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THE ANAEROBIC POWER OF WOMEN WHO HAVE UNDERGONE PHYSICAL TRAINING

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Abstract

Introduction. Anaerobic power is an important factor determining the physical performance in various kinds of sports. Therefore, the aim of this paper is to present women's anaerobic power in soccer players (SP), table tennis players (TT) and weightlifters (WL). ***Methods.*** This study involved 3 groups of professional athletes women: 15 SP, 12 TT and 12 WL, which are of a similar age and sports' level. Anaerobic power in all athletes was recorded during 30-second Wingate test, with resistance set at 0,075 kp x kg (–1). ***Results.*** Relatively expressed total external work (TW), maximal power output (Pmax) and the fatigue index (FI) of tested athletes were similar. Mean power (Pmean) was different among the treatment groups (F=12,445; p<0,001), while in TT group these values were significantly lower than in SP and in WL athletes. Somatic variables in 3 groups of tested athletes have not changed. ***Conclusions.*** Type of practiced sport has an impact on the size of anaerobic power. Several years of sports training in table tennis has not changed the anaerobic potential of surveyed women while specific training in soccer and weightlifting increased only Pmean.

Key words: women, professional sport, anaerobic power, training.

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Цезар Міхальський, Мішель Зіч, Вієслав Пієта, Карол Піліс, Вієслав Піліс, Анна Піліс, Криштоф Штець, Джоанна Родзієвіч-Грухн. Анаеробна потужність у тренованих жінок. ***Актуальність.*** Анаеробна потужність – це важливий фактор, який визначає фізичну результативність у різних видах спорту. Отже, ***мета дослідження*** – визначення анаеробної потужності в жінок, які є футбольними гравцями (ФГ), гравцями в настільний теніс (НТ) і штангістів (ШТ). ***Методи дослідження.*** Дослідження проводили на трьох групах жінок, схожих за віковими й спортивним показниками, усі вони є професійними спортсменками: 15 ФГ, 12 НТ і 12 ШТ. Анаеробну потужність у всіх спортсменок визначали за допомогою 30-секундного Вінгейт-тесту із застосуванням набору опорів 0,075 кгс х кг (–1). ***Результати.*** У цілому загальна зовнішня робота (ЗЗР), максимальна вихідна потужність (МВП) і коефіцієнт утоми (КВ) однакові у всіх групах. Середня потужність (Рср) різниться в тестованих групах (F = 12.445; p <0.001): у групі НТ цей показник значно нижчий, ніж у ФГ і ШТ спортсменок. Соматичні відмінності в трьох тестованих групах не змінилися. ***Висновки.*** Вид спорту впливає на показник анаеробної потужності. Тренування з настільного тенісу, які проводили протягом декількох років, не привели до зміни анаеробного потенціалу в спортсменок, тоді як тренування з футболу й важкої атлетики привели лише до збільшення середньої потужності.

Ключові слова: жінки, професійний спорт, анаеробна потужність, тренування.

Цезарь Михальский, Мишель Зич, Виеслав Пиета, Карол Пилис, Виеслав Пилис, Анна Пилис, Криштоф Штец, Джоанна Родзиевич-Грухн. **Анаэробная мощность у тренированных женщин**. ***Актуальность.*** Анаэробная мощность – это важный фактор, который определяет физическую результативность в разных видах спорта. Таким образом, ***целью исследования*** было определение анаэробной мощности у женщин, которые являются футбольными игроками (ФИ), игроками в настольный теннис (НТ) и штангистами (ШТ). ***Методы исследования.*** Исследование проводили на трех группах женщин, сходных по возрастному и спортивным показателям, все они являются профессиональными спортсменками: 15 ФИ, 12 НТ и 12 ШТ. Анаэробную мощность у всех спортсменок определяли при помощи 30-секундного Вингейт-теста, с применением набора сопротивлений 0,075 кгс х кг (–1). ***Результаты.*** В целом, общая внешняя работа (ОВР), максимальная выходная мощность (МВМ) и коэффициент усталости (КУ) одинаковы во всех группах. Средняя мощность (Рср) различалась в тестируемых группах (F=12.445; p<0,001: в группе НТ этот показатель был значительно ниже, чем у ФИ и ШТ спортсменок. Соматические различия в трех тестируемых группах не изменились. ***Выводы.*** Вид спорта влияет на показатель анаэробной мощности. Тренировки по настольному теннису, которые проводились в течение нескольких лет, не привели к изменению анаэробного потенциала у спортсменок, тогда как тренировки по футболу и тяжелой атлетике привели лишь к увеличению средней мощности.

Ключевые слова: женщины, профессиональный спорт, анаэробная мощность, тренировка.

Introduction. The anaerobic power of women is lower in women than in men [1; 2; 3]. This power in women, like in men, plays an important role in recreational and professional sports, and is an effective

predictor of good performance in many disciplines of sports [4; 5; 6]. It is hypothesized that the ability to train this capacity is genetically determined [7]. At the present stage of knowledge there is evidence that beyond the biological natural development of the body, strength training is most likely to develop anaerobic performance in both women and men [8, 9]. In addition, plyometric training of lower limbs influenced the increase of the results in vertical and horizontal jumps, the shortening of the running time over the distance of 20 and 40 m and the increased strength of these limbs [10].

Among the anaerobic performance tests widely used is the Wingate test. Initially, it was performed with lower limbs for 30-second, followed by 15-second and 60-second versions, but finally the 30-second version became the basic test for evaluation of human anaerobic performance. The 30-second Wingate test evaluates the anaerobic power comprehensively, as it defines its major components: anaerobic capacity, maximal power output, anaerobic endurance, and others. It is also possible to perform the upper limb Wingate test with specially constructed cycloergometer with much lower resistance than the lower limb version. There were also variants of the Wingate test with different loads for men, women and children [11; 12; 13]. The disadvantage of the Wingate test is the specificity of the cycloergometer work that clearly prefers individuals with high muscle strength and above all those who have mastered the technique of cycloergometer work, such as cyclists or triathlon competitors.

The purpose of the presented work is to assess the anaerobic power of women practicing sports disciplines with different levels of development of anaerobic metabolism. Trained women were of similar age and represented a similar level of sport proficiency.

Materials and methods of the study. The study involved 3 women's groups: 15 soccer players (SP), 12 table tennis players (TT), 12 weightlifters (WL), which were of a similar age and represented a similar sports' level (II and I sport class). The length of surveyed athletes training ranged 3–15 years. The subjects reported to the laboratory 2 hours after a light meal, without taking coffee, medications or alcohol for at least 12 hours.

The study began with a determination of athlete's age and body mass (BM). Before the main test the 5-minute warm–up was conducted. Then the 30-second Wingate test was performed on the Excalibur Sports cycloergometer, with resistance set at 0,075 kp x kg (–1) BM. After the test total external work (WT – KJ/kg), maximal power output (Pmax – W/kg), mean power (Pmean – W/kg), and fatigue index (FI – %) were calculated.

Obtained data in first stage of study were analyzed in order to determine their distribution and after confirming their normality, arithmetic means and standard deviations were calculated. Comparison means arithmetic of treated sports group were calculated with non-paired t-test or U Mann-Whitney test using SPSS software, version 24. The level of statistical significance was set at $p<0.05$.

Discussion and the results of the study. The examined women did not differ by age or any of the examined somatic variables (tab. 1).

Table 1

Somatic Variables of Tested Women

Group	Age, *years*		BM, *kg*		BH, *cm*		BF, *%*		BMI, *kg/m2*	
	x	±SD	x	±SD	x	±SD	x	±SD	x	±SD
SP n=15	21,27	2,69	60,03	8,92	165,53	6,02	24,35	1,87	21,84	2,58
TT n=12	21,17	2,21	60,62	7,96	166,92	2,34	25,74	1,72	21,76	2,49
WL n=12	19,33	1,72	61,58	9,81	164,50	2,32	25,43	2,00	22,74	3,35
F	2,855		0,102		0,327		0,162		0,464	
p<	0,071		0,903		0,723		0,851		0,633	
SP vs. TT	1,000		1,000		1,000		1,000		1,000	
SP vs. WL	0,106		1,000		1,000		1,000		1,000	
TT vs. WL	0,170		1,000		1,000		1,000		1,000	

BM – body mass; BW – body height; BF – body fat.

However there was a significant difference in the anaerobic power indices among the examined groups in relation to Pmean ($F=12,445$; $p<0,001$).

Table 2

Anaerobic Power Variables of the Examined Women

Group	TW, *kJ*		Pmax, *W/kg*		Pmean, *W/kg*		FI, *%*	
	x	±SD	x	±SD	x	±SD	x	±SD
SP n=15	12,39	2,63	10,78	2,02	6,91	0,94	57,09	10,89
TT n=12	10,77	2,46	9,57	1,34	5,41	0,86	61,96	16,14
WL n=12	12,59	2,44	11,25	1,99	6,90	0,77	59,89	9,15
F	1,948		2,708		12,445		0,535	
p<	0,157		0,080		0,001		0,590	
SP vs. TT	0,313		0,287		0,001		0.939	
SP vs. WL	1,000		1,000		1,000		1,000	
TT vs. WL	0,252		0,094		0,001		1,000	

TW – total external work; Pmax – maximal power output; Pmean – mean power; FI – fatigue index.

Post hoc analysis revealed significant differences between groups TT and SP, as well as TT and WL ($p<0,001$) in relation to Pmean.

It has been revealed that in case of anaerobic power it has displayed significant sex differences between the components of its physical performance, namely: anaerobic capacity, maximal power output and anaerobic endurance [3; 14; 15; 16]. Men achieve higher anaerobic power (Pmax, Pmean) and lower anaerobic endurance (fatigue index) than women [3; 15]. The anaerobic power values of the women presented in the study were somewhat different and the results obtained by the table tennis players were similar to those of the non–training women. Allison et al. (2015) determined that non–training women in the US Army had Pmax=9,5±1,7 W/kg and Pmean=6,1±0,8 W/kg, and were significantly lower than those of men of similar age ($p <0,001$). The other 2 groups of athletes studied by us gained higher values of anaerobic power indices than those presented by untrained American women and table tennis players of similar age. This is due to the fact that football players in their training perform some of the exercises developing anaerobic power and the overwhelming part of the workout in weight lifting is focused on the development of this motor ability [16,17,18]. The differences between the studied groups of women are relevant to only Pmean parameter. However, there were no intergroup differences in Pmax, although among tested groups there were weightlifting competitors with high muscle strength. This motor ability greatly influences the size of anaerobic power and especially on Pmax [19]. In addition, the maximum muscle strength is reached between age 20 and 30, and it can significantly affect the development of anaerobic power in this decade of life [20].

In our study, however, such positive effects of high muscle strength on anaerobic power in weightlifting athletes have not been found despite the fact that these athletes were of the age corresponding to the maximum development of strength. Likewise, there was no difference in the anaerobic capacity of the women surveyed which are reflected by TW in the present study, although it would seem that footballers should have more developed this anaerobic performance component than the weightlifting athletes and table tennis players. Football players must develop periodically and repeatedly high anaerobic power in 90 minutes of play, which is less common in weight lifting and table tennis competitions.

It should also be mentioned that the Wingate cycloergometric test was not a specific type of work trained by any of the sport teams we have studied and that there were no preferences in the studied subjects, so that the results of the investigated anaerobic power appear to be reliable. It is also noted that the warm–up method before the Wingate test can affect the reliability of the obtained results. Lunn et al. (2015) claim that the best results of anaerobic power determined by the Wingate test are obtained when the last 5 seconds warm–up test is performed at 80 rpm. In the present study, participants performed a 5–minute warm–up on a cycloergometer at a steady speed of about 70 rpm, which should also guarantee reliable results of measured anaerobic power [21].

Conclusions.

1. The structurally and metabolically different nature of table tennis training from soccer and weightlifting athletes was the reason of lower Pmean results.
2. Table tennis training is an inadequate stimulus for development of anaerobic power.

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