results suggest martial arts classes result in the highest level of motor fitness displayed by the best results in the largest number of motor tests, particularly when taking into account the fact that all of the participants were classified as physically inactive while entering the research and over the period under study they took part only in obligatory PE classes. Additionally, the results of this study may have significant implications for educational practice. Physical educators must consider physical effects that different sport-oriented activities may have on students when designing and implementing PE programs that attempt to develop students' motor fitness, their positive motivational beliefs about physical activity and demonstrate its high levels in those programs. Therefore, it can be concluded that practicing martial arts is better suited for the well-rounded development of young males' motor fitness than other forms of physical activity.

References

1. Hargreaves J. Women's boxing and related activities: Introducing images and meanings. Body and Society 1997; 3: 33.
2. Marco E, Viveiros J, Cipriano N. Wrestling with identity: An exploration of female wrestlers' perceptions. WSPAJ 2009; 18(1): 42-53.
3. Woodward TW. A review of the effects of martial arts practice on health. Wisc Med J 2009; 108(1): 40-3.
4. Tophoff M. Daoist Principles in the Martial Arts: Their Relevance for Illness Prevention. Journal of Daoist Studies 2013; 6: 161-175.
5. Kalina RM, Barczyński B, Jagiełło W, et al. Teaching of safe falling as most effective element of personal injury prevention in people regardless of gender, age and type of body build – the use of advanced information technologies to monitor the effects of education. Arch Budo 2008; 4: 82-90.
6. Kalina RM. The profile of Sense of Positive Health and Survival Abilities indices (subjective assessment) as a diagnostic tool used in health-related training. Arch Budo 2012; 8(3): 179-180.
7. Gao Z, Hannon JC, Newton M. Effects of Curricular Activity on Students' Situational Motivation and Physical Activity Levels. Res Quar Exerc Sport 2011; 82(3): 536-544.
8. Vertonghen J, Theeboom M. The social-psychological outcomes of martial arts practice among youth: A review. J Sport Sci Med 2010; 9: 528-537.
9. Cynarski W. Values of martial arts in the light of the anthropology of martial arts. JC SMA 2012; 1(2): 1-4.
10. Kavoura A, Ryba TV, Kokkonen M. Psychological Research on Martial Artists. A Critical View from a Cultural Praxis Framework. Scan Sport Stud Forum 2012; 3: 1-23.
11. Krane V, Baird SM. Using ethnography in applied sport psychology. J Appl Sport Psych 2005; 17(2): 87-107.
12. Thorpe H. Understanding 'alternative' sport experiences: A contextual approach for sport psychology. Int J Sport Exerc Psych 2009; 7(3): 359-379.

13. Lee DH, Kang S, Zum S. A qualitative assessment of personal and academic stressors among Korean collage students: an explanatory study. Coll Stud J 2005; 39(3): 442.
14. Ansari WE, Stock C, John J, Deeny P, Phillips C, Snelgrove S, Adetunji H, Hu X, Parke S, Stoate M, Mabhala A. Health promoting behaviours and lifestyle characteristics of students at seven universities in the UK. Cent Eur J Public Health 2011; 19(4): 197-204.
15. Negasheva MA, Mishkova TA. Morphofunctional Parameters and Adaptation Capabilities of Students at the Beginning of the third Millennium. J Physiol Anthropol Appl Hum Sci 2005; 24(4): 397-402.
16. Stelzer J, Ernest JM, Fenster MJ, Langford G. Attitudes toward Physical Education: A Study of High School Students from Four Countries – Austria, Czech Republic, England, and USA. Coll Stud J 2004; 38(2): 171-179.
17. Bray SR, Born HA. Transition to university and vigorous physical activity: implications for health and psychological well-being. J Am Coll Health 2004; 52: 181-188.
18. Brodersen HH, Steptoe A, Boniface DR, Wardle J. Trends in physical activity and sedentary behaviours in adolescence: ethic and socioeconomic differences. British J Sports Med 2007; 41(3): 140-144.
19. Blair SN, Kohl III HW, Paffenbarger Jr RS, Clark DG, Cooper KH, Gibbons LW. Physical Fitness and All-Cause Mortality. A Prospective Study of Healthy Men and Women. J Am Med Assoc 1989; 262(17): 2395-2401.
20. Swallen KC, Reither EN, Haas SA, Meier AM. Overweight, obesity, and health related quality of life among adolescents: The national longitudinal study of adolescent health. Pediatrics 2005; 115: 340-347.
21. Church TS, Earnest CP, Skinner JS, Blair SN. Effects of Different Doses of Physical Activity on Cardiorespiratory fitness among Sedentary, Overweight or Obese Postmenopausal Women with Elevated Blood Pressure. J Am Med Assoc 2007; 297: 2081-2091.
22. Trost SG, Loprinzi PD. Exercise-promoting healthy lifestyles in children and adolescents. J Clini Lipidol 2008; 2, 162-168.
23. Gordon-Larsen P, Adair LS, Nelson MC, Popkin BM. Five year obesity incidence in the transition period between adolescence and adulthood: the National Longitudinal Study of Adolescent Health. Am J Clin Nutr, 2004; 80: 569-575.
24. Huang TT-K, Harris KJ, Lee RE, Nazir N, Born W, Kaur H. Assessing Overweight, Obesity, Diet, and Physical Activity in College Students. J Am Coll Health 2003; 52(2): 83-86.
25. Serlachius A, Hamer M, Wardle J. Stress and weight change in university students in the United Kingdom. Physiol Behav 2007; 92: 548-553.
26. Podstawski R, Wesołowska E, Gizińska R, Sołoma A. Health attitudes and behaviours of first-year University of Warmia & Mazury students: A call for implementing health education at universities. Prob Edu 21st Cent 2013; 54(54): 76-90.
27. Choszcz D, Podstawski R, Konopka S: Modeling of anthropometric determinants of rowing ergometer performance on a distance of 500 meters for physically inactive males. JPES 2012; 12(3): 274-283.
28. Podstawski R, Sławek M. The influence of political transformation on the functioning of the Department of Physical Education and Sport at the University of Warmia & Mazury in Olsztyn during the academic years of 1998/1999 and 2010/2011. In: Sokołowska B, editor. Public Health in The Aspects of Modern Civilization (pp. 266-278). Biała Podlaska: PWSJPII Press, 2012.
29. Morgan PJ, Hansen V. Classroom teachers' perceptions of the impact of barriers to teaching physical education on the quality of physical education programs. Res Quart Exerc Sport 2008; 79(4): 506-516.
30. National Association for Sport and Physical Education & American Heart Association. 2006 shape of the nation report: Status of physical education in the USA. Reston, VA: National Association for Sport and Physical Education, 2006.
31. Haskell WL, Lee IM, Pate RR, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Med Sci Sports Exerc 2007; 39(8): 1423-1434.
32. Arabacı R, Görgülü R, Çatıkkaş F. Relationship between agility and reaction time, speed and body mass index in taekwondo athletes. Sport Sci 2010; 5(2): 71-77.
33. Chung P, Ng G. Taekwondo training improves the neuromotor excitability and reaction of large and small muscles. Phys Ther Sport 2012; 13(3): 163-9.
34. Čular D, Miletić D, Miletić A. Influence of dominant and non-dominant body side on specific performance in taekwondo. Kinesiology 2010; 42(2): 184-193.
35. Di Prampero PE, Ferretti G. The energetics of anaerobic muscle metabolism: a reappraisal of older and recent concepts. Respir Physiol 1999; 118: 10-115.
36. Zieliński R, Zieliński W. Tablice statystyczne [Statistical tables]. Warszawa: Fundacja Rozwój SGGW Press, 2001 [in Polish].
37. Biernat E, Stupnicki R, Gajewski AK. Międzynarodowy kwestionariusz aktywności fizycznej (IPAQ) wersja Polska [International Physical Activity Questionnaire (IPAQ) Polish version]. Wychowanie Fizyczne i Sport 2007; 51: 47-54 [in Polish].
38. Pilicz S. Pomiar Ogólnej Sprawności Fizycznej [Measuring of general physical fitness]. Studia & Monografie Nr 65. Warszawa: AWF Press, 1997 [in Polish].
39. Szopa J, Chwała W, Ruchlewicz T. Badania struktury zdolności motorycznych o podłożu energetycznym i trafności ich testowania [Investigations on structure of „energetic" motor abilities and validity of their testing]. Antropomotoryka 1998; 17: 3-41 [in Polish].
40. Bauman A, Bull F, Chey T, et al. The International Prevalence Study on Physical Activity: results from 20 countries. Int J Behav Nutr Phys Act 2009; 6: 21. doi: 10.1186/1479-5868-6-21 (online version).
41. Angyán L, Téczely T, Zalay Z, Karsai I. Relationships of anthropometrical, physiological and motor attributes to sport-specific skills. Acta Physiol Hung, 2003; 90(30): 225-231.
42. McGawley K, Bishop D. Reliability of a 5 x 6-s maximal cycling repeated-sprint test in trained female team-sport athletes. Eur J Appl Physiol 2006; 98: 383-393.
43. Almeida AHS, Santos SAG, Castro PJP, Rizzo JA, Batista GR. (2013). Somatotype analysis of physically activity individuals. J Sports Med Phys Fit 2013; 53(3): 268-273.
44. Thorland WG, Johnson GO, Fagot TG, Tharp GD, Hammer RW. Body composition and somatotype characteristics of junior Olympic athletes. Med Sci Sports Exerc 1981; 13(5): 332-338.

45. Monteiro JCV, Pimentel GD, Sousa MV. Relationship between body mass index with dietary fiber intake and skinfolds-differences among bodybuilders who train during morning and nocturne period. Nutrición Hospitalaria, 2012; 27(3): 929-935.
46. MacFarlance D, Kwong WT. Children's heart rates and enjoyment levels during PE classes in Hong Kong primary schools. Pediatr Exerc Sci 2003; 15, 179-190.
47. Klausen K, Rasmussen B, Schibye B. Evaluation of the physical activity of school children during a physical education lesson. In J. Rutenfranz, R. Mocellin, & G Klint, eds., Children and exercise XII (pp. 93-101). Champaign, IL: Human Kinetics, 1986.
48. Kulinna PH, Martin J, Lai Q, Kliber A, Reed B. Student physical activity patterns: Grade, gender and activity influences. J Teach Phys Edu 2003; 22: 298-310.
49. Podstawski R, Choszcz D, Konopka D. The impact of training on the 500 m rowing ergometer time and an assessment of the applied test's relevancy. Human Movement 2011; 12(3): 264-272.
50. Podstawski R, Choszcz D, Wysocka-Welanc M. Assessing the adequacy of taking the measurement of short-term endurance capacity and analysis of the impact of training on the results achieved by the university of Warmia & Mazury students on rowing ergometer. Antropomotoryka 2009; 46: 55-64.
51. Rowe PJ, Schuldheisz JM, van der Mars H. Validation of SOFIT for measuring physical activity of first- to eighth-grade students. Pediatr Exerc Sci 1997; 9, 136-149.
52. Strand B, Reeder S. Using heart rate monitors in research on fitness levels of children in physical education. J Teach Phys Edu 1993; 12: 215-220.
53. Hannon JC, Pellett TL. Comparison of heart-rate intensity and duration between sport games and traditional cardiovascular activities. Percep Motor Skill 1998; 87: 1453-1454.
54. Stratton G. Children's heart rates during British physical education lessons. J Teach Phys Edu 1997; 16: 357-367.
55. Lee AM. Contributions of research on students thinking in physical education. J Teach Phys Edu 1997; 16, 298-310.
56. Pintrich PR. An achievement goal theory perspective in issues in motivation terminology, theory, and research. Contem Edu Psychol 2000; 25: 92-104.

Address for correspondence:
Podstawski Robert
Department of Physical Education and Sport, University of Warmia & Mazury in Olsztyn
ul. Prawocheńskiego 7, 10-720 Olsztyn, Poland
tel. (89) 523-33-08, mobile: +48 601 65 25 27, e-mail: podstawskirobert@gmail.com

Received: 19.06.2013
Accepted: 17.10.2013