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Original Article

A multi-factorial assessment of the 3-Minute Burpee Test

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Abstract
Body composition parameters may be associated with motor fitness. The aim of the study wasto evaluate the relationship between strength endurance, anthropometric features, body composition and physiological parameters in individuals with low or moderate levels of physical activity performing extreme exercise. The study involved 45 female and 51 male participants (20.05±1.81 and 20.20±2.71 y, respectively). The participants' physical activity levels were evaluated before the study with the International Physical Activity Questionnaire. Physiological parameters were measured using a heart rate monitor. The correlations between the evaluated parameters were determined using Spearman's rank correlation test. The analyzed physiological parameters were most significantly correlated with physical exertion values within the maximum effort range. In both female and male participants, the number of cycles was significantly and negatively correlated with body mass (r=-0.78 and r=-0.67), degree of obesity (r=-0.87 and r = -0.74), BMI (r=-0.85 and r = -0.76), BFM (r=-0.81 and r=-0.58) and VFL (r=-0.81 and r=-0.59). Physiological parameters (PTE, energy expenditure, $VO_{2avg, max}$, $EPOC_{avg, peak}$, and $RR_{avg, max}$) were significantly and positively correlated with maximum physical effort. Somatic features and body composition parameters are significantly correlated with strength endurance in females and males aged 18-29 years.
Keywords: strength endurance, extreme effort, 3-MBT, body composition, somatic features.

Introduction

From a morphological perspective, morphological traits that relate to movement, as well as factors that influence movement, in humans are among the key objectives of kinanthropometry (Eston & Reilly, 1996). Kinanthropometry is a scientific discipline which is concerned with the measurement of individual variations in human motor abilities and body parameters (Beunen & Borms, 1990). The relationships between the structure of the human body and movement have been studied extensively for many years (Garber et al., 2011). The key morphological traits that influence human motor abilities include body size, body shape, the relationship between the length and muscular architecture of different body parts, the proportions of different tissue components (body composition analysis) and physical activity (PA) levels (Crecelius et al., 2008, Podstawski et al., 2013; Podstawski et al., 2014).

The relationship between body size and motor ability is usually easily discerned. An increase in somatic parameters, including body mass and height, contributes to absolute muscular strength (Vanderburgh & Laubach, 2008), but limits the development of physiological capacity, endurance and relative strength (Crecelius et al., 2008, Podstawski et al., 2016). Muscular strength is proportional to the physiological cross-sectional area, i.e. the square of the muscle's linear dimension, whereas body weight is a cubic function of height. Consequently, an increase in somatic parameters induces a much greater increase in mass, than in strength, respectively. Even a proportional increase in body height decreases strength relative to weight, which ultimately compromises physical fitness (PF). It has been purported that relative strength is limited by the ratio of fat body

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mass to lean body mass, which is particularly important in heavier individuals (Caruso et al., 2009). In view of the above theoretical assumptions, most empirical studies investigating the effect of morphological traits on PF have focused on the influence of body height and body mass on various components of PF (Mikulić & Ružić, 2008; Podstawski & Borysławski, 2012; Podstawski et al., 2012). The influence of other morphological traits, structures and tissue components has also been evaluated in body composition analyses in population studies (Gibson et al., 2008; Shafer et al., 2009). In recent years, the above factors have taken on a new significance due to the growing levels of overweight and obesity in both children (Milanese et al., 2010; Rohrer et al., 2008) and adults (Garber et al., 2011; Fletcher et al., 2001), as well as decreasing physical activity levels (Krombholz, 2011; Williams, 2001). Research into high-performance sports includes analyses of the somatic and physiological profiles of elite athletes (Dalleck L.,&Dalleck A, 2003; Mermier et al., 2000; Yoon, 2002), the ratio of fast-twitch to slow-twitch muscle fibers (Ahmetovet al., 2016; Lucia et al., 2015), cardiovascular function (Cunha et al., 2010; Byrne & Hills, 2002), hormonal (im)balance(Florini, 1987; Tasmectepligil et al., 2010) and the correlations between morphological parameters and training effects (trainability) (Kaufman & Schilling, 2007; Swain, 1994), which aim to identify physiological responses to exercise (Halverson, 1982). Fewer attempts have been made to determine physiological responses to extreme, hybridized exercise, such as strength endurance training, in individuals with relatively low levels of PA or a sedentary lifestyle.

Therefore, the aim of this study was to determine the correlations between strength endurance, anthropometric features, body composition and physiological parameters in individuals with low or moderate levels of PA performing extreme exercise.

Material and Methods

Participants

The study involved 45 female and 51 male full-time students of the University of Warmia and Mazury in Olsztyn, (mean age of 20.05±1.81 and 20.20±2.71 y, respectively). The participants attended only obligatory physical education classes (90 minutes per week) and performed one 3-MBT per week during preparatory meetings before the study. Every participant performed the 3-MBT five times to ensure the reliability of measurements (Podstawski et al., 2016b). All participants were permanent residents of the Region of Warmia and Mazury in Poland.

Procedures

The research was performed in observance of the Declaration of Helsinki and upon the prior consent of the Bioethical Committee and the authorities of the University of Warmia and Mazury in Olsztyn. Every participant signed a written consent form before the study.

Measurements

The participants' PA levels were evaluated before the study using the International Physical Activity Questionnaire. The associated energy expenditure was calculated and expressed in Metabolic Equivalent of Task (MET) units (ratio of the rate of energy consumed during exercise to the rate of energy consumed at rest), using the Compendium of Physical Activities (Ainsworth et al., 2011). 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. Students performing additional sports and students released from physical education classes for medical reasons were excluded from the study. Only students with low and moderate PA levels were included in the study. Students with high PA levels were excluded from the study. The results of the IPAQ survey revealed two relatively homogeneous groups of students (female and male) characterized by low or moderate PA levels. The average PA levels of female and male participants were calculated based on their corresponding METs.

Body height was measured to the nearest 0.1 cm on a calibrated WB-150 medical scale with a stadiometer (ZPU Tryb Wag, Poland) and a Martin anthropometer, according to standardized guidelines. Body mass (measured to the nearest 0.1 kg), BMI and body composition (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 degree of obesity) were determined by bioelectrical impedance with the In Body 720 analyzer (Gibson et al., 2008).

Physiological parameters (heart rate (HR), energy expenditure – kcal, as well as the estimated values of VO_{2avg}, VO_{2max}, average excess post-exercise oxygen consumption ($EPOC_{avg}$), $EPOC_{max}$, average respiratory rate, maximum respiratory rate) and training parameters (recovery, peak training effect – PTE, exercise intensity scale: easy, moderate, hard, very hard, maximal) were measured indirectly with the Suunto Ambit 3 Peak HR monitor.

Strength endurance was evaluated based on the number of burpee cycles completed in 3 minutes. The stages of the 3-MBT are presented in Figure 1

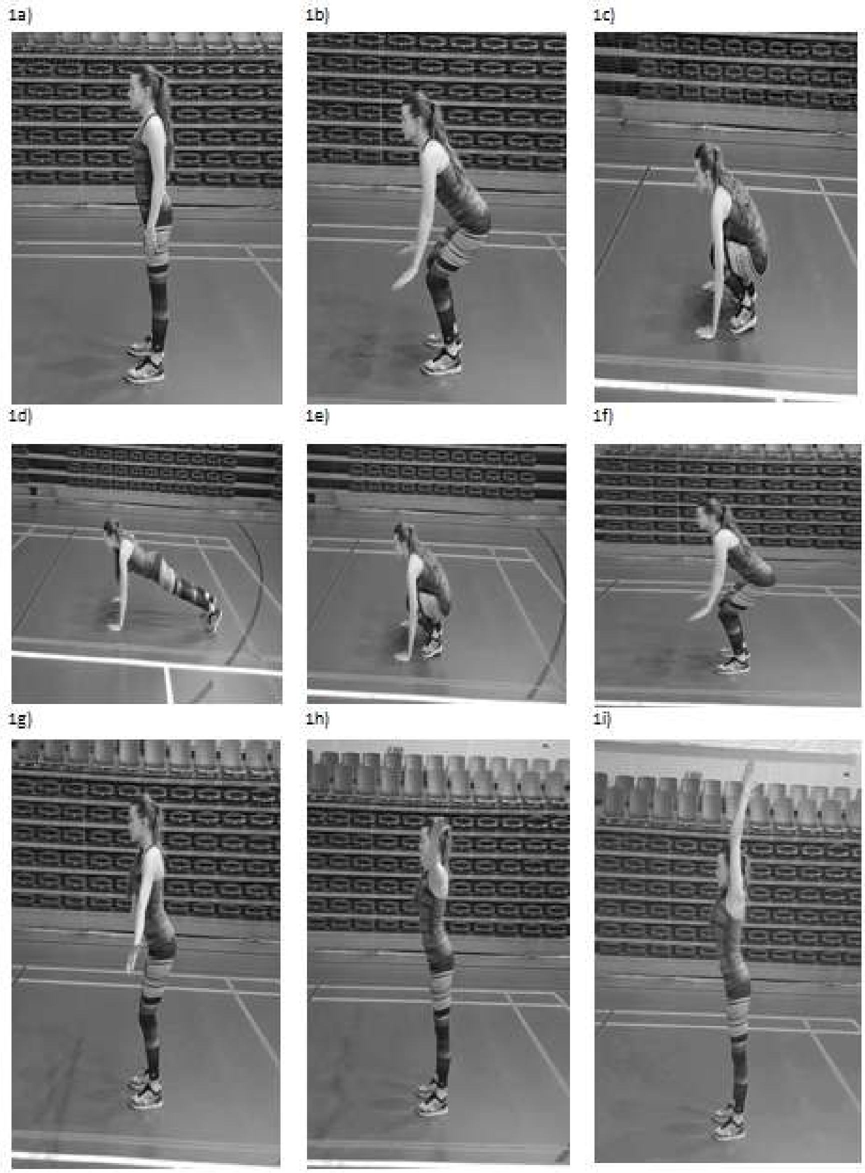

Figure 1. Individual stages of the 3-Minute Burpee test – side view

Stage I Begin in a standing position (Figure 1a) and move into a supported squat with both hands on the ground (Figure 1b).
Stage II From a supported squat (Figure 1b), kick your feet back (Figure 1c) into a plank with arms extended (Figure 1d).
Stage III Return from the plank position (Figure 1d) to a supported squat (Figure 1e).
Stage IV Return to a standing position (Figure 1j), extend your arms over the head and clap your hands (Figures: 1f, 1g, 1h, 1i).

The participants repeat the cycle as many times as possible in a given time limit (3 minutes).

Comments: The exercise has to be performed correctly, and the entire cycle has to 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 results were processed using the Statistica v. 13 program. Basic statistical values, including the arithmetic mean, standard deviation, minimum and maximum values, were presented in table format. The data were not normally distributed, and the relationships between the evaluated parameters were determined by Sperman's correlation analysis. The results were regarded as statistically significant at $p<0.05$.

Results

The results of the study were presented in table format. The average values of somatic parameters, body composition and physiological parameters of female and male participants performing the 3-MBT are presented in Tables 1 and 2. The correlations between the evaluated parameters are presented separately for female and male subjects in Tables 3 and 4, respectively.

Table 1. Somatic parameters of the analyzed women and men

Parameter	Women (n=45)				Men (n=51)			
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.
Age [years]	20.05	1.81	18	24	20.20	2.71	16.3	29
Body height [cm]	166.11	6.02	156	183	180.16	5.71	170	191
Body mass [kg]	63.94	12.81	43.4	104.9	76.42	9.45	55.9	98.6
BMI [kg/m^2]	23.09	3.94	16.6	33.4	23.54	2.76	18.8	30.4
TBW (Total Body Water) [L]	33.02	4.48	24.7	47.3	46.49	5.67	32.9	57.4
Protein[kg]	8.87	1.21	6.7	12.6	12.60	1.55	8.9	15.6
Minerals [kg]	3.26	0.51	2.41	4.88	4.38	0.61	3.24	5.64
BFM (Body Fat Mass) [kg]	18.80	8.71	5.3	41.2	12.95	5.23	4	24.3
FFM (Fat-Free Mass) [kg]	45.15	6.19	33.8	64.8	63.47	7.81	45	78.6
SMM (Skeletal Muscle Mass) [kg]	24.77	3.66	18.1	36.2	36.02	4.69	24.7	45.1
PBF (Percent Body Fat) [%]	28.26	8.17	9.7	48.1	16.74	5.79	6	30.6
InBody Score	73.16	6.24	54	85	79.12	7.10	64	94
Target Weight [kg]	60.71	6.08	52.3	84.2	75.05	7.09	63.6	89.7
Weight Control [kg]	-3.23	9.16	-27.9	14	-1.37	5.52	-12.3	11.7
BFM Control [kg]	-5.11	7.87	-27.9	7.9	-2.48	4.55	-14.1	6.9
FFM Control [kg]	1.87	2.48	0	8.6	1.11	2.14	0	9.1
BMR (Basal Metabolic Rate)[kcal]	1345.47	133.91	1099	1771	1741.02	168.46	1342	2068
WHR (Waist-Hip Ratio)	0.85	0.05	0.75	0.96	0.84	0.06	0.72	0.99
VFL (Visceral Fat Level) [kg]	7.67	4.31	2	19	4.75	2.42	1	10
Degree of obesity	107.87	18.47	77	156	107.33	12.65	85	138
PA level [MET]	668.00	304.80	390	1420	893.33	348.42	430	1400

The average BMI values were within the norm in both female (23.09 kg/m^2) and male participants (23.54 kg/m^2). Due to larger body size, men were characterized by higher values of TBW, proteins and minerals, FFM and SMM (46.49 L, 12.60 kg, 4.38 kg, 63.47 kg, 36.02 kg, respectively) than women (33.02 L, 8.83 kg, 3.26 kg, 45.15 kg, 24.77 kg, respectively). InBody scores were higher in men (79.12±7.10) than in women (73.16±6.24). In both female and male participants, the measured body mass (63.94 kg and 76.42 kg, respectively) exceeded target weight values (60.71 kg and 75.05 kg, respectively) and should be lowered by 3.23 kg and 1.37 kg, respectively. The above goal should be achieved by decreasing BFM values (control BFM: -5.11 and -2.48 kg, respectively) and increasing FFM values (control FFM: 1.87 and 1.11 kg, respectively). The value of WHR (0.85 for women, 0.84 for men) were above the upper reference limit for women and below the upper reference limit for men (WHR: women>0.80 and men>0.90), but they were not indicative of android obesity (WHR ≥1). At the same time, the values of VFL (women: 7.67±4.31 kg, men: 4.75±2.42 kg) and degree of obesity (107.87 and 107.33) were relatively high in both sexes. The average PA levels were determined at 668±304.80 MET in female students (lower range of moderate PA levels) and 893.33±348.82 MET in male students (middle range of moderate PA levels) (Table 1).

Table 2. Strength endurance in the analyzed women and men

Parameter	Women (n=45)				Men (n=51)			
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.
Number of cycles [cycl./3 min.]	38.16	12.17	15	66	47.22	9.51	24	66
HRavg [bpm]	156.53	18.82	127	191	171.20	15.78	115	193
HRmax [bpm]	173.31	16.03	143	201	185.14	14.02	136	201
HRmin [bpm]	104.73	19.82	76	144	111.94	18.06	71	142
HRR (max-min) [bpm]	68.58	18.26	34	125	73.20	15.52	51	117
Recovery time [h]	1.49	0.66	1	3	1.84	0.76	0	3

PTE [Peak Training Effect]	2.06	0.26	1.5	2.3	2.19	0.23	1.3	2.3
Energy expenditure [kcal]	53.93	10.72	36	70	59.49	10.39	29	71
VO2avg [mL/kg/min]	36.20	8.32	18	50	41.57	6.90	21	50
VO2 max [mL/kg/min]	44.31	7.84	30	57	49.67	6.78	27	58
EPOCavg [mL/kg]	8.93	4.07	3	24	11.02	5.08	1	25
EPOCpeak[mL/kg]	20.09	11.73	9	61	27.84	14.72	4	61
RRavg [br/min]	29.20	9.58	9	47	36.29	8.09	18	48
RRmax [br/min]	41.36	11.41	18	63	51.53	10.92	26	70
Exercise intensity								
Easy<107 [bpm]	00:01	00:02	00:00	00:11	00:00	00:02	00:00	00:10
Moderate - 107-124 [bpm]	00:07	00:12	00:00	00:41	00:02	00:07	00:00	00:38
Difficult- 125-141 [bpm]	00:23	00:31	00:00	01:54	00:09	00:22	00:00	02:01
Very difficult- 142-159 [bpm]	00:45	00:48	00:00	02:43	00:14	00:18	00:00	01:22
Maximum ≥ 160 [bpm]	01:44	01:14	00:00	03:00	02:30	00:47	00:00	03:00

On average, women completed 38.16 cycles and men completed 47.22 cycles in the 3-minute version of the Burpee Test. The average heart rate (HR_{avg}) approximated the upper limit of the very difficult effort range in women (156.53 bpm) and the maximum effort range in men (171.20 bpm). Female participants burned 53.93 kcal and male participants burned 59.49 kcal on average during the 3-MBT. Average oxygen consumption was determined at 36.20 mL/kg/min in women and 41.57 mL/kg/min in men. The average respiratory rate during the 3-MBT was 29.20 breaths per minute in female students and 36.29 breaths per minute in male students. Both women and men remained within the maximum effort range for the longest period of time during the 3-MBT (01:44 s and 02:30 s, respectively). The average EPOC values were higher in men (M=11.02±5.08 ml/kg) than in women (M=8.93±4.07 ml/kg). The values of $EPOC_{peak}$ were similar in both groups (men: 27.84±14.72 ml/kg, women: 20.09±11.73 ml/kg) (Table 2).

Table 3. Correlations between motor performance, physiological and body composition parameters of women (n=45)

Parameter	Number of cycles	Hr_{avg}	Hr_{max}	Hr_{min}	HRR	Recovery	PTE	Energy expenditure	VO_{2avg}	VO_{2max}	$Epoc_{avg}$	$Epoc_{Peak}$	RR_{avg}	RR_{max}
Age [years]	-0.0736	-0.2183	-0.2351	-0.0839	-0.0357	-0.2671	-0.2653	-0.2869	-0.2499	-0.2807	**-0.3110**	-0.2464	-0.2878	-0.2266
Body height [cm]	-0.1849	-0.1039	-0.0884	-0.0664	0.0960	0.0252	-0.1003	-0.1351	-0.0986	-0.0507	-0.1540	-0.0807	-0.1478	-0.1035
Body mass [kg]	**-0.7873**	-0.1303	-0.2314	0.0499	**-0.3017**	-0.1278	-0.1980	-0.2508	-0.1839	-0.2521	-0.2090	-0.2536	-0.2526	-0.1870
TBW (Total Body Water)	**-0.4948**	-0.1651	-0.1647	-0.0401	-0.1074	-0.0966	-0.2405	-0.2339	-0.1575	-0.1832	-0.2085	-0.2042	-0.2527	-0.1940
Protein	**-0.5099**	-0.1751	-0.1748	-0.0475	-0.1081	-0.1079	-0.2504	-0.2448	-0.1695	-0.1937	-0.2133	-0.2112	-0.2629	-0.1971
Minerals	**-0.4953**	-0.1829	-0.1876	-0.0270	-0.1468	-0.1053	-0.2479	-0.2486	-0.1766	-0.2006	-0.2393	-0.2204	-0.2548	-0.1938
BFM (Body Fat Mass)	**-0.8159**	-0.0095	-0.2018	0.1396	**-0.4129**	-0.0712	-0.0705	-0.1497	-0.1140	-0.2230	-0.1037	-0.1631	-0.1018	-0.0804
FFM (Fat Free Mass)	**-0.4924**	-0.1692	-0.1701	-0.0388	-0.1108	-0.1018	-0.2419	-0.2381	-0.1627	-0.1874	-0.2158	-0.2069	-0.2549	-0.1943
SMM (Skeletal Muscle Mass)	**-0.5095**	-0.1654	-0.1693	-0.0379	-0.1144	-0.1013	-0.2434	-0.2361	-0.1607	-0.1873	-0.2040	-0.2036	-0.2578	-0.1946
BMI	**-0.8545**	-0.1286	-0.2823	0.0520	**-0.3951**	-0.1507	-0.2167	-0.2621	-0.1991	**-0.3147**	-0.2095	-0.2868	-0.2037	-0.1713
PBF (Percent Body Fat)	**-0.7250**	0.0226	-0.1846	0.1893	**-0.4528**	-0.0770	-0.0179	-0.1052	-0.0979	-0.2080	-0.0749	-0.1252	-0.0446	-0.0362
BMR (Basal Metabolic Rate)	**-0.4921**	-0.1699	-0.1697	-0.0423	-0.1075	-0.1002	-0.2432	-0.2380	-0.1626	-0.1869	-0.2157	-0.2092	-0.2553	-0.1952
WHR (Waist-Hip Ratio)	**-0.6917**	0.1093	-0.1025	0.2621	**-0.4450**	-0.0724	0.0960	-0.0426	-0.0217	-0.1277	0.0638	0.0529	-0.0534	-0.0376
VFL (Visceral Fat Level)	**-0.8133**	-0.0049	-0.2269	0.1458	**-0.4096**	-0.0988	-0.0526	-0.1605	-0.1398	-0.2390	-0.1033	-0.1549	-0.1176	-0.0987
Obesity Degree	**-0.8765**	0.0335	-0.1542	0.1393	**-0.3230**	-0.0465	-0.0922	-0.1326	-0.0573	-0.1861	-0.0463	-0.1647	-0.0858	-0.0495
Exercise intensity														
Easy<107 [bpm]	-0.0835	**-0.6801**	**-0.7455**	**-0.4738**	-0.0868	**-0.6481**	**-0.7289**	**-0.7795**	**-0.7200**	**-0.7548**	**-0.6899**	**-0.6838**	**-0.7924**	**-0.7646**
Moderate - 107-124 [bpm]	-0.0559	-0.1138	-0.1220	0.0136	-0.1628	-0.0782	0.0132	-0.0637	-0.0063	-0.1250	-0.1066	-0.0891	0.0315	0.0955
Difficult- 125-141 [bpm]	0.0828	**0.6145**	**0.6411**	**0.3244**	0.1628	**0.6178**	**0.6382**	**0.6744**	**0.6066**	**0.6683**	**0.6200**	**0.5808**	**0.7027**	**0.6769**
Very difficult- 142-159 [bpm]	0.2878	**0.6015**	**0.7391**	**0.3369**	**0.3939**	**0.6585**	**0.5776**	**0.7118**	**0.6755**	**0.7672**	**0.5926**	**0.5745**	**0.6824**	**0.6283**
Maximum ≥ 160 [bpm]	0.1082	**0.7122**	**0.7303**	**0.5569**	0.0341	**0.6427**	**0.6969**	**0.7638**	**0.7303**	**0.7602**	**0.7202**	**0.6846**	**0.7454**	**0.7206**

Notes: HRR – heart rate reserve (difference between maximum heart rate and resting heart rate), RR – respiration rate In women, the number of completed cycles was bound by the least significant negative correlations with degree of obesity (-0.8765), BMI (-0.8545), BFM (-0.8159) and VFM (-0.8133), but significant correlations were also noted for the remaining parameters (excluding age and body height). The values of HR $_{(min – max)}$ were significantly correlated only with the range of physical effort. The values of the correlation coefficient (r) increased with exercise intensity and were highest for very difficult effort. The values of HR were bound by a significant positive correlation with the very difficult effort range (r = 0.3939) and significant negative correlations with body mass and body fat indicators: BFM, BMI, PBF (strongest correlation, r = -0.4528), VHR, VFL and degree of obesity. Peak training effect, energy expenditure, $VO_{2\ (avg,\ max)}$, EPOC $_{(avg,\ peak)}$ and RR $_{(avg,\ max)}$ were most significantly positively correlated with maximum or very difficult effort, whereas the correlations with easy exercise were very high (sometimes highest), but negative (Table 3).

Table 4. Correlations between motor performance, physiological and body composition parameters of men (n=51)

Parameter	Number of cycles	Hr_{avg}	Hr_{max}	Hr_{min}	HRR	Recovery	PTE	Energy expenditure	VO_{2avg}	VO_{2max}	$Epoc_{avg}$	$Epoc_{Peak}$	RR_{avg}	RR_{max}
Age [years]	-0.2297	0.0230	0.0877	0.1095	-0.0567	0.0806	0.1172	0.0352	0.1201	0.0893	0.2002	0.1201	0.0632	0.0626
Body height [cm]	0.1403	-0.0856	-0.0711	0.0329	-0.0852	-0.0088	-0.0023	-0.0732	-0.1378	-0.1190	0.0047	0.0208	-0.1117	-0.1103
Body mass [kg]	**-0.6720**	-0.1387	-0.1730	-0.0526	-0.2165	-0.1907	-0.1812	-0.1557	-0.2301	-0.2014	-0.1273	-0.1186	-0.1444	-0.1057
TBW (Total Body Water)	**-0.3844**	-0.1764	-0.1922	-0.1066	-0.1564	-0.1567	**-0.2771**	-0.2563	-0.2576	-0.2249	-0.1021	-0.0871	-0.2423	-0.2439
Protein	**-0.4041**	-0.1918	-0.2097	-0.1020	-0.1725	-0.1687	-0.2714	-0.2639	-0.2695	-0.2387	-0.1049	-0.1007	-0.2547	-0.2534
Minerals	**-0.4076**	-0.2268	-0.2231	-0.0724	-0.2008	-0.1958	-0.2549	-0.2441	**-0.3086**	-0.2609	-0.1337	-0.1089	-0.2692	-0.2485
BFM (Body Fat Mass)	**-0.5819**	-0.0525	-0.1205	-0.0433	-0.1545	-0.1879	-0.0588	-0.0033	-0.1074	-0.1206	-0.1808	-0.1762	-0.0124	0.0461
FFM (Fat Free Mass)	**-0.3917**	-0.1850	-0.1981	-0.1016	-0.1622	-0.1615	-0.2747	-0.2565	-0.2653	-0.2299	-0.1049	-0.0927	-0.2470	-0.2456
SMM (Skeletal Muscle Mass)	**-0.3953**	-0.1806	-0.1982	-0.1021	-0.1687	-0.1574	-0.2699	-0.2631	-0.2583	-0.2296	-0.1028	-0.0911	-0.2468	-0.2490
BMI	**-0.7606**	-0.0610	-0.1008	-0.0540	-0.1626	-0.1348	-0.1476	-0.0854	-0.1153	-0.1032	-0.1013	-0.1004	-0.0421	0.0089
PBF (Percent Body Fat)	**-0.4753**	0.0103	-0.0393	-0.0203	-0.0938	-0.1333	0.0178	0.0800	-0.0136	-0.0303	-0.1172	-0.1008	0.0739	0.1258
BMR (Basal Metabolic Rate)	**-0.3927**	-0.1840	-0.1966	-0.1011	-0.1620	-0.1607	-0.2758	-0.2559	-0.2642	-0.2287	-0.1050	-0.0923	-0.2468	-0.2455
WHR (Waist-Hip Ratio)	**-0.4675**	0.1144	-0.0289	0.0534	-0.1690	-0.0682	0.0837	0.1129	0.0468	-0.0173	-0.0683	-0.0930	0.0876	0.1283
VFL (Visceral Fat Level)	**-0.5991**	-0.0383	-0.1130	-0.0327	-0.1413	-0.1704	-0.0391	0.0243	-0.1005	-0.1063	-0.1504	-0.1529	0.0008	0.0728
Obesity Degree	**-0.7467**	-0.0494	-0.0983	-0.0460	-0.1663	-0.1454	-0.1387	-0.0739	-0.1098	-0.0995	-0.1162	-0.1232	-0.0340	0.0147
Exercise intensity														
Easy<107 [bpm]	-0.0295	**-0.6051**	**-0.4834**	**-0.3769**	-0.0267	**-0.5116**	**-0.6142**	**-0.5019**	**-0.5541**	**-0.5282**	**-0.5814**	**-0.5771**	**-0.4974**	**-0.4798**
Moderate - 107-124 [bpm]	0.1831	-0.2256	-0.2259	0.1155	-0.2460	-0.2231	0.0395	-0.0638	-0.2456	-0.2497	-0.2548	-0.2807	-0.1467	-0.1691
Difficult- 125-141 [bpm]	-0.0111	**0.5318**	**0.4133**	**0.1732**	0.1515	**0.4456**	**0.4435**	**0.3960**	**0.4808**	**0.4674**	**0.4605**	**0.4882**	**0.4500**	**0.4508**
Very difficult- 142-159 [bpm]	0.0389	**0.5962**	**0.5410**	**0.3299**	0.1356	**0.4843**	**0.4205**	**0.4389**	**0.5520**	**0.5464**	**0.5015**	**0.5462**	**0.3904**	**0.3965**
Maximum ≥ 160 [bpm]	-0.0848	**0.7283**	**0.6587**	**0.4672**	0.0454	**0.5793**	**0.6047**	**0.6509**	**0.6546**	**0.6845**	**0.6420**	**0.6094**	**0.5830**	**0.5942**

The calculated correlations were similar in both participant groups. The number of completed cycles was bound by the most significant negative correlations with BMI (r = -0.7606), degree of obesity (r = -0.7467) and the remaining body composition parameters, excluding age and body height. The values of HR $_{(min – max)}$ were significantly correlated with exercise intensity and were highest (r+) for the maximum effort range, whereas significant negative correlations were determined for easy exercise. Recovery time was significantly correlated with exercise intensity. Peak training effect, energy expenditure, $VO_{2\ (avg,\ max)}$, EPOC $_{(avg,\ peak)}$, and RR $_{(avg,\ max)}$ were bound by the most significant positive correlations with the maximum effort range and significant negative correlations with easy exercise (Table 4).

Discussion

Despite the fact that the examined women and men were characterized by moderate PA levels on average (M < 1500 METs-min/week), female participants' scores approximated the lower limit of the moderate exercise range, whereas male participants' scores occupied the middle of the moderate exercise range. The noted results validate the general observation that men are characterized by higher PA levels than women (Haase et al., 2004). The above can also be attributed to the fact that the analyzed somatic and physiological parameters (excluding body fat mass) were higher in male than in female participants. The present study did not aim to compare the analyzed parameters between genders; therefore, the differences resulting from sexual dimorphism were discussed only briefly and presented in greater detail in another study (in a review).

The 3-minute variant of the Burpee Test (3-MBT) supported an evaluation of strength endurance among young women and men. It is suggested that the 3-MBT is a more reliable tool for measuring strength endurance than Burpee Tests lasting 30 s and 60 s, respectively (Podstawski et al., 2015; Sakamaki, 1983). In a previous study comparing the strength endurance of early education teachers, first-year female university students, pre-school children and elementary school students (Podstawski et al., 2014), university students completed 10.78 more cycles of the 3-MBT test than in the current study (48.94 cycles/3 min). In an earlier study (Podstawski et al., 2013), female university students also completed more cycles (39.85 cycles/3 min) than in the present research, but the noted differences were smaller (1.69 cycles/ 3 min). A comparison of the above scores suggests a decrease in the strength endurance of female university students (male students were not previously studied). In the present study, the maximum HR values of female university students (173.31±16.03 bpm and 185.14±14.02) were below the values noted in Podstawski et al (2016a) (181.92 bpm), whereas the maximum HR values of male students exceeded those of a Slovak athletics and kickboxing champions in a 3 x 3 minute sequence with a one-minute break between the rounds (Siska & Brodani, 2017). In Siska & Brodani (2017), the average HR value during the first round reached 160 bpm and decreased by 24 bpm to 136 bpm during the break. In the second round, the average HR increased to 163 bpm, whereas the decrease during the break was higher, by 1 bpm (135 bpm), relative to the break after the previous round. The average HR value peaked during the third round at 164 bpm and represented 93.18% of the, estimated, maximum value in the evaluated athlete (Siska & Brodani, 2017).

Podstawski et al.(2013) reported comparable correlations between anthropometric features and strength endurance during the 3-MBT to those found in the present study. Such results putatively indicate that increased body mass, overweightness and obesity negatively influence strength endurance, and that every 1% increase in BMI decreases strength endurance (repetitions performed during the 3-MBT) by 0.93% (Podstawski et al., 2013). Comparable correlations between anthropometric parameters and strength endurance have been observed during 500 m and 1000 m rows on a rowing ergometer; demonstrating that independent variables, i.e. body mass, body height, length of lower and upper limbs, BMI, SI and CPI, may significantly influence performance during 500 m and 1000 m rows among both female (Podstawski et al., 2006; Podstawski et al., 2011; Podstawski et al., 2013; Podstawski et al., 2014) and male participants (Choszcz et al., 2009; Podstawski et al., 2009). The above results were used to develop empirical models based on the basic anthropometric parameters of sedentary university students (female and male) who scored the lowest results during the 500 m row on a rowing ergometer. The best results were scored by students with body height of 185-190 cm, body mass of 90-95 kg, and arm length of 80-90 cm (Choszcz et al., 2012). In the group of physically inactive female university students, the best results were scored by participants with a body height of 170-180 kg, arm length of 75-80 cm, and leg length of 85-90 cm (Podstawski et al., 2014). Contrary to the results reported in our previous research, a comparison of sedentary participants with rowing athletes revealed that the best female and male rowers were generally taller and heavier than other athletes competing in endurance sports and were characterized by relatively low values of BFM, PBF and VFL (Mikulić &Ružić, 2008). However, the physiology of the effort associated with rowing on a rowing ergometer differs considerably from the 3-MBT. During rowing, body mass is compensated by a sliding seat, whereas during the 3-MBT, the individual must repeatedly overcome the resistance associated with body weight. In individuals with similar levels of conditioning, an increase in body mass increases absolute strength, but decreases relative strength (Podstawski et al., 2013; Swain, 1994). Therefore, in exercises where performers must overcome body weight resistance, individuals with higher body mass and higher BMI will, ostensibly, perform worse in relative strength endurance trials such as the 3-MBT.

Strength endurance is often measured in judo and ju-jitsu athletes based on the number of completed squats and sit-ups and the total time in seconds for the flexed arm hang in a bar motor test (Pietraszewska et al., 2014). However, in these tests, strength endurance is evaluated in different segments of the body (leg, abdominal, shoulder girdle, wrist muscles), whereas the 3-MBT and the rowing test evaluate overall strength endurance associated with the entire locomotive apparatus. According to some authors, the strength endurance of abdominal muscles is difficult to assess in athletes because most tests focus on the number of sit-ups performed in 1 minute (Krstulović et al., 2006; Taylor & Brassard, 1981; Vidalet al., 2011). Physiologically, these tests do not measure strength endurance because in the first minute of effort, anaerobic processes supply 80% of the energy and aerobic processes supply only 20% of the energy, whereas in typical endurance tests, effort should be continued for at least 4-5 minutes at 60-80% maximum oxygen intake (VO_{2max}) (Heyward, 2006). For this reason, the 3-MBT should not be considered solely as a measure of endurance, but rather of strength endurance.

Conclusions

The 3-minute variant of the Burpee Test facilitated a detailed evaluation of strength endurance. The 3-MBT assesses physical effort more reliably and objectively than its 30-second and 60-second counterparts. Somatic and body composition parameters are significantly correlated with strength endurance in women and men aged 18-29 years. The parameters indicative of the degree of obesity (BMI, BFM, and VFM) are bound by the least significant negative correlations with motor performance (number of completed cycles) during extreme effort, but significant correlations were also noted for the remaining body composition parameters (excluding age and body height). The analyzed physiological parameters were significantly correlated with the maximum physical effort.

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