SEX-MEDIATED DIFFERENCES AMONG UNIVERSITY STUDENTS PERFORMING EXTREME PHYSICAL ACTIVITY DURING THE 3-MINUTE BURPEE TEST

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Abstract
Introduction. The aim of this study was to evaluate sex differences in anthropometric indicators, body composition, physical fitness, and physiological parameters in young women and men performing extremely strenuous exercise during the 3-Minute Burpee Test (3-MBT). Post-exercise recovery during a 6-minute break was determined in the tested subjects. ***Material and methods.*** Ninety-six university students volunteered to take part in this study (45 women aged 20.05 ± 1.81 years and 51 men aged 20.20 ± 2.71 years). Endurance-strength abilities were determined during the 3-MBT motor fitness test, and body composition was determined with an InBody720 analyser. Data were analysed using a Mann-Whitney U test, with statistical significance accepted at $p \leq 0.05$. ***Results.*** The anthropometric indicators, body composition parameters, physical fitness levels (47.22 cycles/3 min), and physiological parameters measured during the 3-MBT were significantly higher in men (VO_{2avg} – 41.57 mL/kg/min, VO_{2max} – 49.67 mL/kg/min, $EPOC_{avg}$ – 11.02mL/kg, and $EPOC_{peak}$ – 27.84mL/kg) than in women. Women were characterised by significantly higher ($p < 0.05$) body fat mass (BFM = 18.80 kg) and percent body fat (PBF 28.26%) than men. ***Conclusions.*** Male subjects were characterised by higher values of anthropometric indicators, body composition parameters (excluding body fat), motor fitness levels, and physiological parameters than women, and endurance-strength abilities were 23.75% higher, on average, in men than women.

Key words: university students, sex differences, body composition, extreme efforts, 3-MBT

Introduction

This study is a continuation of the research into the applicability of the 3-Minute Burpee Test (3-MBT) for measuring the endurance-strength abilities of persons with various levels of physical activity (PA) and adaptation to training. Previous studies have affirmed that the 3-MBT is a valid [1] and reliable [2] test for evaluating endurance-strength abilities, across a broad age range [3]. Successive studies confirmed that body mass, BMI, and body height are significantly negatively correlated with the number of completed (3-MBT) cycles; concomitantly, the heart rate of female university students performing this highly intensive PA was raised to 181.92 bpm on average [1]. Thousands of measurements performed on differently aged participants have demonstrated that the 3-MBT is easy to conduct, even under the most basic conditions. Variations of the test or its individual stages (e.g., push-ups, jumps) are used by people who engage in functional training (cross-fit, high-intensity circuit training) as well as professional athletes (boxing, mixed martial arts) [4]. The high intensity of the discussed exercise is a key tenet to its popularity. Practically, the 3-MBT can be classified as a short-term maximal incremental exercise, during which maximal oxygen uptake increases from~30% to 100% of VO_{2max} [5].

An incremental anaerobic exercise to volitional fatigue is an activity whose intensity increases progressively over time until the participant is unable to perform any more work. Further, in untrained and moderately trained individuals, respectively, stroke volume may somewhat decrease towards the end of the exercise [6]. Evaluations of interval training rely on five variables: intensity and length of work-time, intensity and length of rest-time, and total training volume [7]. Based on the length of work intervals, high-intensity interval training (HIIT) can be classified as long (3-15 min), moderate (1-3 min), or short (10 s-1 min) [8].

The growing participation of women in high-endurance sports and PA has resulted in contemporary challenges for exercise physiologists and practitioners. Research into the influence of high workloads on the female body have revealed that female athletes still fall 10% short of the results of their male counterparts, on average [9]. Many physiological parameters are significantly correlated with body mass and height [10, 11]. On average, adult women are 7-8% shorter (8-12 cm) and 25-30% lighter (12-18 kg) than men from the corresponding age group [9]. However, men and women differ most significantly in strength abilities [12]. Lower limb and upper limb strength is 25-30% and 40-60% lower in women than men, respectively. The aforementioned absolute differences decrease when strength is expressed relatively, in terms of kg of body mass (5-15%), and they are even smaller when strength is calculated in terms of kg of fat-free mass [9]. These findings play an important role in the 3-MBT, which is a muscular endurance interval exercise.

In maximal incremental exercises, the cardiovascular response is equivalent in women and men, but the attained maximal values tend to differ between the sexes. In absolute terms (litres per minute), VO_{2max} is generally 40-60% higher in males than in females [13]. However, when VO_{2max} is expressed in relative terms (millilitres per kilogram per minute), the differences between the sexes decrease to 20-30%. These variations drop to 0-15% when VO_{2max} is determined in relation to fat-free mass (millilitres per kilogram of fat-free mass per minute) [13]. Tests where VO2max is expressed relative to fat-free mass provide valuable information about the influence of adiposity and fat-free mass on VO2max. However, it should be noted that in reality, oxygen is never consumed in relation to fat-free mass alone, and fat mass cannot be disregarded during exercise. Males have greater oxygen-carrying capacity than females because they have approximately 6% more red blood cells and 10-15% more hemoglobin than females [14], whilst maximal cardiac output is generally 30% higher in men than in women [15]. Maximal stroke volume is also higher for men, but the increase in stroke volume during maximal exercise relies on the same mechanisms in both sexes [16], and differences are not observed in maximal stroke volume, which is expressed relative to body mass, whilst maximal HR remains indistinguishable between sexes.

Whilst sex differences in traditional training modalities have been well explored, hybrid incremental exercises to exhaustion, such as endurance-strength training, have been less extensively researched. Therefore, the aims of this study were: 1) to determine the differences in the endurance-strength capabilities of men and women performing the 3-MBT, and 2) to compare the physiological parameters during the 3-MBT and post-exercise recovery during a 6-minute break between females and males.

Materials 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 years, 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 [2]. 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 (Polish short version) [17]. The students were asked to indicate how much exercise (minimum of 10 minute bouts) they had performed in the weeks preceding the study. The associated energy expenditure was calculated and expressed in Metabolic Equivalent of Task (MET) units, using the Compendium of Physical Activities [18]. The MET is the ratio of the rate of energy consumed during exercise to the rate of energy consumed at rest. One MET unit denotes the amount of oxygen consumed per minute, which is approximately equal to 3.5 mL/kg/min. 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. Increased PA levels of students participating in extracurricular sports could significantly distort the examined relationships; therefore, students involved in additional sports activities and students released from physical education classes for medical reasons were excluded from it. Only students with low and moderate PA levels participated in the study, and 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) characterised by low or moderate PA levels. In the female group, 34 students had low PA levels and 11 had moderate PA levels. In the male group, 21 students had low PA levels and 30 had moderate PA levels.

Body height was measured to the nearest 0.1 mm on a calibrated WB-150 medical scale with a stadiometer (ZPU Tryb Wag, Poland) using a Martin anthropometer, according to standardised 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, 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 InBody720 analyser [19].

Physiological parameters were measured indirectly with the Suunto Ambit 3 Peak HR monitor. These included heart rate – HR, energy expenditure – kcal, as well as the estimated values of $VO_{2\ (avg,\ max)}$, average excess post-exercise oxygen consumption – EPOC $_{(avg,\ peak)}$, respiration rates $_{(avg,\ max)}$, and training parameters (recovery time; peak training effect – PTE; exercise intensity scales – easy, moderate, difficult, very difficult, and maximal).

Endurance-strength abilities were determined during the 3-MBT motor fitness test. The stages of the 3-MBT were the following:

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 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

Initially, data were processed in a descriptive statistics module (arithmetic mean, standard deviation, minimum and maximum values). A Shapiro-Wilk test confirmed the data were not normally distributed; therefore, non-parametric inferential tests were used in the statistical analysis. The data were analysed using the Mann-Whitney U test, with an *a priori* alpha level of $\alpha = 0.05$ (values in bold). The differences in the results obtained by female and male participants were also expressed in percentage terms (D).

Results

Selected anthropometric measurements and body composition values are presented in Table 1.

Table 1 reveals significant differences in the body height and body mass of the evaluated female and male students (8.46% and 19.50% on average, respectively). Their BMI values were similar and within the norm, which can be attributed to similar body mass-to-body height ratios. Significant differences were not observed between sex groups. In the body composition analysis, the following parameters were significantly higher ($p < 0.05$) in male than in female participants: TBW, protein, minerals, FFM, SMM, InBody score, target weight, FFM control, and BMR. Significant ($p < 0.05$) differences were not noted between the sexes in terms of BMI, weight control, BFM control, WHR, and degree of obesity. Women were characterised by significantly ($p < 0.05$) higher BFM (by 31.13%; women – 18.80 kg, men – 12.95 kg) and PBF values (by 40.78%; women – 28.26%, men – 16.74%). The greatest differences (>50%) between female and male students were observed in the values of weight control and BFM control (57.67% and 51.47%, respectively), whereas smaller but significant differences were noted in the values of SMM, protein, TBW, InBody Score, and BMR (45.42%, 42.06%, 40.79%, 8.15%, and 29.40%, respectively) (Tab. 1).

Men completed a significantly ($p = 0.0003$) higher number of cycles in the 3-MBT than women (47.22 vs. 38.16) and were characterised by significantly ($p = 0.0002$ and $p = 0.0001$, respectively) higher mean values of HR_{avg} and HR_{max} (women: 156.53 and 173.31 bpm, men: 171.20 and 185.14 bpm, respectively). Percentage differences were 23.75% for the number of completed cycles, 9.37% for HR_{avg}, 6.82% for HR_{max}, and 6.88% for HR_{min}. Despite an absence of significant differences in HRR values, the percentage difference between the sexes was 6.73%. The average energy expenditure during the 3-MBT was 53.93 kcal in women, and it was significantly ($p = 0.0067$) higher (by 10.30%) in men (59.49 kcal). The average values of VO_{2avg}, VO_{2max}, $EPOC_{avg}$, and $EPOC_{peak}$ were also significantly higher in male students (14.83%, 12.09%, 23.35%, and 38.60%, respectively). Male participants were characterised by a higher average respiration rate ($p = 0.0004$) than female participants (36.29 and 29.20 bpm, respectively). The maximum respiration rate was determined at 51.53 brpm in men, and it was significantly ($p = 0.0000$) lower in women at 41.36 brpm (Tab. 2).

Table 1. Selected somatic parameters and body composition values of female and male participants

Parameter	Women (n = 45)				Men (n = 51)				D%	*p*
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.		
Age [years]	20.05	1.81	18	24	20.20	2.71	16.3	29	0.72	0.7619
Body height [cm]	166.11	6.02	156	183	180.16	5.71	170	191	8.46	**0.0000**
Body mass [kg]	63.94	12.81	43.4	104.9	76.42	9.45	55.9	98.6	19.50	**0.0000**
BMI [kg/m^2]	23.09	3.94	16.6	33.4	23.54	2.76	18.8	30.4	1.95	0.5149
TBW (Total Body Water) [L]	33.02	4.48	24.7	47.3	46.49	5.67	32.9	57.4	40.79	**0.0000**
Protein [kg]	8.87	1.21	6.7	12.6	12.60	1.55	8.9	15.6	42.06	**0.0000**
Minerals [kg]	3.26	0.51	2.41	4.88	4.38	0.61	3.24	5.64	34.52	**0.0000**
BFM (Body Fat Mass) [kg]	18.80	8.71	5.3	41.2	12.95	5.23	4	24.3	31.13	**0.0003**
FFM (Fat Free Mass) [kg]	45.15	6.19	33.8	64.8	63.47	7.81	45	78.6	40.58	**0.0000**
SMM (Skeletal Muscle Mass) [kg]	24.77	3.66	18.1	36.2	36.02	4.69	24.7	45.1	45.42	**0.0000**
PBF (Percent Body Fat) [%]	28.26	8.17	9.7	48.1	16.74	5.79	6	30.6	40.78	**0.0000**
InBody Score	73.16	6.24	54	85	79.12	7.10	64	94	8.15	**0.0002**
Target Weight [kg]	60.71	6.08	52.3	84.2	75.05	7.09	63.6	89.7	23.61	**0.0000**
Weight Control [kg]	−3.23	9.16	−27.9	14	−1.37	5.52	−12.3	11.7	57.67	0.4314
BFM Control [kg]	−5.11	7.87	−27.9	7.9	−2.48	4.55	−14.1	6.9	51.47	0.1435
FFM Control [kg]	1.87	2.48	0	8.6	1.11	2.14	0	9.1	40.76	**0.0287**
BMR (Basal Metabolic Rate) [kcal]	1345.47	133.91	1099	1771	1741.02	168.46	1342	2068	29.40	**0.0000**
WHR (Waist-Hip Ratio)	0.85	0.05	0.75	0.96	0.84	0.06	0.72	0.99	2.18	0.1105
Degree of obesity	107.87	18.47	77	156	107.33	12.65	85	138	0.49	0.7216

Note: D – percentage differences, *p* – significance level.

Table 2. Motor performance and physiological parameters of female and male participants during 3-MBT

Parameter	Women (n = 45)				Men (n = 51)				D%	*p*
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.		
Number of cycles [N]	38.16	12.17	15	66	47.22	9.51	24	66	23.75	**0.0003**
HR_{avg} [bpm]	156.53	18.82	127	191	171.20	15.78	115	193	9.37	**0.0002**
HR_{max} [bpm]	173.31	16.03	143	201	185.14	14.02	136	201	6.82	**0.0001**
HR_{min} [bpm]	104.73	19.82	76	144	111.94	18.06	71	142	6.88	0.0526
HRR (max-min) [bpm]	68.58	18.26	34	125	73.20	15.52	51	117	6.73	0.1938
Recovery time [h]	1.49	0.66	1	3	1.84	0.76	0	3	23.79	**0.0211**
PTE [Peak Training Effect]	2.06	0.26	1.5	2.3	2.19	0.23	1.3	2.3	6.23	**0.0062**
Energy expenditure [kcal]	53.93	10.72	36	70	59.49	10.39	29	71	10.30	**0.0067**
VO_{2avg} [mL/kg/min]	36.20	8.32	18	50	41.57	6.90	21	50	14.83	**0.0013**
VO_{2max} [mL/kg/min]	44.31	7.84	30	57	49.67	6.78	27	58	12.09	**0.0003**
$EPOC_{avg}$ [mL/kg]	8.93	4.07	3	24	11.02	5.08	1	25	23.35	**0.0162**
$EPOC_{peak}$ [mL/kg]	20.09	11.73	9	61	27.84	14.72	4	61	38.60	**0.0006**
Respiration $rate_{avg}$ [brpm]	29.20	9.58	9	47	36.29	8.09	18	48	24.29	**0.0004**
Respiration $rate_{max}$ [brpm]	41.36	11.41	18	63	51.53	10.92	26	70	24.60	**0.0000**
Physical effort										
Easy (107) [bpm]	00:01	00:02	00:00	00:11	00:00	00:02	00:00	00:10	35.52	0.8143
Moderate (107-124) [bpm]	00:07	00:12	00:00	00:41	00:02	00:07	00:00	00:38	70.95	**0.0315**
Difficult (125-141) [bpm]	00:23	00:31	00:00	01:54	00:09	00:22	00:00	02:01	61.56	**0.0080**
Very difficult (142-159) [bpm]	00:45	00:48	00:00	02:43	00:14	00:18	00:00	01:22	68.94	**0.0002**
Maximal (≥160) [bpm]	01:44	01:14	00:00	03:00	02:30	00:47	00:00	03:00	44.40	**0.0037**

Note: HRR – heart rate reserve, EPOC – post-exercise oxygen consumption, brpm – breaths per minute, D – percentage difference, *p* – significance level.

Bursts of maximum effort were the longest in both sexes. Their duration was determined at 01:40 min in women, and it was significantly ($p = 0.0037$) higher (by 44%) in men at 02:30 min. The duration of very difficult, difficult, and moderate effort was significantly ($p = 0.0002$, $p = 0.0080$, $p = 0.0315$, respectively) longer in women (Tab. 2).

During the 6-minute break, the average values of HR_{avg}, HR_{max}, and HRR were significantly ($p = 0.0439$, $p = 0.0001$, and $p = 0.009$, respectively) higher in men (4.84%, 6.82%, and 4.38%, respectively). The average energy expenditure was determined at 60.11 kcal in female students, and it was significantly ($p = 0.0269$) higher (by 9.34%) in male students at 65.73 kcal. Men were also characterised by significantly ($p < 0.05$) higher values of VO_{2avg}, VO_{2max}, average respiration rate, and maximum respiration rate, whereas the observed differences in $EPOC_{avg}$ and $EPOC_{peak}$ were not statistically significant. In percentage terms, the above values were 17.45%, 7.25%, 19.86%, and 14.54%, respectively, higher in men than in women (Tab. 3).

The parameters measured during the 6-minute break indicate that the duration of maximum effort was significantly higher (by 47.06%) in male than in female participants (00:21 and 00:14 min, respectively). Significant differences in the duration of the remaining categories of effort intensity were not observed between sexes (Tab. 3).

Discussion

The results of this study support the hypothesis that the values of anthropometric parameters, physical fitness levels and physiological parameters associated with exercise are higher in men than in women. The endurance-strength capabilities measured in the 3-MBT were also 23.75% higher in males than in females. Additionally, significant percentage differences in selected physiological parameters (VO_{2avg}, VO_{2max}, $EPOC_{avg}$, and $EPOC_{peak}$) were observed between the sexes, the corresponding values being systematically higher in males. In Busing and West's study [20], males were characterised by higher values of VO_2 (males – 62.60 ml/kg/min, females – 40.58 ml/kg/min) and higher scores in strength tests (push-ups – 29.71:13.64 [N], partial curl-ups – 33.15:18.36 [N]). In training practice, push-ups and partial curl-ups are used to measure muscular endurance, but aerobic endurance tests are classified as exercises longer than 4 minutes, which has considerable implications from a physiological perspective [21]. However, it remains equivocal as to whether 1-minute and 30-second Burpee tests can also be used to measure endurance capabilities [22].

Endurance-strength capabilities are typically measured in 500-m [23] and 1000-m [24] rowing ergometer tests. Evaluations of the endurance-strength capabilities of female [25] and male university students [26] have revealed that men scored

Table 3. Physiological parameters of female and male participants during 6-minute bre

Parameter	Women (n = 45)				Men (n = 51)				D%	*p*
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.		
HR_{avg} [bpm]	119.73	13.83	94	150	125.53	13.34	95	153	4.84	**0.0439**
HR_{max} [bpm]	173.31	16.03	143	201	185.14	14.02	136	201	6.82	**0.0001**
HR_{min} [bpm]	104.36	13.23	80	132	108.92	13.16	81	136	4.38	0.1016
HRR (max-min)	68.96	11.37	42	87	76.22	13.04	47	100	10.53	**0.0090**
Recovery time [h]	0.67	0.56	0	2	1.00	0.49	0	2	50.00	**0.0134**
PTE (Peak Training Effect)	1.53	0.33	1.1	2.3	1.68	0.35	1.1	2.4	9.34	**0.0424**
Energy expenditure [kcal]	60.11	12.65	36	94	65.73	13.71	38	93	9.34	**0.0269**
VO_{2avg} [mL/kg/min]	19.67	5.51	9	32	23.10	4.62	13	33	17.45	**0.0016**
VO_{2max} [mL/kg/min]	32.07	6.02	23	45	34.39	5.79	23	46	7.25	**0.0431**
$EPOC_{avg}$ [mL/kg]	6.20	3.52	1	16	7.43	3.95	1	18	19.86	0.1170
$EPOC_{peak}$ [mL/kg]	9.47	6.33	2	27	10.84	6.17	2	28	14.54	0.1619
Respiration $rate_{avg}$ [brpm]	29.20	9.58	9	47	36.29	8.09	18	48	24.29	**0.0004**
Respiration $rate_{max}$ [brpm]	41.36	11.41	18	63	51.53	10.92	26	70	24.60	**0.0000**
Physical effort										
Easy (<107) [bpm]	01:46	01:52	00:00	04:53	01:02	01:29	00:00	05:19	41.83	0.0879
Moderate (107-124) [bpm]	01:59	01:26	00:00	05:24	01:57	01:30	00:00	04:32	1.66	0.9063
Difficult (125-141) [bpm]	01:27	01:16	00:12	04:52	01:55	01:25	00:14	04:25	32.89	0.0521
Very difficult (142-159) [bpm]	00:33	00:32	00:00	02:29	00:44	00:35	00:00	02:34	33.83	0.0538
Maximal (≥160) [bpm]	00:14	00:23	00:00	01:26	00:21	00:22	00:00	01:24	47.06	**0.0470**

Note: HRR – heart rate reserve, EPOC – post-exercise oxygen consumption, brpm – breaths per minute, D – percentage differences, *p* – significance level.

significantly quicker times in the 500-m rowing ergometer test (103.45 s on average) than women (122.8 s). Furthermore, male participants were also characterised by higher values of anthropometric features (body mass – 72.67 kg, body height – 180.33 cm) than women (body mass – 58.5 kg, body height – 167.3 cm). Mikulić and Ružić [27] reported comparable results to Podstawski et al. [25] and Choszcz et al. [26], utilising a 1000-m rowing ergometer test. In the present study, body mass and height were 19.5% and 8.4% higher in male than in female students.

Strength abilities are known to highly correlate with body mass and speed abilities, despite the fact that the latter are strongly genetically conditioned, which conceivably and partially explains why males are characterised by higher speed abilities (for example in the Finger Tapping Test) than females [28]. In this study, FFM and protein values were 40% higher, and SMM values were more than 45% higher in male than in female students.

Previous observations of somatic and motor development across age groups highlight that boys have a significant and increasing advantage over girls in throwing performance already in elementary school [29], which can be partially attributed to environmental factors [30]. Halverson et al. [30] demonstrated that elementary-aged boys practised specific skills (such as throwing and catching) more frequently, were more often involved in competitive games (such as soccer) than girls, and generally participated in games of longer duration [31, 29]. Kubaisy, Mohamad, Ismail, and Abdullah [32] also found lower levels of exercise performance in females than males and concluded that the sex factor influences motivation for performing regular exercise. The above mentioned observations remain consistent through the life course; however, they may be mediated by PA levels and educational influencers beyond the early years of life, as demonstrated by Kolokoltsev, Iermakov, and Jagiello [33] as well as Podstawski and Borysławski [31]. Furthermore, Kozina et al. [34] proposed an algorithm for the selection of training programmes, determined by individual features of body length and body weight. In the perspective of further research, the application of the 3-Minute Burpee Test may help attenuate issues of individualisation of the training process for men and women, depending on their morphofunctional feature

Limitations

The only limitation of this study was that the values of VO_{2avg}, VO_{2max}, $EPOC_{avg}$, and $EPOC_{peak}$ were estimated based on HR. It should be noted that this is a valid approach for testing adults with a sedentary lifestyle and low (L < 600 METs-min/week) and moderate PA levels (M < 1500 METs-min/week), but not athletes performing extreme sports [23, 38].

Conclusions

The results of this study confirmed that anthropometric features, body composition values (excluding body fat mass and percent body fat), physical activity levels, and physiological parameters are generally higher in men than in women. In addition, endurance-strength abilities were 23.75% higher, on average, in male than in female participants.

Acknowledgments

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