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MOTOR PERFORMANCE ACCORDING TO PHYSICAL ACTIVITY LEVELS

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ABSTRACT

This study evaluated the influence of extreme effort on physiological parameters of males and females with low or moderate levels of physical activity (PA) and different body composition parameters. Ninety-six participants (45 females, aged 20.05±1.81 years; 51 males, aged 20.20±2.71 years) took part in this study. PA levels were evaluated with the International Physical Activity Questionnaire (IPAQ) and they performed the 3-Minute Burpee Test (3-MBT). The Mann-Whitney U test and correlation analysis were applied. Participants with low levels of PA had significantly higher (p<0.05) body mass and body composition parameters (total body water, protein, minerals, body fat mass, fat-free mass, skeletal muscle mass, body mass index, percent body fat and waist-hip ratio (WHR). Participants with moderate levels of PA completed significantly more training cycles during the 3-MBT than their sedentary peers. Physiological parameters and exercise intensity were higher, albeit non-significantly, in more physically active participants. Extreme effort duration was significantly (p=0.0445) longer in males with low levels of PA (00:29 min) than moderate levels of PA (00:15 min). Females and males with moderate levels of PA have significantly higher endurance-strength abilities and are characterised by non-significantly higher values of physiological parameters during extreme effort than their sedentary peers.

***Keywords*:** University students; Physical activity levels; Body composition; Physiological parameters; 3-MBT.

INTRODUCTION

The importance of life-long physical activity (PA) and its positive impact on health have been well documented by scientific research (Epstein & Roemmich, 2001; Haase *et al*., 2004; Podstawski *et al*., 2017b). Professional organisations and government agencies publish numerous recommendations for exercise and physical activity to improve the health and well-being of individuals in various age groups (Pate *et al*., 1995; Bennet *et al*., 2009; Garber *et al*., 2011). Empirical evidence suggests that regular PA is required to improve the relative-risk profile of individuals with health risk factors (Mayer *et al*., 2006; Lee *et al*., 2011). According to global recommendations, adults and children older than 2 years should perform at least 30 minutes of moderate-intensity exercise, preferably on all days of the week (Pate *et al*., 1995).

Sound knowledge of the terms and concepts associated with PA is required to understand how PA and exercise fit into the model of modern health. *Physical activity* is defined as any bodily movement that involves skeletal muscles and leads to energy expenditure (Casperson *et al*., 1985). *Exercise* is a subset of PA, and it is defined as planned, structured, repetitive and purposeful activity, which is performed to improve or maintain physical fitness (Pate *et al*., 1995). *Physical fitness* (PF) involves several attributes and parameters related to PA, including cardiorespiratory fitness, muscle strength, body composition and flexibility (Shephard & Balady, 1999).

Exercise intensity is an important parameter in exercise training workouts, and it denotes the physiological load during exercise (ACSM, 2013; Garber *et al*., 2011; Roy, 2015). Bodily responses to physical effort are determined, in part, by the size of the involved muscle groups and energy expenditure, which induces changes in systemic mechanisms of oxygen supply. Exercise intensity can be measured in various units (energy expenditure in kcal, kJ, MET, 1 kcal = 4.18 kJ, 1 MET = 3.5 ml of oxygen/kg/min; load in Watts (W), kg·m/min, 1 W = 6.12 kg·m/min). The maximum rate of oxygen consumption (VO_{2max}) is asserted to be the most accurate parameter for evaluating physical exertion, and it denotes the maximum heart rate (HR) at which oxygen can be taken up and consumed by the body during intense exercise (Dalleck & Dalleck, 2008).

Other indicators are also used to monitor exercise intensity, including target HR, rate of perceived exertion (RPE) and the Talk Test (Roy, 2015). In most PA guidelines, exercise intensity is measured by the percentage of age-related maximum HR, and it is classified into the following HR zones: very light, light, moderate, vigorous and near-maximal to maximal exercise (Garber *et al*., 2011). Exercise intensity in each HR zone is described by the following parameters: very light – <57% of HR_{max} or <37% of VO_{2max}; light – 57-63% of HR_{max} or 37-45% of VO_{2max}; moderate – 64%-76% of HR_{max} or 46-63% of VO_{2max}; vigorous – 77-95% of HR_{max} or 64-90% of VO_{2max}; near-maximal to maximal – ≥96% of HR_{max} or ≥91% of VO_{2max} (Swain & Franklin, 2006; ACSM, 2013;). It should be noted, however, that exercise test protocols, exercise mode, exercise intensity, resting HR, physical fitness (PF) level, age, body composition as well as other factors can considerably influence the relationships between actual energy expenditure, HRR, VO_2, $\%HR_{max}$ and $\%VO_{2max}$ (Rotstein & Meckel, 2000; Byrne & Hills, 2002; Pinet *et al*., 2008; Cunha *et al*., 2010).

According to researchers, exercise intensity should be classified based on the absolute energy demand of PA (Shephard, 2001). Interval training is an example of high-intensity exercise performed during brief bouts. The intensity of exercise during interval training varies at fixed intervals during a single bout of exercise, and it can increase the total volume and/or average exercise intensity during the session. In healthy adults, short-term (≤ 3 months) interval training induces similar or greater improvements in cardiorespiratory fitness and cardiometabolic markers, including blood lipoproteins, glucose, interleukin-6, tumour necrosis factor α and muscle fatty acid transport, in comparison with adults performing fixed-intensity training (Clarkson, 2007; Croft *et al*., 2009; Talanian *et al*., 2010) and persons with metabolic, cardiac and pulmonary disorders (Beauchamp *et al*., 2010; Guimaraes *et al*., 2010).

Maximal HR is determined during a maximal exercise test or with the use of the following formula: 220 minus the individual's age (Marti & Howald, 1990; Mesquita *et al*., 1996; Tanaka *et al*., 2004). The reliability of the aforementioned formula, however, has been questioned by several authors (Whaley *et al*., 1992; Klusiewicz & Faff, 2003; Pimentel *et al*., 2003; Tanaka *et al*., 2004). Heart rate and oxygen uptake should be measured directly to formulate personalised recommendations for exercise. When such measurements, however, are not feasible, exercise intensity can be estimated sub-maximally (Garber *et al*., 2011).

A sedentary lifestyle contravenes a physically active lifestyle, and is associated with a plethora of health risks. Low energy expenditure associated with television watching, computer use, driving or sitting at a desk is eponymous features of sedentary behaviour (Volaklis *et al*., 2007). Prolonged sedentary behavior is associated with a higher risk of coronary heart disease mortality (Warren *et al*., 2010), depression (Teychenne *et al*., 2010), high blood pressure, low lipoprotein lipase activity and impaired biomarkers of chronic disease, such as blood glucose, insulin and lipoprotein levels (Healy *et al*., 2008; Thorp *et al*., 2010).

PURPOSE OF RESEARCH

The aim of this study was to evaluate the effects exerted by extreme effort on physiological parameters. Males and females with low or moderate levels of PA and different body composition parameters were analysed.

METHODOLOGY

Participants

The study involved 45 female and 51 male full-time university students (mean age: 20.05±1.81 and 20.20±2.71, respectively). The participants attended only compulsory physical education classes (90 minutes per week) and performed one 3-MBT per week. To facilitate the reliability of measurements, every participant performed the 3-MBT five times during five weekly physical education classes preceding the study (Podstawski *et al*., 2016b).

Ethical procedures

The study was performed in compliance with the Declaration of Helsinki and upon the prior consent of the Bioethical Committee and the authorities at the University. The participants gave their written consent to the study.

Measurements

Physical activity

The PA levels were evaluated before the study with the use of the International Physical Activity Questionnaire (Polish short version) (Biernat *et al*., 2007). In the questionnaire, the participants were asked to indicate the average weekly amount of exercise (minimum of 10 minutes) they had performed in the weeks preceding the study. The energy expenditure associated with the declared amount of weekly exercise was calculated and expressed in Metabolic Equivalent of Task (MET) units. The MET is the ratio of the rate of energy consumed during exercise to the rate of energy consumed at rest. One MET unit represents the amount of oxygen which is consumed in one minute, which is approximately equal to 3.5 mL/kg/min. Based on the declared frequency, intensity and duration of exercise, the students were divided into groups with low

(L<600 METs-min/week), moderate (M<1500 METs-min/week) and high (H≥1500 METs-min/week) PA levels. Ultimately, only the subjects with low and moderate PA levels were included in the study. The results of the IPAQ survey were analysed to reveal two relatively homogeneous groups of female and male students with low or moderate levels of PA.

Physical parameters

Body height was measured to the nearest 0.1mm with a calibrated WB-150 medical scale with a stadiometer (ZPU Tryb Wag, Poland) and the Martin anthropometer according to standardised guidelines. Body mass (measured to the nearest 0.1kg), 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}, InBody score, target weight, weight control, BFM control, FFM control, basal metabolic rate [BMR], waist-hip ratio [WHR], visceral fat level [VFL] and level of obesity) were determined by bioelectrical impedance (Gibson *et al*., 2008) with the InBody 720 body composition analyser.

Physiological parameters

Physiological parameters (heart rate [HR], calories burned, estimated average rate of oxygen consumption [VO_{2avg}], maximum rate of oxygen consumption [VO_{2max}], average excess post-exercise oxygen consumption [$EPOC_{avg}$], maximum excess post-exercise oxygen consumption [$EPOC_{max}$], average respiratory rate [RR_{avg}], maximum respiratory rate [RR_{max}]) and training parameters (recovery, peak training effect [PTE], exercise intensity: low (<107bpm), moderate (107-124bpm), high (125-141bpm), very high (142-159bpm), maximal (≥160bpm) were measured indirectly with the Suunto Ambit3 Peak GPS watch. The strength-endurance abilities of the participants were determined during the 3-MBT.

Stages of the 3-MBT

Stage 1 Begin in a standing position and move into a supported squat with both hands on the ground;

Stage 2: From a supported squat, kick your feet back into a plank with arms extended;

Stage 3: Return from the plank position to a supported squat;

Stage 4: Return to a standing position, extend your arms over the head and clap your hands. The participants repeat the cycle as many times as possible in the given time limit (3 minutes).

The exercise must be performed correctly, and the entire cycle must be completed in the specified order. The plank position should be maintained on extended arms without arching the back, but an exception can be made for individuals without adequate upper body strength. The legs should be fully extended in the plank position. A cycle is not counted when individual stages are not correctly performed.

Statistical analysis

The measured data were processed in view of the participants' gender and PA levels with the use of descriptive statistics (arithmetic mean, standard deviation, minimum and maximum values). The data were not normally distributed, and non-parametric procedures were applied. The results were compared using the Mann-Whitney U test at a significance level of $p<0.05$ (values in bold).

RESULTS

The PA levels of the evaluated females and males are presented in Metabolic Equivalent of Task (MET) units in Table 1. The results of the body composition analysis of female and male students with low and moderate levels of PA are presented in Table 2 and Table 3. The tested PF levels, physiological parameters during the 3-MBT and recovery parameters measured within six minutes directly after exercise are presented in Tables 4 to 7.

***Table 1*. PHYSICAL ACTIVITY LEVELS OF FEMALES AND MALES IN MET UNITS PER MIN/WEEK**

Gender group PA	**Metabolic Equivalent of Task (MET) units** Mean±SD	Min	Max	p-Value
Females (n=34) with LOW PA	537.84±51.45	420	600	**0.0000**
Females (n=11) with MODERATE PA	864.54±198.83	650	1210	
Males (n=21) with LOW PA	565.57±31.09	496	600	**0.0000**
Males (n=30) with MODERATE PA	1076.00±254.42	612	1350	

In the group of 45 evaluated female students, 34 were characterised by low PA levels, and 11 subjects by moderate PA levels. In the group of 51 males, 21 were characterised by low PA levels and 30 had moderate PA levels. In the group of females, the mean PA levels expressed in MET units differed significantly (p=0.0000) between Group I (low PA levels) with 537.84 METs and Group II (moderate PA levels) with 864.54 METs. Males were characterised by higher PA levels than females. Significant (p=0.0000) differences in this parameter were also noted between men with low PA levels (Group I= 565.57 METs) and males with moderate PA levels (Group II= 1076.00 METs) (Table 1).

An analysis of basic anthropometric parameters did not reveal significant differences in the age and height of females with different PA levels. Sedentary females had significantly higher (p<0.05) body mass and BMI than females with moderate PA levels. The body composition analysis revealed that females with low PA levels were characterised by significantly higher (p<0.05) values of the following parameters: TBW, protein, minerals, BFM, FFM, SMM, BMI, PBF and WHR. The weight control parameter indicates that sedentary females should reduce their body mass by 6.11kg and that the more physically active females should increase their body mass by 5.66kg (p=0.0001). Based on the values of BFM control, sedentary females should decrease their BFM by 7.27 kg, whereas physically active females should increase their BFM by 1.58kg.

The FFM control parameter suggests that sedentary females should increase their FFM by 1.16kg, and physically active females should increase their FFM by 4.08kg. Females with low PA levels were typified by a significantly higher (p=0.0168) basal metabolic rate (1372.56kcal) than females with moderate PA levels (1261.53kcal). The level of obesity was significantly higher in sedentary females (113.5) than in females with moderate PA levels (90.45) (Table 2).

Table 2. **COMPARISON OF DIFFERENT PA LEVELS OF FEMALES FOR SOMATIC PARAMETERS AND BODY COMPOSITION**

PARAMETER	LOW PA FEMALES (n=34) Mean±SD	Min	Max	MODERATE PA FEMALES (n=11) Mean±SD	Min	Max	p-Value
Age [years]	20.06±1.66	18.0	23.0	20.01±2.29	18.2	24.0	0.9305
Body height [cm]	166.41±6.17	156.0	183.0	165.18±5.69	158.0	174.0	0.5619
Body mass [kg]	67.51±12.34	52.3	104.9	52.93±6.57	43.4	63.3	**0.0006**
BMI [kg/m^2]	24.29±3.65	19.3	33.4	19.38±2.07	16.6	23.4	**0.0001**
TBW (Total Body Water) [L]	33.91±4.38	24.7	47.3	30.25±3.76	24.9	37.8	**0.0174**
Protein [kg]	9.11±1.17	6.7	12.6	8.10±1.02	6.7	10.2	**0.0111**
Minerals [kg]	3.37±0.49	2.41	4.88	2.93±0.40	2.41	3.62	**0.0134**
BFM (Body Fat Mass) [kg]	21.11±8.66	5.3	41.2	11.65±3.52	6.2	19.1	**0.0001**
FFM (Fat-Free Mass) [kg]	46.40±6.04	33.8	64.8	41.28±5.16	34.0	51.6	**0.0168**
SMM (Skeletal Muscle Mass) [kg]	25.51±3.56	18.1	36.2	22.47±3.04	18.1	28.6	**0.0135**
PBF (Percent Body Fat) [%]	30.35±7.85	9.7	48.1	21.82±5.48	13.2	31.2	**0.0013**
InBody Score	73.15±6.69	54.0	85.0	73.18±4.87	66.0	82.0	0.7406
Target Weight [kg]	61.40±6.47	52.3	84.2	58.59±4.27	53.6	65.1	0.2095
Weight Control [kg]	-6.11±8.17	-27.9	6.1	5.66±5.75	-4.9	14.0	**0.0001**
BFM Control [kg]	-7.27±7.64	-27.9	3.8	1.58±3.85	-6.2	7.9	**0.0002**
FFM Control [kg]	1.16±1.81	0	6.7	4.08±3.02	0	8.6	**0.0046**
BMR (Basal Metabolic Rate)[kcal]	1372.56±130.56	1099.0	1771.0	1261.73±111.53	1104.0	1484.0	**0.0168**
WHR (Waist-Hip Ratio)	0.87±0.05	0.75	0.96	0.81±0.03	0.78	0.86	**0.0029**
Level of obesity	113.50±17.07	90.0	156.0	90.45±9.89	77.0	109.0	**0.0001**

Table 3. **COMPARISON OF DIFFERENT PA LEVELS OF MALES FOR SOMATIC PARAMETERS AND BODY COMPOSITION**

PARAMETER	**LOW PA MALES** (n=34) **Mean±SD**	**Min**	**Max**	**MODERATE PA MALES** (n=11) **Mean±SD**	**Min**	**Max**	**p-Value**
Age [years]	20.91±3.07	18.1	29.0	19.70±2.36	16.3	29.0	0.1169
Body height [cm]	179.43±5.37	170.0	190.0	180.67±5.97	170.0	191.0	0.4517
Body mass [kg]	82.13±9.64	55.9	98.6	72.41±7.04	58.9	87.3	**0.0001**
BMI [kg/m^2]	25.51±2.92	18.8	30.4	22.17±1.59	19.2	25.3	**0.0000**
TBW (Total Body Water) [L]	48.56±6.12	32.9	57.4	45.04±4.94	35.5	56.1	**0.0216**
Protein [kg]	13.20±1.68	8.9	15.6	12.18±1.32	9.6	15.0	**0.0176**
Minerals [kg]	4.61±0.62	3.24	5.64	4.22±0.56	3.28	5.31	**0.0181**
BFM (Body Fat Mass) [kg]	15.77±6.00	5.0	24.3	10.97±3.55	4.0	18.8	**0.0042**
FFM (Fat-Free Mass) [kg]	66.37±8.40	45.0	78.6	61.44±6.79	48.4	76.4	**0.0201**
SMM (Skeletal Muscle Mass) [kg]	37.83±5.12	24.7	45.1	34.75±3.98	27.1	43.0	**0.0191**
PBF (Percent Body Fat) [%]	19.03±6.58	7.3	30.6	15.13±4.64	6.0	23.8	**0.0211**
InBody Score	80.57±9.20	64.0	94.0	78.10±5.09	69.0	89.0	0.3434
Target Weight [kg]	77.98±7.60	63.6	89.7	73.00±6.02	63.6	87.3	**0.0172**
Weight Control [kg]	-4.16±6.20	-12.3	11.7	0.58±4.04	-8.1	8.3	**0.0022**
BFM Control [kg]	-4.93±5.18	-14.1	6.9	-0.76±3.14	-8.1	5.0	**0.0025**
FFM Control [kg]	0.77±2.22	0	9.1	1.35±2.10	0	7.3	0.1188
BMR (Basal Metabolic Rate)[kcal]	1803.48±181.07	1342.0	2068.0	1697.30±146.67	1415.0	2020.0	**0.0195**
WHR (Waist-Hip Ratio)	0.86±0.07	0.77	0.99	0.82±0.05	0.72	0.91	**0.0103**
Level of obesity	116.14±13.57	85.0	138.0	101.17±7.32	89.0	115.0	**0.0000**

Table 4. **TRAINING PARAMETERS DURING 3-MBT IN FEMALES WITH LOW AND MODERATE PA LEVELS**

PARAMETER	**LOW PA FEMALES** (n=34) Mean±SD	Min.	Max.	**MODERATE PA FEMALES** (n=11) Mean±SD	Min.	Max.	p-Value
No. of cycles [cycl./3 min.]	33.32±9.09	15	46	53.09±7.38	44	66	**0.0000**
HRavg [bpm]	155.44±19.43	127	187	159.91±17.20	138	191	0.4596
HRmax [bpm]	170.88±16.55	143	196	180.82±12.02	165	201	0.1577
HRmin [bpm]	103.53±19.76	77	144	108.45±20.50	76	142	0.3835
HRR (max-min) [bpm]	67.35±16.37	34	109	72.36±23.71	40	125	0.4758
Recovery time [h]	1.44±0.61	1	3	1.64±0.81	1	3	0.5792
PTE [Peak Training Effect]	2.02±0.28	1.5	2.3	2.17±0.16	1.8	2.3	0.1956
Energy expenditure [kcal]	52.18±11.25	36	69	59.36±6.73	50	70	0.0790
VO_{2avg} [mL/kg/min]	35.06±8.79	18	47	39.73±5.59	32	50	0.1956
$VO_{2ma}x$ [mL/kg/min]	42.88±8.21	30	57	48.73±4.45	44	57	0.0790
$EPOC_{avg}$ [mL/kg]	8.38±3.57	3	19	10.64±5.16	6	24	0.1616
$EPOC_{max}$ [mL/kg]	18.47±10.21	9	48	25.09±15.00	13	61	0.0590
RR_{avg} [br/min]	28.03±9.68	9	45	32.82±8.69	17	47	0.1823
RR_{max} [br/min]	40.65±11.84	18	61	43.55±10.17	25	63	0.4205
Exercise intensity							
Low <107 [bpm]	00:00±00:02	00:00	00:11	00:01±00:03	00:00	00:11	0.4677
Moderate 107-124 [bpm]	00:08±00:13	00:00	00:41	00:04±00:07	00:00	00:21	0.6066
High 125-141 [bpm]	00:28±00:35	00:00	01:54	00:11±00:12	00:00	00:31	0.3030
Very high 142-159 [bpm]	00:48±00:49	00:00	02:30	00:35±00:46	00:00	02:43	0.5524
Maximal ≥160 [bpm]	01:36±01:18	00:00	03:00	02:09±00:55	00:00	03:00	0.3622

Table 5. **TRAINING PARAMETERS DURING 3-MBT OF MALES WITH LOW AND MODERATE PA LEVELS**

PARAMETER	LOW PA MALES (n=21) Mean±SD	Min.	Max.	MODERATE PA MALES (n=30) Mean±SD	Min.	Max.	p-Value
No. of cycles [cycl./3 min.]	38.00±4.59	24	45	53.67±6.08	41	66	**0.0000**
HRavg [bpm]	168.00±21.18	115	191	173.43±10.36	156	193	0.9238
HRmax [bpm]	183.05±18.75	136	201	186.60±9.56	169	200	0.7961
HRmin [bpm]	112.71±22.17	71	142	111.40±14.92	74	130	0.6529
HRR (max-min) [bpm]	70.33±15.36	51	99	75.20±15.57	54	117	0.3196
Recovery time [h]	1.76±0.83	0	3	1.90±0.71	1	3	0.6120
PTE [Peak Training Effect]	2.10±0.34	1.3	2.3	2.25±0.06	2.1	2.3	0.7019
Energy expenditure [kcal]	56.71±13.89	29	69	61.43±6.60	49	71	0.8184
VO_{2avg} [mL/kg/min]	40.29±8.85	21	50	42.47±5.10	31	50	0.8482
VO_{2max} [mL/kg/min]	48.67±8.73	27	57	50.37±5.04	41	58	0.9771
$EPOC_{avg}$ [mL/kg]	10.90±5.26	1	24	11.10±5.03	7	25	0.6053
$EPOC_{max}$ [mL/kg]	28.48±15.27	4	61	27.40±14.57	15	61	0.5920
RR_{avg} [br/min]	35.62±10.28	18	48	36.77±6.28	28	48	0.9924
RR_{max} [br/min]	50.33±14.34	26	70	52.37±7.87	37	64	0.8859
Exercise intensity							
Low <107 [bpm]	00:01±00:03	00:00	00:10	00:00±00:00	00:00	00:00	0.5723
Moderate 107-124 [bpm]	00:04±00:11	00:00	00:38	00:01±00:02	00:00	00:08	0.8708
High 125-141 [bpm]	00:15±00:33	00:00	02:01	00:05±00:06	00:00	00:18	0.9390
Very high 142-159 [bpm]	00:18±00:24	00:00	01:22	00:12±00:12	00:00	00:43	0.8482
Maximal ≥160 [bpm]	02:14±01:09	00:00	03:00	02:41±00:16	02:08	03:02	0.9695

Table 6. **RECOVERY PARAMETERS SIX MINUTES AFTER EXERCISE OF FEMALES WITH LOW AND MODERATE PA LEVELS**

PARAMETER	**LOW PA FEMALES** (n=34) Mean±SD	Min.	Max.	**MODERATE PA FEMALES** (n=11) Mean±SD	Min.	Max.	p-Value
HRavg [bpm]	118.15±14.40	94	150	124.64±11.07	107	143	0.1823
HRmax [bpm]	170.88±16.55	143	196	180.82±12.02	165	201	0.1577
HRmin [bpm]	102.71±13.14	80	132	109.45±12.72	91	128	0.1738
HRR (max-min) [bpm]	68.18±11.43	42	87	71.36±11.37	44	85	0.4054
Recovery time [h]	0.65±0.54	0	2	0.73±0.65	0	2	0.7917
PTE [Peak Training Effect]	1.52±0.33	1.1	2.3	1.57±0.33	1.2	2.1	0.5612
Energy expenditure [kcal]	59.50±12.70	36	94	62.00±12.92	47	83	0.5792
VO_{2avg} [mL/kg/min]	19.03±5.70	9	32	21.64±4.59	16	29	0.1616
VO_{2max} [mL/kg/min]	31.53±6.24	23	45	33.73±5.20	29	44	0.1956
$EPOC_{avg}$ [mL/kg]	6.09±3.62	1	16	6.55±3.33	3	13	0.6066
$EPOC_{max}$ [mL/kg]	9.65±6.67	2	27	8.91±5.38	4	19	0.9789
RR_{avg} [br/min]	28.03±9.68	9	45	32.82±8.69	17	47	0.1823
RR_{max} [br/min]	40.65±11.84	18	61	43.55±10.17	25	63	0.4205
Exercise intensity							
Low <107 [bpm]	01:51±01:59	00:00	04:53	01:32±01:33	00:00	04:03	0.6440
Moderate 107-124 [bpm]	02:00±01:30	00:00	05:24	01:57±01:15	00:00	03:39	0.8949
High 125-141 [bpm]	01:24±01:15	00:12	04:52	01:36±01:23	00:18	03:55	0.8019
Very high 142-159 [bpm]	00:32±00:35	00:00	02:29	00:37±00:18	00:20	01:13	0.2002
Maximal ≥160 [bpm]	00:13±00:22	00:00	01:26	00:18±00:25	00:00	01:08	0.4282

Table 7. **RECOVERY PARAMETERS SIX MINUTES AFTER EXERCISE OF MALES WITH LOW AND MODERATE PA LEVELS**

PARAMETER	**LOW PA MALES** (n=21) **Mean±SD**	**Min.**	**Max.**	**MODERATE PA MALES** (n=30) **Mean±SD**	**Min.**	**Max.**	**p-Value**
HRavg [bpm]	128.67±16.01	95	153	123.33±10.85	102	143	0.1406
HRmax [bpm]	183.05±18.75	136	201	186.60±9.56	169	200	0.7961
HRmin [bpm]	111.05±16.08	81	136	107.43±10.70	86	128	0.3583
HRR (max-min) [bpm]	72.00±14.81	47	98	79.17±10.96	60	100	0.0940
Recovery time [h]	1.00±0.63	0	2	1.00±0.37	0	2	0.9924
PTE [Peak Training Effect]	1.78±0.41	1.1	2.4	1.61±0.29	1.2	2.1	0.1380
Energy expenditure [kcal]	68.76±16.08	38	93	63.60±11.60	40	83	0.2100
VO_{2avg} [mL/kg/min]	23.90±5.52	13	33	22.53±3.88	13	29	0.2670
VO_{2max} [mL/kg/min]	35.62±7.06	23	46	33.53±4.64	26	44	0.2242
$EPOC_{avg}$ [mL/kg]	8.67±4.96	1	18	6.57±2.82	2	13	0.1305
$EPOC_{max}$ [mL/kg]	12.86±7.62	2	28	9.43±4.53	3	19	0.1355
RR_{avg} [br/min]	35.62±10.28	18	48	36.77±6.28	28	48	0.9924
RR_{max} [br/min]	50.33±14.34	26	70	52.37±7.87	37	64	0.8859
Exercise intensity							
Low <107 [bpm]	00:59±01:39	00:00	05:19	01:04±01:23	00:00	04:28	0.4448
Moderate 107-124 [bpm]	01:27±01:28	00:00	03:45	02:19±01:27	00:00	04:32	**0.0414**
High 125-141 [bpm]	02:08±01:27	00:16	04:24	01:47±01:23	00:14	04:25	0.4495
Very high 142-159 [bpm]	00:57±00:47	00:00	02:34	00:36±00:20	00:00	01:33	0.1119
Maximal ≥160 [bpm]	00:29±00:26	00:00	01:24	00:15±00:18	00:00	01:01	**0.0445**

Concomitant to the results noted in the female group, significant differences in age and body height were not noted in males with different levels of PA. Sedentary males were had significantly higher ($p<0.05$) body mass, BMI, TBW, protein, minerals, BFM, FFM, SMM, PBF, BMR and WHR. The average BMI values were indicative of overweight in Group I males (25.51kg/m^2) and normal body weight in Group II males (22.17kg/m^2). Sedentary males were characterised by significantly lower ($p<0.05$) values of body control parameters: weight control (body mass:-4.16 kg) and BFM control (adipose tissue:-4.93 kg). The BMR was significantly ($p=0.0195$) higher in males with low PA levels (1803.48kcal) than in males with moderate PA levels (1697.67kcal), and a similar trend was noted in the level of obesity (116.14 and 101.17, respectively) (Table 3).

The females with moderate PA levels completed significantly more ($p=0.0000$) cycles in the 3-MBT (53.09 cycles/3 min) than their sedentary peers (33.32 cycles/3min). Physiological parameters and exercise intensity were higher in the more physically active females, yet no significant differences ($p>0.05$) were found between the two groups (Table 4).

The males with moderate PA levels completed significantly more ($p=0.0000$) cycles (53.67 cycles/3 min) in the 3-MBT than male students with low PA levels (38.00 cycles/3min). Physiological and training parameters were higher ($p>0.05$) in the more physically active males, but no significant differences ($p>0.05$) were observed between the two groups (Table 5).

No significant differences ($p>0.05$) in physiological and training parameters during recovery were noted between Group I and Group II females, but the analysed values were higher during post-exercise recovery in females with moderate PA levels (Table 6).

The physiological parameters evaluated during recovery did not differ significantly between Group I and Group II males. The duration of maximal exertion was significantly longer ($p=0.0445$) in sedentary males (00:29min) than in males with moderate PA levels (00:15min), and the duration of moderate exertion was significantly shorter ($p=0.0414$) in male students with low PA levels (01:27 min) than in the more physically active males (02:19min). No significant differences ($p>0.05$) in physical exertion levels were observed between Group I and Group II males (Table 7).

DISCUSSION

In the literature, physiological responses to extreme physical effort have been analysed during various types of short and long workouts (Bąk & Kalina, 2008; Prusik *et al*., 2013; Sousa *et al*. 2013). Siska and Brodani (2017) relied on the Burpee test to evaluate the decrease in performance (fatigue index) during combat sports conditioning.

This study involved female and male participants with various PA levels to obtain information about anthropometric parameters and physiological responses to extreme effort during the 3-MBT. An analysis of the anthropometric parameters and body composition revealed significantly higher body mass and BMI in sedentary females than in females with moderate PA levels. These results could be attributed to the fact that Group II females (moderate PA) had participated in more sports activities and recreational events involving physical activity. Body composition analysis revealed that both female and male students with low PA levels were characterised by significantly higher values of TBW, protein, minerals, BFM, FFM, SMM, BMI, PBF, WHR and level of obesity. The average BMI values in Group I (low PA) males were indicative of overweight. This study confirmed the generally acknowledged observation that overweight and obesity are more prevalent among sedentary individuals (Podstawski *et al*., 2017a; Podstawski *et al*., 2017b).

Concordant with previous literature (Van Deventer *et al*., 2016), females and males with higher (moderate) PA levels were typified by higher endurance-strength abilities. These participants completed more cycles during extreme exercise (3-MBT) than their sedentary peers. Siska and Brodani (2017) relied on the 3-MBT to evaluate the performance of individuals with high PA levels during combat sports conditioning training and reported significantly higher results than those noted in our study.

Physiological and training parameters did not differ significantly in the evaluated groups of female and male university students, but the analysed parameters and indicators were generally higher in individuals with moderate PA levels. These findings could be attributed to minor differences in the types of PA undertaken by the studied subjects. It should be noted that despite significant differences in the participants' PA levels, the number of MET units per min/week scored by both females and males with low PA levels (537.84 and 565.57 METs, respectively) was very close to the upper threshold in the low PA level category.

In females with moderate PA levels, the average number of MET units was close to the lower threshold (565.57 METs) of the moderate PA level category (601-1500 METs-min/week). The difference in the average number of MET units scored by Group I and Group II males was greater than that noted in females (510.43 and 326.7 METs-min/week, respectively). For this reason, post-exercise recovery was shorter for individuals with moderate PA levels than their sedentary peers. An analysis of physiological responses to extreme effort (3-MBT) revealed very high HR values which were similar to those noted in our previous study (Podstawski *et al*., 2016a) and other authors' findings (Arseneau *et al*., 2011; Ouergui *et al*., 2015; Siska & Brodani, 2017), which confirms that the 3-MBT is a highly intensive exercise.

The physical activities undertaken by the participants, particularly high-intensity exercise, had a positive influence on the analysed parameters. Endurance-strength abilities are largely conditioned by cardiovascular efficiency (Ramsbottom *et al*., 2010). According to Wenger and Bell (1986), individuals who want to maintain their physical fitness should perform high-intensity exercise twice a week, whereas individuals who want to improve their aerobic fitness should perform high-intensity exercise at least three times a week (VO_{2max}>50 $ml \cdot kg^{-1} \cdot min^{-1}$).

In the current study, the duration of maximal exertion was significantly longer in sedentary males than in males with moderate PA levels, whereas the duration of moderate exertion was significantly shorter in male students with low PA levels than in the more physically active males. Females with low and moderate PA levels did not differ significantly in physical exertion levels. The 3-MBT supported an evaluation of endurance-strength abilities, indicating that physical activities performed during physical educational classes at university have a positive impact on the participants' performance and adaptation to high-intensity exercise.

The findings of this study have practical implications for physical training. Extreme exercise, such as the 3-MBT, is not always recommended for individuals with low PA levels. In such persons, physiological recovery after extreme effort would be a long process, which could disrupt the training program. In extreme cases, individuals could be unable to proceed with training. The 3-MBT is highly recommended for individuals with high PA levels who perform high intensity interval training, as well as athletes, particularly martial arts performers, who have to endure 3-minute-long rounds. In these cases, the 3-MBT prepares individuals for intensive effort during the fight.

LIMITATIONS

The low number of female participants with moderate PA levels was a limitation of this study. Hence, future corroboration of these findings with a larger female population is warranted.

CONCLUSION

Female and male university students with moderate PA levels were characterised by significantly higher endurance-strength abilities and relatively higher values of physiological parameters during extreme exercise in comparison with their sedentary peers. However, the observed differences were not statistically significant. Post-exercise recovery was shorter (significantly faster decrease in HR) in males with moderate PA levels than in sedentary males. No significant differences in post-exercise recovery were found between females with low and moderate PA levels.

REFERENCES

ACSM (American College of Sports Medicine) (2013). *ACSM's guidelines for exercise testing and prescription (9th ed.)*. Philadelphia, PA: Lippincott Williams & Wilkins.

ARSENEAU, E.; MEKARY, S. & LEGER, L. (2011). VO_2 requirements of boxing exercises. *Journal of Strength and Conditioning Research*, 25(2): 348-359.

BĄK, R. & KALINA, R.M. (2008). Extreme sports perceived by students of faculties of Physical Education, Tourism and Recreation (P252). *Engineering of Sport*, 2(7); 551-556.

BEAUCHAMP, M.K.; NONOYAMA, M.; GOLDSTEIN, R.S.; HILL, K.; DOLMAGE, T.E.; MATHUR, S. & BROOKS, D. (2010). Interval versus continuous training in individuals with chronic obstructive pulmonary disease: A systematic review. *Thorax*, 65(2): 157-164.

BENNETT, G.G.; WOLIN, K.Y.; PULEO, E.M.; MASSE, L.C. & ATIENZA, A.A. (2009). Awareness of National Physical Activity Recommendations for health promotion among US adults. *Medicine and Science in Sports and Exercise*, 41(10): 1849-1855.

BIERNAT, E.; STUPNICKI, R. & GAJEWSKI, K. (2007). Międzynarodowy Kwestionariusz Aktywności Fizycznej (IPAQ): Wersja Polska [*trans*.: International Physical Activity Questionnaire (IPAQ): Polish version. [In Polish]. Wychowanie Fizycznei sport [*trans*.: *Physical Education and Sport*], 51(1): 47-54.

BYRNE, N.M. & HILLS, A.P. (2002). Relationships between HR and VO_2 in the obese. *Medicine and Science Sports and Exercise*, 34(9): 1419-1427.

CASPERSON, C.; POWELL, K. & CHRISTENSON, G. (1985). Physical Activity, Exercise, and Physical Fitness: Definitions and distinctions for health-related research. *Public Health Reports*, 100(2): 126-131.

CLARKSON, P.M. (2007). Exertional rhabdomyolysis and acute renal failure in marathon runners. *Sports Medicine*, 37(4-5): 361-363.

CROFT, L.; BARLETT, J.D.; MACLAREN, D.P.; REILLY, T.; EVANS, L.; MATTEY, D.L.; NIXON, N.B.; DRUST B. & MORTON, J.P. (2009). High-intensity interval training attenuates the exercise-induced increase in plasma IL-6 in response to acute exercise. *Applied Physiology, Nutrition and Metabolism*, 34(6): 1098-1107.

CUNHA, F.A.; MIDGLEY, A.W.; MONTEIRO, W.D. & FARIATTI, P.T. (2010). Influence of cardiorespiratory exercise testing protocol and resting VO_2 assessment on $\%HR_{(max)}$, %HRR, $\%VO_{2max}$ and VO_2R relationships. *International Journal of Sports Medicine*, 31(5): 319-326.

DALLECK, L. & DALLECK, A. (2008). The ACSM exercise intensity guidelines for cardiorespiratory fitness: Why the misuse? *Journal of Physiology* (online), 11(4): 1-11.

EPSTEIN, L.H. & ROEMMICH, J.N. (2001). Reducing sedentary behavior: Role in modifying physical activity. *Exercise and Sport Sciences Reviews*, 29(3): 103-108.

GARBER, C.E.; BLISSMER, B.; DESCHENES, M.R.; FRANKLIN, B.A.; LAMONTE, M.J.; LEE, I.M.; Nieman, D.C.; SWAIN D.P.& American College of Sports Medicine (2011). Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. *Medicine and Science in Sports and Exercise*, 43(7): 1334-1359. Doi: 10.1249/MSS.0bo13e318213fefb

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. *American Journal of Clinical Nutrition*, 87(2): 332-338.

GUIMARAES, G.V.; CIOLAC, E.G., CARVALHO, V.O.; D’AVILA, V.M., BORTOLOTTO, L.A. & BOSCHI, E.A. (2010). Effects of continuous vs. interval exercise training on blood pressure and arterial stiffness in treated hypertension. *Hypertension Research*, 33(6): 627-632.

HAASE, A.; STEPTOE, A.; SALLIS, J.F. & WARDLE, J. (2004). Leisure-time physical activity students from 23 countries: Associations with health beliefs, risk awareness, and national economic development. *Preventive Medicine*, 39(1): 182-190.

HEALY, G.T.N.; DUNSTAN, D.W.; SALMON, J.; SHAW, J.E.; ZIMMET, P.Z. & OWEN, N. (2008). Television time and continuous metabolic risk in physically active adults. *Medicine and Science in Sports and Exercise*, 40(4): 639-645.

KLUSIEWICZ, A. & FAFF, J. (2003). Indirect methods of estimating maximal oxygen uptake on the rowing ergometer. *Biology of Sport*, 20(3): 181-194.

LEE, D.C.; SUI, X.; ORTEGA, F.B.; KIM, Y-S.; CHURCH, T.S.; WINNET, R.A.; EKELUND, U.; KATZMARZYK, P.T. & BLAIR, S.N. (2011). Comparison of leisure-time physical activity and cardiorespiratory fitness as predictors of all-cause mortality in men and women. *British Journal of Sports Medicine*, 45(6): 504-510. Doi: 10.1136/bjsm.2009.066209

MARTI, B. & HOWALD, H. (1990). Long-term effects of physical training on aerobic capacity: Controlled study of former elite athletes. *Journal of Applied Physiology*, 69(4): 1451-1459.

MAYER, T.; AURACHER, M.; HEEG, K.; URHAUSEN, A. & KINDERMANN, W. (2006). Does cumulating endurance training at the weekend impair training effectiveness? *European Journal of Cardiovascular Preventive Rehabilitation*, 13(4): 578-584.

MESQUITA, A.; TRABULO, M.; MENDES, M.; VIANA, J.F. & SEABRA-GOMEZ, R. (1996). The maximum heart rate in the exercise test: The 220-age formula or Sheffield's table? *Portuguese Journal of Cardiology*, 15(2): 139-144.

OUERGUI, I.; HOUCINE, N.; MARZOUKI, H.; DAVIS, P.; ZAOUALI, M.; FRANCHINI, E.; GMADA, N. & BOUHLEL, E. (2015). Development of a non-contact kickboxing circuit training protocol that simulates elite male kickboxing competition. *Journal of Strength and Conditioning Research*, 29(12): 3405-3411.

PATE, R.R.; PRATT, M.; BLAIR, S.N.; HASKELL, W.L.; MACERA, C.A.; BOUCHARD, C.; BUCHNER, D.; ETTINGER, W.; HEATH, G.W.; KING, A.C.; KRISKA, A.; LEON, A.S.; MARCUS, B.H.; MORRIS, J.; PAFFENBARGER, R.S.; PATRICK, K.; POLLOCK, M.L.; RIPPE, J.M.; SALLIS, J. & WILMORE, J.H. (1995). Physical activity and public health: A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of the American Medical Association*, 273(5): 402-407.

PIMENTEL, A.E.; GENTILE, C.L.; TANAKA, H.; SEALS, D.R. & GATES, P.E. (2003). Greater rate of decline in maximal aerobic capacity with age in endurance-trained than in sedentary men. *Journal of Applied Physiology,* 94(6): 2406-2413.

PINET, B.M.; PRUD'HOMME, D.; GALLANT, C.A. & BOULAY, P. (2008). Exercise intensity prescription in obese individuals. *Obesity (Silver Spring),* 16(9): 2088-2095.

PODSTAWSKI, R.; MARKOWSKI, P.; CHOSZCZ, D. & ŻUREK, P. (2016a). Correlations between anthropometric indicators, heartrate and endurance-strength abilities during high-intensity exercise of young women. *Archives of Budo Science of Martial Arts and Extreme Sports,* 12(February): 17-24.

PODSTAWSKI, R.; MARKOWSKI, P.; CHOSZCZ, D.; KLIMCZAK, J.; RAMOS, O.R. & MARBAN, R.M. (2016b). Methodological aspect of evaluation of the reliability the 3-Minute Burpee Test. *Archives of Budo Science of Martial Arts and Extreme Sports*, 12(1): 137-144.

PODSTAWSKI, R.; MARKOWSKI, P.; CHOSZCZ, D.; LIPIŃSKI, A. & BORYSŁAWSKI, K. (2017a). Effectiveness of martial arts training vs. other types of physical activity: differences in body height, body mass, BMI and motor abilities. *South African Journal for Research in Sport, Physical Education and Recreation*, 39(1): 111-134.

PODSTAWSKI, R.; CHOSZCZ, D. & POLAKOWSKA, P. (2017b). Effectiveness of the "Slimming down Olsztyn Residents" health program: Motivation to participate and withdraw. *Baltic Journal of Health and Physical Activity*, 9(2): 50-63.

PRUSIK, K.; PRUSIK, K.; STANKIEWICZ, B.; CHILIŃSKI, I.; KORTAS, J. & ZUKOW, W. (2013). The reaction of the body to the extreme efforts of amateur runners in the men's 100 kilometers, *Journal of Health Sciences,* 3(9): 427-446.

RAMSBOTTOM, R.; CURRIE, J. & GILDER, M. (2010) Relationships between components of physical activity, cardiorespiratory fitness, cardiac autonomic health, and brain-derived neurotrophic factor. *Journal of Sports Sciences,* 28(8): 843-849.

ROTSTEIN, A. & MECKEL, Y. (2000). Estimation of %VO_2 reserve from heart rate during arm exercise and running. *European Journal of Applied Physiology*, 83(6): 545-550.

ROY, B.A. (2015). Monitoring of exercise intensity. *ACSM's Health and Fitness Journal,* 19(4): 3-4.

SHEPHARD, R.J. (2001). Absolute versus relative intensity of physical activity in a dose-response context. *Medicine and Science in Sports and Exercise*, 33(Suppl 6): S400-418; discussion S19-20.

SHEPHARD, R.J. & BALADY, G.J. (1999). Exercise as cardiovascular therapy. *Circulation*, 99(7): 963-972.

SISKA, L. & BRODANI, J. (2017). Use of burpees in combat sports conditioning training: A pilot study. *International Journal of Sports and Physical Education* 3(4): 1-6.

SOUSA, A.; DE JESUS, K.; FIGUEIREDO, P.; VILAS-BOAS, J.P. & FERNANDES, R.J. (2013). Clinic oxygen uptake kinetics at moderate and extreme swimming intensities. *Revista Brasileira de Medicina do Esporte* (trans.: *Brazilian Journal of Sports Medicine*), 19(3): 23-34.

SWAIN, D.P. & FRANKLIN, B.A. (2006). Comparative cardioprotective benefits of vigorous vs. moderate intensity aerobic exercise. *American Journal of Cardiology*, 97(1): 141-147.

TALANIAN, J.L.; HOLLOWAY, G.P.; SNOOK, LA.; HEIGENHAUSER, G.J.; BONEN, A. & SPRIET, L.L. (2010). Exercise training increases sarcolemmal and mitochondrial fatty acid transport proteins in human skeletal muscle. *American Journal of Physiology-Endocrinology Metabolism,* 299(2): E180-188.

TANAKA, H.; MONAHAN, K.D. & SEALS, D.R. (2004). Age-predicted maximal heart rate revisited. *Journal of American College Cardiology,* 37(1): 153-156.

TEYCHENNE, M.; BALL, K. & SALMON, J. (2010). Sedentary behavior and depression among adults: A review. *International Journal of Behavioral Medicine*, 17(4): 246-254.

THORP, A.A.; HEALY, G.N.; OWEN, N.; SALMON, J.; BALL, K.; SHAW, J.E.; ZIMMET, P.Z. & DUNSTAN, D.W. (2010). Deleterious associations of sitting time and television viewing time with cardiometabolic risk biomarkers: Australian Diabetes, Obesity and Lifestyle (AUS-DIAB) study 2004-2005. *Diabetes Care*, 33(2): 327-334.

VOLAKLIS, K.A.; SPASSIS, A.T. & TOKMAKIDIS, S.P. (2007). Land versus water exercise in patients with coronary artery disease: Effect on body composition, blood lipids, and physical fitness. *American Heart Journal*, 154(3): 560.el-1-6.

WARREN, T.Y.; BARRY V.; HOOKER S.P.; SIU, X.; CHURCH, T.S. & BLAIR, S.N. (2010). Sedentary behaviors increase risk of cardiovascular disease mortality in men. *Medicine and Science in Sports and Exercise*, 42(5): 879-885.

WENGER, H.A. & BELL, G.J. (1986). The interactions of intensity, frequency and duration of exercise training in altering cardiorespiratory fitness. *Sports Medicine*, 3(5): 346-356.

WHALEY, M.H.; KAMINSKY, L.K.A.; DWYER, G.B.; GETCHEL, L.H. & NORTON, J.A. (1992). Predictors of over- and underachievement of age-predicted maximal heart rate. *Medicine and Science in Sports and Exercise*, 24(10): 1173-1179.

VAN DEVENTER, K.J.; COZENS, K.; DU PLESSIS, K.D. & LA GRANGE, R.P. (2016). Acute effect of physical activity exercise session on cognitive functioning: Moderately active sport persons versus sedentary individuals. *South African Journal for Research in Sport, Physical Education and Recreation*, 38(3): 243-258.

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