THE INTENSITIES OF VARIOUS FORMS OF PHYSICAL ACTIVITY IN PHYSICAL EDUCATION PROGRAMS OFFERED BY UNIVERSITIES FOR MALE UNIVERSITY STUDENTS

Robert Podstavski[1*], Kevin J. Finn[2], Cain C. T. Clark[3], Ferenc Ihasz[4], Zoltan Alfodi[5], Piotr Żurek[6]

[1] University of Warmia and Mazury in Olsztyn, Department of Tourism, Recreation and EcologyOlsztyn, Poland
[2] University of Central Missouri, School of Nutrition, Kinesiology, & Psychological Science, Warrensburg, MO USA
[3] Coventry University, Faculty of Health and Life Sciences, Coventry (U.K.)
[4] Eötvös Lóránd University, Faculty of Psychology and Pedagogy, Institute of Sports Sciences, Szombathely, Hungary
[5] University of Pécs, Doctoral School of Health Sciences, Faculty of Health Sciences, Pécs, Hungary
[6] Poznan University of Physical Education, Department of Physical Education in Gorzow Wielkopolski

DOI. 10.51371/issn.1840-2976.2021.15.1.5 *Original scientific paper*

Abstract

The aim of this study was to evaluate the effectiveness of various forms of physical activity (PA) among male students in physical education (PE) programs offered by universities in Poland, Hungary and the United Kingdom. The study involved 200 full-time male university students (mean age: 19.86±0.82), enrolled in nine different PA programs. The participants' anthropometric traits and body composition parameters were determined with the InBody analyser. Based on the students' physiological parameters, the effectiveness of various types of PA was measured with Suunto. Ambit3 peak heart rate monitors during 60 minutes of physical exertion. The average values of body mass, body mass index (BMI), body fat mass (BFM), percent body fat (PBF), waist hip ratio (WHR), and visceral fat (VFL) were significantly ($p<0.05$) lower in students who performed jogging, followed by sauna (JFBS) and martial arts than in the remaining PA groups. Minutes of difficult and very difficult intensities were highest in martial art students, followed by jogging students, and they were significantly ($p<0.05$) higher than the values noted in the remaining PA groups (golf, bodybuilding/fitness, swimming, general PE classes, cycling and individual training). Physiological parameters were significantly ($p<0.05$) lowest in golf players and students who trained individually. Martial arts and JFBS are the most effective types of PA among male university students. Students performing martial arts and JFBS were characterized by the lowest relative, body fat, whereas students who practiced swimming had the highest body fat levels in the population sample.

Keywords: *male university students, physical education, physical activity, body composition, physiological parameters*

Introduction

Physical literacy is defined as "the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life", Whitehead, M. (2010) as cited on the International Physical Literacy Association website (2017). Langmuir and Tremblay (2016) suggested that in physical literacy should be viewed as a "journey" in which can change throughout life and be influenced by environment. The individual's motivation, confidence, and physical competence changes with factors such as successful interventions (a physical education program), parental and family support, and the attitudes toward health and wellness. For young adults, who leave the structure of secondary school, family and home confines, and are surrounding by new peers from various environmental upbringing, the physical literacy journey would expect to be altered. Those who continue their educational path to obtain university degrees are subject to new surroundings with expectations for academic growth while maintaining healthy lifestyles. Promoting physical activity (PA) in daily living during these youths of early independence have been encouraged by health professionals to maintain both physical and mental health.

Research into the health of university students provides particularly interesting observations because the increased incidence of overweight and obesity conditions between the ages of 18 and 29 (Gordon-Larsen, Adair, Nelson, & Popkin, 2004). University students are more likely to gain weight than young adults who are not enrolled in college (Mokdad et al., 1999). A recent meta-analysis revealed that first-year university students gain approximately four pounds (1.8 kilograms) during a period of 3 to 12 months (Vella-Zarb & Elgar, 2009). In most cases, excess weight contributes to an increase in fat mass (Butler, Black, Blue, & Gretebeck, 2004; Hajhosseini et al., 2006) and individuals continue to gain weight in the successive years of college (Lloyd Richardson, Bailey, Fava, & Wing, 2009). University students generally gain weight due to low levels of PA as well as excessive caloric intake. The Youth Risk Behavior Survey (Kaan et al., 1996) demonstrated that 55% of high school seniors have adequate PA levels, whereas less than 40% of university students meet the recommended standard (Douglas, et al., 1997). A similar decrease in PA levels between adolescence and adulthood has been reported in the literature (Bray & Born, 2004) in particular in the first year (Serlachius, Hamer & Wardle, 2007) and in successive years of university (Huang, et al., 2003). According to international research, the percentage of sedentary university students varies across countries, from 23% in Western Europe and the USA, to 30% in Central and Eastern Europe, 39% in the Mediterranean region, 42% in the Asia-Pacific region, and 44% in developing countries (Haase, Steptoe, Sallis, & Wardle, 2004). A study of PA levels in 51 countries, with mostly low or middle incomes, revealed several trends [16]. In global terms, PA levels were lower among women than men, with the exception of several Eastern European countries. However, the reasons behind the decrease in PA levels in developing countries have been rarely explored. According to Ng, Norton and Popkin, 2009), the average weekly PA levels decreased by 32% between 1991 and 2006, and around 32% of adults (18 years and older) around the world were characterized by insufficient levels of PA (20% of men and 27% of women). Low levels of PA were reported in 26% of men and 35% of women residing in high-income countries, and in only 12% of men and 24% of women from low-income countries (World Health Organization, 2016).

The PA levels of university students are significantly influenced by socioeconomic factors, including the parents' educational attainment, monthly income, place of residence, and type and location of high school (Podstawski & Choszcz, 2014; Podstawski, Honkanen, Tuohino & Gizińska, 2015; Podstawski, Moran, Mańkowski, Choszcz & Sarcevic, 2017).

As a result, considerable variations in the PA levels of university students can be expected across different countries in Europe (Martínez-González et. al., 2001; Ståhl et al., 2001; Steptoe, et al., 1997). These findings indicate that leisure-time PA is correlated with the economic development of a given country as well as specific cultural and geopolitical determinants. In general, young adults from highly developed countries, excluding the Mediterranean region, tend to devote more time to leisure-time PA (Haase et al., 2004).

In past educational systems, students were expected to perform various types of PA during obligatory physical education (PE) classes. Indeed, a study conducted by the Polish Academic Sports Association (AZS) demonstrated that PE classes were obligatory in only four out of the 25 analyzed universities in Europe (Poland Austria, Belgium, Finland, Spain, Netherlands, Ireland, Germany, Slovakia, Slovenia, Sweden, Hungary and Italy), and that PE classes were mandatory in selected former Soviet bloc countries (including Poland), although their duration and frequency had been considerably reduced (Korpak, 2005).

A study of Slovenian university students paints a more optimistic picture (Lipošek, Planinšek, Leskošek, & Pajtler, 2018). Only 7.4% of the surveyed subjects did not perform at least moderate exercise, however 26.6% of students did not perform any type of vigorous exercise. As regards to organized forms of PA, 20.5% of the investigated students belonged to a sports club. The percentage of Slovenian university students who belonged to a sports club was similar to that noted in Croatia:23% (Andrijašević, Paušić, Bavčević & Ciliga, 2005), but according to a different study, only 16% of Slovenian university students were sports club members (Golja & Robič, 2014).

To better understand the cultural differences in physical literacy, monitoring of physical activity within the university setting is needed. At the present time, little is known about the PA levels of university students, and the existing knowledge has been derived from a small number of studies (Pagnano & Langley, 2001). Langmuir and Tremblay (2016) identify a need to monitor the physical literacy journey across cultures to determine the extent of environmental factors in individual levels of PA. In Poland, legal regulations on obligatory PE classes at the university and their minimum duration have been recently reintroduced. At the present time, are no regulations on the qualifications of PE teachers and the form of PE classes, which in some cases turn into lectures (Podstawski, 2018). The effectiveness of different types of PE classes on providing moderate and vigorous physical activity should be investigated. Therefore, the aim of this study was to determine the levels of PA in PE classes offered by universities in three countries (Poland, Hungary and the United Kingdom) for male university students. A secondary aim was to evaluate the body composition of students engaged in this study to determine if certain types of physical activity classes are taken by those with certain fitness traits. For this study, only male students were used in the investigation since body composition (levels of fat mass and skeletal muscle) is sex specific.

Methods

Participants

The study involved 200 full-time male university students (mean age: 19.86 ±0.82 years) enrolled in various PA programs at university, including golf, martial arts, bodybuilding/fitness, 45-minutes of jogging followed by 15-minutes of sauna (JFBS), swimming, traditional PE classes, cycling, and individual training (any type of PA without formal supervision). In the surveyed universities, students have to enroll on-line in a selected PE program at the beginning of every semester in order to obtain credit. In Hungarian universities, students are also given credit for individual training which takes place at a specified location and time and is registered by the PE teacher; whilst in British universities PA is not specifically mandated. Every analyzed form of PA was represented by 25 students from six universities in Poland, Hungary, and the United Kingdom (two universities in each country). To guarantee the correct estimation of sample size, up to five students could participate in a program taught by one PE teacher, and each analyzed form of PA had to be represented by students from at least two countries. All of the surveyed students attended programs taught by a total of 49 PE teachers/instructors. Students were randomly selected based on random selection tables to produce 8 groups of 25 students each enrolled in different types of PA. A student who did not wish to participate in the study was replaced by another randomly selected candidate. The participants were volunteers who did not take any medication or nutritional supplements, were in good health, and had no history diseases affecting biochemical and biomechanical factors. The study was performed in compliance with the Declaration of Helsinki and upon approval of the University of Warmia and Mazury in Olsztyn bioethics committee (39/2011) and authorities. The participants gave their written consent to the study.

Instruments and measures

Body height was measured to the nearest 1 mm with a calibrated WB-150 medical scale with a stadiometer (ZPU Tryb Wag, Poland) according to standardized guidelines. Body mass (measured to the nearest 0.1 kg), BMI and body composition parameters (weight, total body water – TBW, protein, minerals, body fat mass – BFM, fat-free mass – FFM, skeletal muscle mass – SMM, body mass index – BMI, percent body fat – PBF, waist-hip ratio – WHR, visceral fat level – VFL, and levels of obesity) were determined by bioelectrical impedance with the InBody 720 body composition analyser (Gibson, Holmes, Desautels, Edmonds & Nuudi, 2008). All anthropometric measurements and body mass composition parameters were analysed immediately before the physical training, in the state of rest.

Physiological parameters, including heart rate ($HR_{min,\ avg,\ max}$), and estimated values of the energy expenditure, oxygen uptake ($VO_{2\ avg,\ max}$), excess post-exercise oxygen consumption ($EPOC_{avg,\ peak}$), respiratory rate ($_{avg,\ max}$) and training parameters (recovery time, peak training effect – PTE), exercise intensity: low (<107 bpm), moderate (107-124 bpm), high (125-141 bpm), very high (142-159 bpm), maximal (≥ 160 bpm), were measured directly during 60 minutes of each PA program with Suunto Ambit3 Peak Sapphire heart rate monitors which are widely used in studies of the type (Podstawski et. al., 2019 a,b; Scoon, Hopkins, Mayhew, & Cotter, 2007), and are considered accurate and reliable (Bouillod, Cassirame, Bousson, Sagawa & Tordi, 2015; Sandercock & Brodie,2006). Pulsometers were placed on the wrist, and HR monitor sensor was attached to the chest. Every pulsometer was programmed to sex, year of birth, body mass and PA level. Every participant activated the pulsometer for 60 minutes immediately before training (each PA type). At the end of training, the participants deactivated their pulsometers and switched to the data save mode by saving the results in Movescount Suunto application.

All participants visited a dry sauna during weekly PE classes on the same day, in the same location and over the same period of time, to minimize the effect of diurnal variation on the results (Valdez, Ramírez, García, Talamantes & Cortez, 2007). Every participant attended one 15-minute sauna session (temperature: 90°C; relative humidity: 14-16 %) remaining in a sitting position. The results from sauna sessions offered additional data for analyses and comparisons with the results from other forms of PA, as they assisted in determining the intensity of physiological processes in jogging vs sauna.

Statistical analysis

The participants were divided into coherent groups of 25 subjects each. Anthropometric features, body composition and physiological parameters were analysed using the Statistica PL v. 13.5. The basic descriptive statistics, such as mean values, standard deviation, and the minimum and maximum values of the measured parameters were conducted for each group. In each PA type, results that did not differ significantly were separated by a comma, and results that differed significantly were separated by the ">" symbol. The results of the 15-minute sauna session were used to determine the participants' physiological characteristics in this part of the training. One-way ANOVA with LSD 'post hoc' was used to assess the mean differences between the groups. The statistical significance was set at level of $p<0.05$. We computed achieved power, *a posteriori*, and based on the sample size (4 groups (consisting of the amalgamation of 2 locations per group)), an observed effect size of 0.39 (for BMI), and an alpha error probability of 0.05, a power (1–beta probability) of 0.99 was attained.

Results

The study results are presented in a table format, where the measured parameters for each PA group are presented separately in columns. The differences between the PA groups are presented in the last column, from maximum to minimum values. The non-significant results are separated by a comma, and the significant results are separated by '>'.

The studied groups did not differ significantly ($p>0.05$) in age, height, TBW, proteins, minerals, FFM or SMM. The average values of body mass, BMI, BFM, PBF, WHR, VFL and obesity degree were significantly lower in students who performed martial arts and jogging followed by sauna than in the remaining groups, whereas a reverse trend was noted in the values of BFM Control. BMI values were highest and within the overweight range in swimmers (25.7 kg/m^2), and they were lowest in men who performed martial arts and jogging (21.0 kg/m^2 in both groups). WHR values were highest (0.89) and indicative of gynoid obesity (accumulation of fat in thighs and buttocks) in swimmers, and they were lowest in students who jogged (Table 1).

Table 1. Somatic traits and body composition parameters in women performing various types of PA

The values of HR_{avg} were highest in men performing martial arts (131.7 bpm) and jogging (123.6 bpm), and they were significantly higher than in the remaining groups (Table 2). As a result, students performing marital arts and jogging followed by sauna were characterized by the highest energy expenditure (706.7.4 and 606.6 kcal, respectively) and the highest values of $VO_{2\ avg,\ max}$, $EPOC_{avg,\ peak}$, and $RR_{\ avg,\ max}$. Significant differences were also noted between other groups, excluding individual training and golf which were characterized by the lowest average values of HR within the easy effort range (92.3 and 86.8 bpm, respectively). The highest average values of HR_{max} were also noted in the martial arts group (156.6 bpm – very difficult effort) where the maximum non-averaged values reached the maximum effort range (174 bpm). Significantly lower, but still high average values of HR_{max} (154.4 bpm) were observed in the jogging group where the maximum values exceeded those noted in the martial arts group (181 bpm). Students who played golf and trained individually were characterized by the lowest values of HR_{max} (123.1 and 125.5 bpm, respectively) and the lowest energy expenditure (253.5 and 297.3 kcal, respectively).

An analysis of exercise intensity in each group revealed that the duration of the easy effort range was significantly ($p<0.05$) longest in golf (53:02 min), individual training (47:44 min), bodybuilding/fitness (40:30 min) and cycling (37:59 min) groups. The duration of the moderate effort range was longest in the swimming group (28:39 min); the duration of the difficult effort range was longest in martial arts (27:33 min) and jogging (26:57 min) groups; and the duration of very difficult and maximal effort ranges was longest in the martial arts group (14:47 and 0:50 min, respectively) at a significance level of $p<0.05$. Maximal physical effort was not noted in golf, bodybuilding/fitness, general PE, cycling and individual training groups.

Table 2. Physiological parameters in men performing various types of PA

Table 1. Somatic traits and body composition parameters in men performing various types of physical activity

Traits	Golf	Martial arts	Aerobic	Jogging	Swimming	General P.E.	Sauna	Cycling	Individual training	F(*p*)	Differences
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**		
Age [years]	20.4±1.82 (16.9-24)	19.59±1.57 (18-24)	19.44±2.99 (16.3-29)	18.56±0.98 (17.4-22)	21.04±6.2 (16.3-48)	20.93±2.09 (18.2-29)	20.7±1.87 (18.2-24)	19.11±1.37 (17.4-22)	19.6±2.72 (17.1-29)	2.41(<.05)	5,6,7,1,9,2,3>8,4
Body height [cm]	179.36±5.36 (170-190)	180.52±7.51 (168-192)	179.32±5.1 (170-189)	180.46±6.62 (170-191)	178.66±5.51 (166-191)	184.12±7.43 (170-196)	179.48±6.1 (166-194)	181.48±6.95 (166-191)	179.68±6.59 (170-194)	1.68(0.104)	*ns*
Body mass [kg]	79.94±11.07 (55.9-98.6)	68.41±7.44 (55.1-88.1)	78.83±11.03 (56.8-111)	68.74±9.7 (50.5-84.2)	82.42±16.47 (64-137.7)	81.82±11.88 (65.2-110.3)	83.45±13.2 (55.9-130.9)	75.88±8.68 (58.9-95.9)	78.09±15.39 (54.3-130.9)	5.51(<.001)	7,5,6,1,3,9,8>4,2
TBW (Total Body Water) [L]	47.75±6.18 (32.9-56.3)	43.54±4.83 (34.9-55.1)	46.93±5.53 (34.6-57.8)	44.58±6.83 (31.6-55.2)	47.8±5.92 (38.2-61.7)	49.8±5.63 (40.4-61)	48.28±6.15 (32.9-64)	47.25±5.31 (35.5-55)	46.8±6.71 (34.9-64)	2.62(<.01)	6,7,5,1,8,3,9>4,2
Proteins [kg]	12.97±1.67 (8.9-15.4)	11.77±1.33 (9.4-15)	12.73±1.53 (9.3-15.7)	12.06±1.86 (8.6-15.1)	12.98±1.62 (10.4-16.8)	13.5±1.54 (10.9-16.5)	13.1±1.65 (8.9-17.2)	12.8±1.44 (9.6-14.9)	12.66±1.81 (9.4-17.2)	2.75(<.01)	6,7,5,1,8,3,9>4,2
Minerals [kg]	4.51±0.62 (3.24-5.51)	4.06±0.52 (3.07-5.21)	4.38±0.61 (3.26-5.65)	4.13±0.66 (2.92-5.3)	4.44±0.62 (3.52-5.71)	4.71±0.64 (3.56-6.09)	4.58±0.61 (3.24-6.25)	4.41±0.58 (3.28-5.3)	4.36±0.74 (3.07-6.25)	2.78(<.01)	7,5,3,1,9,6,8>2,4
BFM (Body Fat Mass) [kg]	14.71±5.88 (4-24.3)	9.05±3.35 (4.1-15.6)	14.78±6.81 (6.1-31.8)	7.96±2.78 (3.4-15.4)	17.2±11.52 (5.9-63.8)	13.78±6.37 (5-29.2)	17.48±8.15 (7.5-43.4)	11.4±4.97 (5.2-23.3)	14.24±8.71 (5.7-43.4)	5.7(<.001)	7,5,3,1,9,6,8>2,4
FFM (Fat Free Mass) [kg]	65.23±8.46 (45-76.8)	59.37±6.67 (47.4-75.3)	64.05±7.64 (47.2-79.2)	60.77±9.35 (43.1-75.3)	65.22±8.14 (52.1-84.2)	68.04±7.79 (54.9-83.3)	65.96±8.39 (45-87.5)	64.48±7.32 (48.4-75.2)	63.84±9.25 (47.4-87.5)	2.67(.01)	6,7,1,5,8,3,9,4,2
SMM (Skeletal Muscle Mass) [kg]	37.13±5.06 (24.7-44.2)	33.53±4.04 (26.5-43.5)	36.43±4.63 (26.1-45.5)	34.4±5.67 (23.7-43.6)	37.18±4.89 (29.2-48.5)	38.82±4.62 (30.9-47.7)	37.54±5.01 (24.7-50)	36.62±4.39 (27.1-43.1)	36.26±5.5 (26.5-50)	2.77(<.01)	6,7,5,1,8,3,9,>4,2
BMI (Body Mass Index) [kg/m^2]	24.83±3.25 (19.3-30.4)	21.02±2.11 (17.2-26)	24.47±3.02 (19.2-32.4)	21.02±1.9 (16.9-23.8)	25.69±4.18 (21-40.2)	24.08±2.58 (18.8-29)	25.87±3.47 (19.3-34.8)	23.02±2.08 (19.2-28)	24.06±3.64 (18.8-34.8)	8.96(<.001)	7,5,1,3,6,9,8>2,4
PBF (Percent Body Fat) [%]	18.12±5.98 (6-30.6)	13.14±4.56 (7.2-23.3)	18.29±6.41 (7.7-30.3)	11.65±4.13 (5.8-21.9)	19.71±7.94 (8.8-46.3)	16.38±5.57 (7.3-26.8)	20.42±6.95 (10.2-33.1)	14.83±5.6 (7.1-30.3)	17.42±7.01 (7.7-33.1)	5.87(<.001)	7,5,3,1,9,6,8>2,4
WHR (Waist-Hip Ratio)	0.85±0.07 (0.72-0.97)	0.81±0.04 (0.75-0.88)	0.87±0.08 (0.75-1.03)	0.8±0.04 (0.74-0.91)	0.89±0.09 (0.74-1.2)	0.86±0.06 (0.75-1)	0.88±0.09 (0.75-1.1)	0.83±0.06 (0.74-0.98)	0.87±0.09 (0.76-1.1)	5.25(<.001)	5,7,9,3,6,1,8>2,4
VFL (Visceral Fat Level) [kg]	5.68±2.7 (1-10)	2.92±1.52 (1-6)	5.64±3.15 (1-14)	2.48±1.36 (1-6)	6.76±5.37 (1-28)	5.19±2.94 (1-12)	6.96±3.78 (2-19)	4.08±2.31 (1-10)	5.44±4.08 (1-19)	5.86(<.001)	7,5,1,3,9,6,8>2,4
Target Weight [kg]	77.03±7.94 (63.6-90.3)	72.88±6.53 (62.1-88.1)	74.83±7.51 (58.3-93.2)	72.26±6.61 (59.7-84.2)	76.6±9.08 (63-99)	79.79±8.11 (64.6-96.3)	78.15±8.12 (63.6-103)	74.68±6.84 (62.1-87.4)	74.7±9.39 (63.6-103)	2.48(<.01)	6,7,1,5,3,9,8>2,4
Weight Control [kg]	-2.91±5.72 (-12.3-7.9)	4.47±5.31 (-3.7-15.9)	-4±6.22 (-17.8-8.6)	3.52±5.25 (-0.6-15.9)	-5.82±10.81 (-50.8-3.2)	-2.03±6.17 (-15.1-11.7)	-5.3±8.13 (-27.9-7.9)	-1.2±4.58 (-13.9-8.3)	-3.39±7.54 (-27.9-9.3)	7.05(<.001)	2,4>8,6,1,93,7,5
BFM Control [kg]	-3.8±4.98 (-14.1-4.9)	1.55±3.63 (-6-6.9)	-4.3±5.83 (-17.8-4.1)	1.3±3.26 (-4.7-11.7)	-6.24±10.61 (-50.8-3.2)	-2.73±5.2 (-15.1-6.9)	-6.17±7.43 (-27.9-3.3)	-1.7±3.94 (-13.9-5)	-4.09±7.05 (-27.9-3.8)	5.42(<.001)	2,4,8>6,1,9,3,7,5
FFM Control [kg]	0.89±2.09 (0-9.1)	2.92±2.66 (0-9.1)	0.3±1 (0-4.5)	2.22±3.89 (0-12.9)	0.42±1.24 (0-5.7)	0.7±1.91 (0-7.1)	0.88±2.11 (0-9.1)	0.5±1.58 (0-7.3)	0.7±1.74 (0-6.6)	4.34(<.001)	2,4>1,7,6,9,8,5,3
Obesity Degree	113.12±14.67 (88-138)	95.54±9.58 (78-118)	112.36±13.81 (87-147)	96.08±8.65 (77-108)	117.12±19.07 (95-183)	109.5±11.79 (85-132)	118±15.91 (88-158)	104.76±9.21 (89-127)	110.28±16.88 (85-158)	9.11(<.001)	7,5,1,3,9,6,8>4,2

Note: ***ns*** – not statistically significant

Table 2. Physiological parameters in men performing various types of physical activity

Parameter	Golf 1	Martial arts 2	Aerobic 3	Jogging 4	Swimming 5	General P.E. 6	Sauna 7	Cycling 8	Individual training 9	F(*p*)	Differences
HRmin [bpm]	67,16±3,62 (57-72)	86,62±10,8 (70-109)	73,72±6,5 (59-86)	82,08±11,29 (62-102)	82,68±6,85 (71-97)	75,81±7,46 (59-91)	88,88±9,69 (69-108)	73±8,49 (60-85)	70,64±6,82 (60-86)	20,72(<.001)	7,2>5,4>6,3,8>9,1
HRavg [bpm]	86,76±8,58 (71-100)	131,73±6,45 (122-146)	101,84±8,9 (87-118)	123,64±6,16 (108-135)	122,16±9,48 (105-149)	110,12±8,24 (93-121)	108,76±8,3 (96-128)	102,48±15,51 (78-124)	92,32±12,55 (74-125)	59,08(<.001)	2>4,5>6,7>8,3>9>1
HRmax [bpm]	123,12±15,98 (96-156)	156,65±8,81 (135-174)	135,16±15,93 (109-168)	154,36±14,47 (105-181)	146,84±13,17 (128-177)	148,77±11,73 (124-168)	132,88±8,21 (117-149)	132±18,93 (107-163)	125,48±29,36 (12-168)	14,81(<.001)	2,4,6,5>3,7,8,9,1
Recovery time [h]	0,8±1 (0-3)	15,81±3,54 (10-23)	3,2±2,35 (0-8)	10,96±2,7 (5-17)	9,64±5,28 (4-26)	5,62±2,74 (1-11)	1,24±0,6 (0-3)	4,32±3,78 (0-11)	1,88±2,39 (0-10)	73,67(<.001)	2>4,5>6,8>3>9,7,1
PTE-Peak Training Effect	1,46±0,39 (1-2,2)	3,15±0,52 (2,4-4,6)	1,91±0,59 (1,2-3,4)	2,71±0,28 (2,1-3,1)	2,43±0,64 (1,7-4,3)	2,32±0,48 (1,4-3,9)	1,68±0,29 (1,2-2,3)	1,96±0,68 (1,1-3)	1,66±0,55 (1-3,2)	29,77(<.001)	2>4,5,6>8,3,7,9,1
Energy expenditure [kcal]	253,52±45,78 (176-361)	706,73±70,16 (600-818)	374,64±61,78 (273-476)	606,56±60,59 (506-754)	537,04±81,87 (337-679)	448,69±95,51 (284-580)	124,68±17,37 (98-167)	395,92±118,13 (201-585)	297,28±85,16 (186-498)	144,8(<.001)	2>4>5>6>8,3>9>1>7
VO2avg [mL/kg/min]	8,48±2 (6-13)	24,92±2,4 (19-28)	13,68±3,99 (7-24)	20,88±2,32 (17-26)	19,84±2,75 (15-25)	17,38±5,99 (6-33)	18,8±2,77 (14-25)	13,84±4,71 (7-20)	10,92±4,42 (6-21)	49,83(<.001)	2>4,5,7,6>8,3>9>1
VO2max [mL/kg/min]	22,44±6,2 (12-33)	35,19±4,11 (29-45)	26,24±5,21 (18-39)	32,16±4,82 (25-48)	27,8±4,75 (21-37)	32,88±11,32 (22-85)	26,6±2,75 (21-32)	26,08±6,24 (18-37)	24,32±7,45 (11-39)	11,58(<.001)	2,6,4>5,7,3,8,9,1
EPOCavg [mL/kg]	3,16±1,7 (1-7)	33,5±10,87 (18-54)	8,75±5,43 (2-19)	21,72±6,98 (8-36)	16,24±7,6 (7-39)	10,54±4,84 (3-21)	4,32±2,78 (2-13)	9,2±6,36 (2-21)	5,56±5,16 (2-22)	61,84(<.001)	2>4>5>6,8,3,9,7,1
EPOCmax [mL/kg]	8,12±5,41 (2-22)	57,54±23,09 (27-125)	17,16±13,03 (4-47)	39,8±8,89 (24-57)	25,52±13,44 (9-59)	25,88±11,63 (7-52)	11,08±5,57 (5-28)	20,84±15,67 (2-48)	12,92±12,75 (3-61)	36(<.001)	2>4>6,5,8,3,9,7,1
Respiratory rateavg [brpm]	16,68±1,65 (13-19)	24,35±2,45 (17-30)	19,04±1,46 (17-22)	22,84±1,49 (20-27)	21,49±1,48 (20-26)	20,31±1,32 (18-22)	18,72±1,46 (17-22)	19,68±2,38 (15-24)	17,64±2,38 (13-24)	45,41(<.001)	2>4>5>6,8,3,7>9,1
Respiratory ratemax [brpm]	24,96±2,92 (19-34)	37,08±4,49 (29-45)	27,44±3,72 (23-39)	34,96±3,92 (28-42)	28,75±3,91 (25-39)	32,04±6,58 (23-54)	25,48±2,73 (22-33)	30,12±5,71 (22-44)	26,72±5,05 (19-42)	22,29(<.001)	2,4>6,8,5,3,9,7,1
Exercise intensity [min:s]											
Easy <107 [bpm]	53:02±7:18 (37:49-60:00)	4:36±5:07 0:00-21:43	40:30±13:06 20:26-60:00	8:37±7:46 0:00-31:52	7:41±7:49 0:22-31:12	26:56±13:04 8:07-50:15	5:59±3:26 0:00-11:22	37:59±18:22 8:23-1:00	47:44±11:56 23:22-59:43	83,57(<.001)	1,9>3,8>6>4,5,7,2
Moderate 107-124 [bpm]	5:42±6:16 (0:00-21:16)	12:14±7:13 4:07-33:15	13:11±9:47 0:00-34-14	18:19±7:32 2:43-37:11	28:39±9:47 10:59-44:41	19:41±8:31 6:06-34:23	6:03±2:06 1:40-10:24	11:50±9:49 0:00-36:33	8:11±7:40 0:17-31:07	21.7(<.001)	5>6,4>3,2,8,9,7,1
Difficult 125-141 [bpm]	1:10±1:51 (0:00-5:35)	27:33±9:16 9:15-45:18	4:58±6:44 0:00-20:42	26:57±9:13 10:29-45:34	20:38±10:40 0:00-43:42	11:39±7:32 0:00-25:02	1:50±1:54 0:00-7:15	7:59±9:09 0:00-28:45	3:08±4:37 0:00-13:23	51.39(<.001)	2,4>5>6,8,3>9,7,1
Very Difficult 142-159 [bpm]	0:06±0:22 (0:00-1:45)	14:47±9:32 0:00-32:06	1:21±3:10 0:00-0:00	5:42±4:01 0:03-11:43	2:59±6:17 0:00-22:52	1:43±2:12 0:00-7:43	0:09±0:26 0:00-1:43	2:11±3:28 0:00-14:05	0:57±3:17 0:00-0:00	26.59(<.001)	2>4>5,8,6,3,9,7,1
Maximal ≥ 160 [bpm]	0:00±0:00 (0:00-0:00)	0:50±2:14 0:00-10:28	0:00±0:00 0:00-0:00	0:27±1:14 0:00-4:26	0:03±0:15 0:00-1:12	0:00±0:00 0:00-0:00	0:00±0:00 0:00-0:00	0:00±0:00 0:00-0:00	0:00±0:00 0:00-0:00	2.99(<.01)	2,4>5,1,3,6,7,8,9,

Discussion

Effectiveness is an important consideration in the analysis of the performance of PE teachers and educators, and it plays a key role in every physical training program. Teacher effectiveness is difficult to measure (Collier & Hebert, 2004; Podstawski & Borysławski, 2014), but teachers whose students attain the preset goals are generally regarded as effective (Harris & Henderson, 1999; Mawer, 1995). Teacher effectiveness can be evaluated based on several key criteria, including lesson planning, class organization and management, maintenance of discipline (Chase, Lirgg, Miami & Sakelos, 2003), as well as personal traits such as honesty and adaptability (McCullick, 2001; Vasiliadou, Deri, & Galanis, 2009). In physical and health education, proper training, assessment of progress, and the intensity and duration of physical effort are the key prerequisites for success (Seiler, 2010). Programs characterized by low levels of physical exertion and low exercise intensity are unlikely to produce the desired improvement in fitness (Helgerud et al., 2007). The progressive decrease in the number of obligatory PE classes in tertiary education contributes to a further decline in the PA levels of university students (Helgerud et. al., 2007).

The observed differences in anthropometric indicators (body mass, BMI, BFM, PBF, WHR, VFL and obesity degree) varied across the evaluated activity groups. Body mass and body fat indicators were significantly lower in the jogging group, followed by sauna and martial arts groups. Similar results were noted in a previous study analyzing the influence of body mass, body height and BMI on the motor abilities of male students performing various types of PA, measured at the beginning and end of the semester (Podstawski, Markowski, Choszcz & Klimczak, 2015). The body mass, BMI and motor fitness levels of sedentary male students were correlated with their choice of PA. Less intensive forms of PA, such as golf and bodybuilding/fitness, were selected by students with higher body mass and higher BMI, whereas comparatively lower weight students opted for more vigorous forms of PA, including general PE classes, martial arts, jogging followed by sauna, and volleyball. The type of PA was correlated with differences in the participants' body mass, BMI and motor abilities between the beginning and the end of semester. Students enrolled in general PE classes, martial arts, jogging with sauna, and volleyball scored higher in most motor ability tests, which suggests that these types of activities were most conducive to improving motor skills (Podstawski et.al., 2015). In another study of university students, motor abilities were also correlated with the type of PA, and martial arts students scored significantly higher in this category than participants performing other activities (Podstawski, Honkanen, Choszcz & Boraczyński, 2013). Similar relationships were noted in female students (Podstawski, Markowski, Choszcz, Lipiński & Borysławski, 2017). The present study provides further evidence that both martial arts and jogging followed by sauna are characterized by the highest levels of physical exertion. Higher levels of physical intensity could explain the lower body fat percentages in these groups; however, this is merely a speculation because the study had a descriptive research design. Higher levels of body fat in swimmers could be considered a "selection bias" as fat provides buoyancy in water and, therefore, tends to attract heavier individuals to this mode of PA.

Various forms of PA promote different locomotor skills (Angyán, Téczely, Zalay & Karsai, 2003; McGawley & Bishop, 2006) and have a different impact on anthropometric parameters and fitness levels (Almeida, Santos, Castro, Rizzo & Batista, 2013).

A 10-week PA program involving aerobic training and combined aerobic and resistance training (1-mile run, trunk flexion test, curl-ups, right hand grasping force, left hand grasping force, and long-jump) contributed to a decrease in body mass and BMI and an improvement in fitness levels among children (Lee et al., 2012). In a study of male university students performing different forms of PA, bodybuilding was the only discipline which induced a significant increase in body mass and BMI. The above parameters did not change significantly in subjects enrolled in martial arts, jogging followed by sauna, golf and general PE classes, and they decreased significantly in volleyball players (Podstawski et al., 2012). Kayihan (2014) reported significant variations in body mass, BMI, body height, body fat and skinfold thickness among 236 volunteers, including 84 subjects who performed martial arts, 72 team sport players, and 80 subjects who did not perform any type of PA. Team sports players were significantly taller than participants who performed martial arts. Body fat and skinfold thickness was also significantly lower in martial arts athletes than in sedentary subjects (Kayihan, 2014).

In the current study, the physiological parameters (HR; energy expenditure; $VO2_{avg, max}$; $EPOC_{avg, peak}$; respiratory rate $_{avg, max}$) were significantly higher in students who performed marital arts and jogging than in the remaining groups. These values were lowest in golf players and students who trained individually. Our findings suggest that PE classes should be taught by suitably qualified teachers and instructors to deliver the optimal results. The presented results also indicate that students are unable to effectively plan and implement individual training programs. They lack the relevant knowledge and skills, and their busy academic schedules prevent them from practicing sports regularly. According to Lu and De Lisio (2009), instructors' failure to adequately prepare for class was the main reason why PE programs are not effectively implemented in schools. Ineffective use of class time decreases students' motivation to participate in sports and physical activity. (Silverman & Scrabis, 2004). Students require mentors who will encourage them to improve their PA levels, motor fitness and overall well-being.

Suitably qualified and predisposed PE teachers and instructors can play such a role (Ball, Thames & Phelps, 2008; Dodds, Place, Doolittle, Ratliffe & Portman, 1992; Rink, 1996). Physical education classes that are not only well organized, but also fun, will be more effective in instilling conscious health and fitness habits in students (Pagnano & Langley, 2001).

According to King (2001) voluntary PA programs can effectively improve fitness levels and decrease body mass, but participants who drop out after the first two or three months are more likely to return to their baseline weight or even gain weight (yo-yo effect). Individual traits such as lifestyle, habits, PA levels, gender, health, overall fitness levels, as well as character traits, including motivation, temperament and willpower, determine the extent to which the participants will be able to achieve the preset goals. Environmental factors and the type of undertaken PA also influence goal achievement (Podstawski et al., 2015). According to Neupert et al. (2009) 30-50% of individuals who enroll in a training program quit after two or three months, whereas more than 50% of the participants continue the program for up to six months. Dropout rates are highest among people with a sedentary lifestyle, and university students generally fall into this category (Dishman & Sallis, 1994; Podstawski, Choszcz, Konopka, Klimczak, & Starczewski, 2014). Despite the above, PE classes offering a regular and well-planned exercise regimen can be expected to bring positive results after five months of training. Dishman and Sallis (1994) reviewed health-related fitness programs and concluded that subjects were more likely to continue training if they did not quit in the first six months.

Strengths and limitations

The presented results expand our theoretical knowledge and provide valuable practical inputs regarding PA at all levels of education, from primary school to university. This is one of the very few studies to reliably evaluate the effectiveness of different forms of PA, including in physical education, among university students. In practice, the analyzed forms of PA can be introduced at all educational stages, regardless of the participants' age. They can also be implemented intermittently in different periods of physical development to increase the intensity of physical exercise and increase physical activity levels among students.

The use of Suunto Ambit3 Peak Sapphire heart rate monitors for measuring the participants' estimated values of physiological parameters was a potential limitation of this study. However, devices of the type are widely used to analyze physical exertion levels in both performance and health training. It should also be noted that other types of measuring equipment could not have been used as effectively in a study that was conducted on a large and homogenous sample (200 university students).

Conclusions

The highest levels of physical exertion were noted among male university students who performed martial arts and jogging followed by sauna. Students performing martial arts and jogging are characterized by the lowest, relative, body fat levels, compared with those participating in golf, bodybuilding/fitness, swimming and general PE classes, as well as students who trained individually. Participants who play golf and train individually remain within the easy effort range for the longest time, but body fat levels are highest in swimmers.

Acknowledgments

The authors would like to thank all students who volunteered for the study.

Funding

The funding for this research received from the University of Warmia and Mazury in Olsztyn does not lead to any conflict of interest.

References

Almeida, A. H., Santos, S. A., Castro, P. J., Rizzo, J. A., & Batista, G. R. (2013). Somatotype analysis of physically active individuals. *The Journal of Sports Medicine and Physical Fitness*, *53*(3), 268–273.

Andrijašević, A., Paušić, J., Bavčević, T., & Ciliga, D. (2005). Participation in leisure activities and self-perception of health in the students of the University of Split. *Kinesiology*, 37(1): 21–31.

Angyán, L., Téczely, T., Zalay, Z., & Karsai, I. (2003). Relationship of anthropometrical, physiological and motor attributes to sport-specific skills. *Acta Physiologica Hungarica*, *90*(3), 225–231. https://doi.org/10.1556/APhysiol.90.2003.3.5

Ball, D.L., Thames, M.H., & Phelps, G. (2008). Concept Knowledge for Teaching: What Makes It Special? *Journal of Teacher Education*. 59(5): 389-407.

Bouillod, A., Cassirame, J., Bousson, J.M., Sagawa, Y. Jr., & Tordi, N. (2015) Accuracy of the Suunto system for heart rate variability analysis during a tilt-test. *Revista Brasileira de Cineantropometria e Desempenho Humano*, 17(4): 409-417

Bray, S. R., & Born, H. A. (2004). Transition to university and vigorous physical activity: implications for health and psychological well-being. *Journal of American College Health*, *52*(4), 181–188. https://doi.org/10.3200/JACH.52.4.181-188

Butler, S. M., Black, D. R., Blue, C. L., & Gretebeck, R. J. (2004). Change in diet, physical activity, and body weight in female college freshman. *American Journal of Health Behavior*, *28*(1), 24–32. https://doi.org/10.5993/ajhb.28.1.3

Chase, M., Lirgg, M., Miami, C., & Sakelos, T. (2003). Teacher efficacy and effective teaching behaviors in physical education (Pedagogy). *Research Quarterly for Exercise and Sport*, 6, 102-112.

Collier, D., & Hebert, H. (2004). Undergraduate physical education teacher preparation: What practitioners tell us? *Physical Education*, 61, 102-112.

Dishman, R.K., & Sallis, J.F. (1994). Determinants and interventions for physical activity and exercise. In C. Bouchard R.J. Shepard & T. Stephens T (Eds.), *Physical activity, fitness, and health* (214-238). Champaign, IL: Human Kinetics.
Dodds, P., Place, J., Doolittle, S., Ratliffe, T.A., & Portman, P.A. (1992). Teacher/coach recruits: Background profiles, occupational decision factors, and comparisons with recruits into other physical education occupations. *Journal of Teaching in Physical Education*, 11, 161-176.
Douglas, K. A., Collins, J. L., Warren, C., Kann, L., Gold, R., Clayton, S., … Kolbe, L. J. (1997). Results from the 1995 National College Health Risk Behavior Survey. *Journal of American College health*, *46*(2), 55–66. https://doi.org/10.1080/07448489709595589
Gibson, A. L., Holmes, J. C., Desautels, R. L., Edmonds, L. B., & Nuudi, L. (2008). Ability of new octapolar bioimpedance spectroscopy analyzers to predict 4-component-model percentage body fat in Hispanic, black, and white adults. *The American Journal of Clinical Nutrition*, *87*(2), 332–338. https://doi.org/10.1093/ajcn/87.2.332
Golja, P., & Robič, T. (2014). The role of sports clubs in sports activity of students. *Zdra-vstveno Varstvo*, 53(1), 26–33.
Gordon-Larsen, P., Adair, L. S., Nelson, M. C., & Popkin, B. M. (2004). Five-year obesity incidence in the transition period between adolescence and adulthood: the National Longitudinal Study of Adolescent Health. *The American Journal of Clinical Nutrition*, *80*(3), 569–575. https://doi.org/10.1093/ajcn/80.3.569
Guthold, R., Ono, T., Strong, K. L., Chatterji, S., & Morabia, A. (2008). Worldwide variability in physical inactivity a 51-country survey. *American Journal of Preventive Medicine*, *34*(6), 486–494. https://doi.org/10.1016/j.amepre.2008.02.013
Haase, A., Steptoe, A., Sallis, J.F., & Wardle, J. (2004). Leisure-time physical activity in university students from 23 countries: Associations with health beliefs, risk awareness, and national economic development. *Preventive Medicine*, 39(1), 182–190.
Hajhosseini, L., Holmes, T., Mohamadi, P., Goudarzi, V., McProud, L., & Hollenbeck, C. B. (2006). Changes in body weight, body composition and resting metabolic rate (RMR) in first-year university freshmen students. *Journal of the American College of Nutrition*, *25*(2), 123–127. https://doi.org/10.1080/07315724.2006.10719522
Harris, C., & Henderson, J. (1999). Improving Schools through Teacher Leadership. *Educational Journal*, 59, 22-23.
Helgerud, J., Høydal, K., Wang, E., Karlsen, T., Berg, P., Bjerkaas, M., … Hoff, J. (2007). Aerobic high-intensity intervals improve VO2max more than moderate training. *Medicine & Science in Sports & Exercise*, *39*(4), 665–671. https://doi.org/10.1249/mss.0b013e3180304570
Huang, T. T., Harris, K. J., Lee, R. E., Nazir, N., Born, W., & Kaur, H. (2003). Assessing overweight, obesity, diet, and physical activity in college students. *Journal of American College health*, *52*(2), 83–86. https://doi.org/10.1080/07448480309595728
International Physical Literacy Association. (2017). *International Physical Literacy Association homepage*. Available at: https://www.physical-literacy.org.uk.
Kaan, L. Warren, C.W., Harris, W.A., Collins, J.L., Williams, B.I., Ross, J.G., & Kolbe, L.J. (1996). Youth Risk Behavior Surveillance – United States 1995. *MMWR CDC Surveillance Summary*, 45, 1-84.
Kayihan, G. (2014). Comparison of physical fitness levels of adolescents according to sports participation: Martial arts, team sports and non-sports. *Archives of Budo*, 10: 227-232.
King, A. C. (2001). Interventions to promote physical activity by older adults. *The Journals of Gerontology*. Series A, Biological sciences and medical sciences, 56(Spec No 2), 36–46. https://doi.org/10.1093/gerona/56.suppl_2.36
Korpak, B. (2005). Wychowanie fizyczne studentów w uczelniach wyższych (In Polish: Physical education of students at universities). In H. Hanusz & B. Korpak (Eds.), *Wychowanie fizyczne studentów. Przeżytek czy konieczność* (153-158). Warszawa: AZS Press.
Lee, I.M., Shiroma, E.J., Lobelo, F., Puska, P., Blair, S.N., & Katzmarzyk, P.T., (2012). Lancet Physical Activity Series Working Group. Effect of physical inactivity on major noncommunicable diseases worldwide: An analysis of burden of disease and life expectancy. *Lancet*, 380(9838), 219-229. doi: 10.1016/S0140-6736(12)61031-9.
Lipošek, S., Planinšek, J., Leskošek, B., & Pajtler, A. (2018). Physical activity of university students and its relation to physical fitness and academic success. *Annales Kinesiologae*, 9(2), 89-104.
Lloyd-Richardson, E. E., Bailey, S., Fava, J. L., Wing, R., & Tobacco Etiology Research Network (TERN) (2009). A prospective study of weight gains during the college freshman and sophomore years. *Preventive Medicine*, *48*(3), 256–261. https://doi.org/10.1016/j.ypmed.2008.12.009
Longmuir, P. E., & Tremblay, M. S. (2016). Top 10 Research Questions Related to Physical Literacy. *Research Quarterly for Exercise and Sport*, *87*(1), 28–35. https://doi.org/10.1080/02701367.2016.1124671
Lu, C., & DeLisio, A. (2009). Specifics for generalists: Teaching elementary physical education. *International Electronic Journal of Elemantary Education*, 1(3), 170-187.
Martínez-González, M. A., Varo, J. J., Santos, J. L., De Irala, J., Gibney, M., Kearney, J., & Martínez, J. A. (2001). Prevalence of physical activity during leisure time in the European Union. *Medicine and Science in Sports and Exercise*, *33*(7), 1142–1146. https://doi.org/10.1097/00005768-200107000-00011
Mawer, M. (1995). The effective teaching of physical education. Journal of Teaching in Physical Education, 2, 3-16.
McCullick, B.A. (2001). Practitioners' perspectives on values, knowledge, and skills needed by PETE participants. *Journal of Teaching in Physical Education*, 21, 35-56.
McGawley, K., & Bishop, D. (2006). Reliability of a 5 x 6-s maximal cycling repeated-sprint test in trained female team-sport athletes. *European Journal of Applied Physiology*, *98*(4), 383–393. https://doi.org/10.1007/s00421-006-0284-8
Mokdad, A. H., Serdula, M. K., Dietz, W. H., Bowman, B. A., Marks, J. S., & Koplan, J. P. (1999). The spread of the obesity epidemic in the United States, 1991-1998. *Journal of American Medical Association*, *282*(16), 1519–1522. https://doi.org/10.1001/jama.282.16.1519
Neupert, S.D., Lachman, M.E., & Whitbourne, S.B. (2009). Exercise, self-efficacy and control beliefs predict exercise behavior after an exercise intervention for older adults. *Journal of Aging and Physical Activity*, 17(1), 1-16.
Ng, S.W., Norton, E.C., & Popkin, B.M. (2009). Why have physical activity levels declined among Chinese adults? Findings from the 1991–2006 China health and nutrition surveys. *Social Science and Medicine*, 68(7), 1305–1314.
Pagnano, K., & Langley, D.J. (2001). Teacher Perspectives on the Role of Exercise as a Management Tool in Physical Education. *Journal of Teaching in Physical Education*, 21, 57-74.
Podstawski, R. (2018). Physical education as an integral component of health education in higher schools. In A. Bodasińska, T. Jaślikowska-Sadowska & K. Piech (Eds.), *Dylematy szkolnego wychowania fizycznego* [Dilemmas of school physical education] (pp.21-34). Biała Podlaska: AWF im. J. Piłsudskiego Press. (In Polish, English abstract).
Podstawski, R., & Borysławski, K. (2014). Influence of PE teacher's qualifications on the motor abilities of early school age children. *Physical Education of Students*, 1, 56-63.

Podstawski, R., & Choszcz, D. (2014). The legitimacy of physical education classes for university students. *Problems of Education in 21th Century*, 58(58), 118-126.
Podstawski, R., & Sławek, M. (2012). The Influence of Political Transformation in Poland on the Functioning of the Department of Physical Education and Sport at The University of Warmia and Mazury in Olsztyn During The Academic Years of 1998/1999 and 2010/2011. In B. Sokołowska (Ed.), *Public Health in The Aspect of Modern Civilization* (pp. 266-278). Biała Podlaska: PSW JPII Press.
Podstawski, R., Borysławski, K., Clark, C.C.T., Choszcz, D., Finn, K.J., & Gronek, P. (2019a). Correlations between repeated use of dry sauna for 4 x 10 minutes, physiological parameters, anthropometric features, and body composition in young sedentary and overweight men: health implications. *BioMed Research International*, Article ID 7535140, 13 pages, https://doi.org/10.1155/2019/7535140
Podstawski, R., Choszcz, D., Konopka, S., Klimczak, J., & Starczewski, M. (2014). Anthropometric determinants of rowing ergometer performance in physically inactive collegiate females. *Biology of Sport*, 31(4), 315-321.
Podstawski, R., Choszcz, D., Siemianowska, E., & Skibniewska, K.A. (2012). Determining the effect of selected anthropometric parameters on the time needed to cover 1000 m on a rowing ergometer by physically inactive young women. *Isokinetics & Exercise Science*, 20(3), 197-204.
Podstawski, R., Honkanen, A., Choszcz, D., & Boraczyński, M. (2013). Maximizing University students' motor fitness by implementing a physical education program incorporating martial arts – implicational study. *Journal of Combat Sports Marshal Arts*, 4(2), 197-205.
Podstawski, R., Honkanen, A., Tuohino, A., & Gizińska, R. (2015). The influence of socioeconomic and psychological factors on the popularity of sauna treatment among female university students. *Baltic Journal of Health Physical Activity*, 7(2), 67-82.
Podstawski, R., Markowski, P., Choszcz, D., & Klimczak J. (2015). Anthropometric indicators and motor abilities of university students performing various types of physical activities (martial arts, volleyball, bodybuilding/fitness, jogging followed by sauna, golf, general PE classes). In R.M. Kalina (Ed.), *Archives of Budo Conference Proceedings: Health and Martial Arts in Interdisciplinary Approach* (pp. 139-148). Częstochowa, Poland: Archives of Budo Press.
Podstawski, R., Markowski, P., Choszcz, D., Lipiński, A., & Borysławski, K. (2017). Effectiveness of martial arts training vs. other types of physical activity: Differences in body height, body mass and motor abilities. *South African Journal of Research in Sports, Physical Education and Recreation*, 39(1), 111-133.
Podstawski, R., Moran, K., Mańkowski, S., Choszcz, D., & Sarcevic Z. (2017). Socioeconomics Influences on the Water Competencies of Young Adult Polish Males. *Physical Culture and Sport Studies and Research*, 74(1), 19-33.
Podstawski, R., Żurek, P., Clark, C.C.T., Laukkanen, J.A., Markowski, P., & Gronek, P. (2019b). A multi-factorial assessment of the 3-Minute Burpee Test. *Journal of Physical Education and Sport*, 19(2), 1083-1091
Rink, J.E. (1996). Effective instruction in physical education. In S.J. Silverman, C.D. Ennis (Eds.), *Student learning in physical education: Applying research to enhance instruction* (pp. 171-198). Champaign, Illinois: Human Kinetics, 171-198.
Sandercock, G. R., & Brodie, D. A. (2006). The use of heart rate variability measures to assess autonomic control during exercise. *Scandinavian Journal of Medicine & Science in Sports*, *16*(5), 302–313. https://doi.org/10.1111/j.1600-0838.2006.00556.x
Scoon, G. S., Hopkins, W. G., Mayhew, S., & Cotter, J. D. (2007). Effect of post-exercise sauna bathing on the endurance performance of competitive male runners. *Journal of Science and Medicine in Sport*, *10*(4), 259–262. https://doi.org/10.1016/j.jsams.2006.06.009
Seiler, S. (2010). What is best practice for training intensity and duration distribution in endurance athletes? *International Journal Sports Physiology & Performance*, 5, 276-291.
Serlachius, A., Hamer, M., & Wardle, J. (2007). Stress and weight change in university students in the United Kingdom. *Physiology & Behavior*, *92*(4), 548–553. https://doi.org/10.1016/j.physbeh.2007.04.032
Silverman, S., & Scrabis, K.A. (2004). A review of research on instructional theory in physical education 2002-2003. *Journal of Teaching in Physical Education*, 41, 4-12.
Ståhl, T., Rütten, A., Nutbeam, D., Bauman, A., Kannas, L., Abel, T., … van der Zee, J. (2001). The importance of the social environment for physically active lifestyle--results from an international study. *Social Science & Medicine (1982)*, *52*(1), 1–10. https://doi.org/10.1016/s0277-9536(00)00116-7
Steptoe, A., Wardle, J., Fuller, R., Holte, A., Justo, J., Sanderman, R., & Wichstrøm, L. (1997). Leisure-time physical exercise: prevalence, attitudinal and behavioral correlates in young Europeans from 21 countries. *Preventive Medicine*, 26, 845-854.
Valdez, P., Ramírez, C., García, A., Talamantes, J., & Cortez, J. (2007). Circadian and homeostatic variation in sustained attention. *Chronobiology International*, 27(2), 393-416.
Vasiliadou, O., Deri, V., & Galanis, N. (2009). Training in-service physical educators to improve class time management. Rev Int De Cien Del Deporte, 5(17), 33-43.
Vella-Zarb, R. A., & Elgar, F. J. (2009). The 'freshman 5': a meta-analysis of weight gains in the freshman year of college. *Journal of American College Health*, *58*(2), 161–166. https://doi.org/10.1080/07448480903221392
Whitehead, M. (2010). *Physical literacy throughout the life course*. London: Routledge, Taylor and Francis Group.
World Health Organization. (2016). *Physical activity. Levels of insufficient physical activity*. Available at: http://www.who.int/mediacentre/factsheets/fs385/en/.

Corresponding information:

Received:11.11.2020.
Accepted:07.05.2021.
Correspondence to: Robert Podstawski
University: University of Warmia and Mazury in Olsztyn, Poland
Faculty: Department of Tourism, Recreation and Ecology
Phone: +48 89 523 41 67
E-mail: podstawskirobert@gmail.com