UDC 796.42

STUDY OF PHYSICAL WORKABILITY IN STUDENT-ATHLETES USING THE PWC$_{170}$ TEST

R.M. Baghirova

Azerbaijan State Academy of Physical Education and Sport, *Fatali Khan Khoyski Street 98a, AZ 1072, Baku, Azerbaijan*

E-mail: rafiga_bagirova1@mail.ru

Access this article online:

QR code:

Website: https://ajp.az

DOI: 10.59883/ajp.76

How to cite this article:

Baghirova RM. Study of physical workability in student-athletes using the PWC170 test. Azerbaijan Journal of Physiology. 2023;38(2):40-44. doi:10.59883/ajp.76

Abstract:

In the present work, the functional state and process of adaptation of the cardiorespiratory system to physical activity were studied in student-athletes using the PWC$_{170}$ bicycle ergometer test. The conducted studies showed that the majority of athletes in both martial arts (cyclic) and team sports (acyclic) had an average level of physical performance. It should be noted that a fairly high percentage of student-athletes at the Azerbaijan State Academy of Physical Education and Sports (ASAPES) had an average level of performance. However, a very small number of students had below-average and high PWC$_{170}$ scores. The results of the study made it possible to assess the anaerobic performance and adaptive capabilities of athletes as average. The ability of the circulatory system to recover was below average.

Keywords: physical load, working capacity, the cardiovascular system.

INTRODUCTION

The problem of training athletes in a university environment has always been and remains relevant. Therefore, determining the level of special physical fitness and functional state of student team athletes is a necessary condition for the effective construction of the educational and training process at a university [11]. The study of the functional readiness of athletes, as well as the timely detection of signs of overwork and deterioration in health, becomes most significant and objective if these characteristics are being measured while performing standard dosed loads (functional tests) [6, 7, 8, 11, 12]. The use of these tests at different periods of the training process provides valuable information about the dynamics of changes in the functional state of athletes [2, 3]. The bicycle ergometer test PWC$_{170}$ allows us to evaluate the aerobic capabilities of the cardiorespiratory system of the athlete's body. The main link limiting the physical performance of an athlete is the cardiovascular system, which most integrally reflects the functional capabilities of the body. Adequate physical activity increases the efficiency of the functioning of the cardiovascular system; excessive exercise leads to the development of physical overstrain of the cardiovascular system (CVS) [1, 9]. The use of standard dosed loads is also used during observations at various periods of the training process, which provides valuable information about the dynamics of changes in the functional state of the athlete's body [3]. To study the physical preparedness of student-

athletes of ASAPES, a study was carried out on the functional state of the body and physical performance according to the absolute indicator PWC_{170}.

METHODS

54 students from ASAPES took part in the study, five of whom were masters of sports (MS), and 3 were candidates for masters of sports (CMS), who had many years of sports and competitive experience. 28 students had a first sports class, and the rest (18 students) had a second sports class. At the time of the study, the average age of the students was 20.5 years, the average height was 176 ± 1.9 cm, and the average weight was 70.3 ± 3.5 kg.

The essence of the PWC_{170} test (from the English Physical Working Capacity) was as follows: two loads of different power (M1 and M2) were performed on a bicycle ergometer, each lasting 5 min. The break after each load (rest) was 3 min. The pedals rotated at a speed of 60 rpm. The power of the 1st (M1) and 2nd (M2) loads were selected according to a special table compiled by V.L. Karpman [5]. To conduct research and obtain results on physical performance, the load is selected in such a way that several heart rate values were obtained in the range of 120 to 170 beats/min. The power of the second load depended on the power and heart rate of the first load; tables were used to simplify the calculations. To obtain a reliable result, the second load should bring the heart rate to a level of 10–15 beats less than the age optimum. At the end of each load (in the last minute), heart rate was measured (HR1 and HR2, respectively). The physical workability indicator was calculated using the formula:

$$PWC_{170} = M_1+(M_2-M_1)\cdot(170-HR_1)/(HR_2-HR_1)$$

HR_1 and HR_2: heart rate after the first and second loads; M_1 and M_2: the power of the first and second loads (kgm/min or W). There are concepts of relative and absolute indicators of physical performance. This makes it possible to conduct a comparative analysis of the level of physical performance of people of different ages and genders, as well as with different body weights. In this case, the relative values of PWC_{170} per 1 kg of body weight are calculated (in kgm/min/kg). To do this, the absolute value of the physical performance indicator obtained from the formula must be divided by the value of the body mass indicator (in kg) [11].

Determination of maximum oxygen consumption (MOC). The MOC indicator characterizes the largest amount of oxygen consumed by a person in one minute and is a measure of aerobic power. One of the indicators of aerobic (oxygen) power is the maximum oxygen consumption (MOC), which reflects the largest amount of oxygen consumed by a person in a minute. The study of this indicator is necessary to study the professional preparedness of student-athletes. In addition, it is also used to assess the physical fitness of athletes and to diagnose the functional state of the cardiorespiratory system. The value of the MOC can be calculated with an error of no more than 10% using the formula:

$$MOC = (1.7 \text{ X } PWC_{170} + 1070)/P,$$

where MOC is oxygen consumption per unit of body weight (in ml/min/kg); PWC_{170} - is the absolute value of physical working capacity in kgm/min; P - is body weight in kg.

RESULTS AND DISCUSSION

The study of physical (aerobic) working capacity using the bicycle ergometric test showed that the PWC_{170} absolute indicator of the studied athletes-students was 1200 kgm/min, and the relative value was 17.4 and corresponded to low and high levels. For athletes specializing in the studied sports, the indicator of physical working capacity (PWC_{170}) was at an average level (bottom lines in each weight). The spread of individual data was within a fairly wide range from 740 to 1710 kgm/min and corresponded to low and high levels. The average level of MOC was 3.79 l/min in all tested subjects. Individual indicators varied widely from 2.7 to 4.8 l/s.

Our research has shown that the indicator of physical work capacity according to the bicycle ergometric test mainly depends on the activity of the respiratory and cardiovascular systems and the blood system, which has

individual characteristics. In people who do not do sports, the absolute indicator of OMS was 2.5–3.5 l/min, and in athletes, it fluctuates between 4–6 l/min and more. When converted to 1 kg of body weight in non-sports people, OMS was 40–50 ml/min/kg, and in high-level athletes, it was up to 70–90 ml/min/kg. However, the absolute indicator of MOC was higher in a person with a large body weight; the value of its relative indicator increased with weight loss.

In addition, a comparative analysis of data obtained from representatives of single combat sports, differing in weight categories, was carried out mainly according to the relative indicators of PWC_{170} and MOC. Thus, according to the average kgm/min/kg. The spread of individual data from 740 to 1710 kgm/min was in a fairly wide range between the values of PWC_{170}; the absolute value was 1066 kgm/min, and the relative value was 16.8 kgm/min/kg in representatives engaged in single combat sports (Table 1).

Table 1. The average of the physical working capacity indicators of the PWC_{170} bicycle ergometer test among athletes in martial arts and gaming sports.

Indicators		Kind of sport	
		Martial sports	Gaming kinds of sports
PWC_{170} performance	$PWC_{(abs.)}$ kgm/min	1066	1366
	$PWC_{(rel.)}$ kgm/min/kg	16.8	17.6
	$MOC_{(abs)}$ kg l/min	3.5	3.9
	$MOC_{(rel.)}$ ml/min/kg	53.8	54.7
Heart rate at rest		74	73
Recovery time, min		10-20	10-15

The absolute index of OMS was on average 3.5 l/min, and the relative was 53.8 ml/min/kg. The recovery of the pulse took place in the 15th minute of rest. The spread of individual data for the PWC_{170} absolute value was within 740–1710 kgm/min/kg. In other words, taking into account the weight of the test subjects, the analysis of their indicators showed the following: 6.7% of the studied athletes showed a high level; the relative values of PWC_{170} were 23.2 and 26.8 kgm/min/kg, OMS were 70.7 and 74.3 ml/min/kg, respectively. These athletes had a first sports class and more than 5 years of training experience. Above-average indicators were observed in 16.7% of athletes: PWC_{170} (relative) had values from 19.1–23.2 kgm/min/kg and MOC (relative) 59.0–67.0 ml/min/kg. A study of the relative indicators of the values of PWC_{170} and MOC based on the body weight of each student-athlete revealed that PWC_{170} was 14.1–18.0 kg/min/kg, and MOC was 48.3–59.3 ml/min/kg. 30.0% of athletes had values below average: PWC_{170} 10.8–14.9 kgm/min/kg and OMS 38.5–49.5 ml/min/kg. It was shown that half of the studied student-athletes who showed physical working capacity at average and below average levels had a low athletic level (second sports class); almost the same number had a first sports class; and even one of them was a master of sports.

A study of physical (aerobic) performance in student-athletes specializing in team sports revealed that the studied indicators PWC_{170} and MOC had a wide range of values - with an assessment from high to below average levels. For highly qualified athletes in team sports, just like the martial arts athletes we examined, an appropriate level of performance was identified. In this group, there were those who, despite being highly qualified, had low indicators, and conversely, those with low qualifications had relatively high PWC_{170} and MOC indicators; however, it should be noted that this discrepancy was rare and was less pronounced in athletes of game (acyclic) sports.

The study of the blood oxygen saturation level by the indirect method of photo-oxyhemometry in both groups of athletes showed that under resting conditions it was at the normal level and amounted to 97–100%. Measurements were carried out on the 4th finger of the non-working hand. A decrease in this

indicator by 5–10% was noted immediately after performing the test on a bicycle ergometer and slightly less after the second load—by 3–5%. These changes were not significant.

Analysis of the data obtained showed that both among athletes of martial arts (cyclic) and team sports (acyclic), the level of physical performance, identified by the indicators of the PWC_{170} bicycle ergometer test, was at an average level for the majority of subjects. It should be especially emphasized that a fairly high percentage of athletes had an average level of performance. Along with this, a very small number of subjects had PWC_{170} scores below average or high. For each of the studied athletes, the level of aerobic performance was calculated and shown, and their differences are a consequence of several reasons, including the presence of genotypic and phenotypic characteristics in the development of functions in individuals; aerobic endurance trainability; athlete qualifications; experience in training activities; the stage of preparation at which the athlete was during the period of this study; and an ineffective system for planning general physical training [10].

CONCLUSION

Thus, using the PWC_{170} bicycle ergometer test, we assessed the functional state of the cardiovascular system of student-athletes at the Academy of Physical Education and Sports. The research results we obtained allowed us to evaluate the anaerobic performance and adaptation capabilities of athletes as average. The process of restoring the circulatory system was at a lower-than-average level.

REFERENCES

[1] Badtieva VA, Pavlov VI, Sharykin AS, Khokhlova MN, Pachina AV, Vybornov VD. An Overtraining syndrome as functional cardiovascular disorder due to physical overload. Russian Journal of Cardiology. 2018;23(6):180-190. (in Russian). https://doi.org/10.15829/1560-4071-2018-6-180-190

[2] Iordanskaya FA. Abramova TF, Buchina EV. Functional fitness of the academic rowing athletes in the process of preparation and selection to major competitions. Bulletin of sports science. 2018;(4):25–29. (in Russian).

[3] Iordanskaya FA. Disturbances of “urgent” adaptation indicators in the process of stressed training work in elite athletes and means of their prevention. Bulletin of sports science. 2018;(3):35–40. (in Russian).

[4] Kalinkin LA, Statsenko EA, Ponomareva AG, Morozov VN, Kutnyakhova LV, Krivoshchapov MV, et al. Oxidative stress in physical training: methods of diagnosis and correction of antioxidant status. Sports Science Bulletin. 2014;(2):31-35. (in Russian).

[5] Karpman VL. Testing in the diagnosis of physical performance and functional readiness of athletes. In the book: Sports Medicine: Textbook for Physical Education Institutes. 2nd edition. M.: Physical Culture and Sports; 1987, p. 120-160. (in Russian).

[6] Kornyakova V, Badtieva V, Balandin M, Ashvits I. Physical fatigue in sports. Human. Sport. Medicine 2020;19(4):142-149. Russian. https://doi.org/10.14529/hsm190417

[7] Makarova GA, Loktev SA, Porubajko LN. Risk factors of overstrain syndrome in athletes. Mezhdunarodnyj zhurnal eksperimental'nogo obrazovaniya. 2014;4(1):170-172. (in Russian).

[8] Mikhailova AV, Smolensky AV. Overstrain of the cardiovascular system in athletes: monograph. M.: Sport; 2019, 122 p. (in Russian).

[9] Rakhmanov RS, Razgulin SA, Blinova TV, Kolesov SA, Strakhova LA, Berzin IA, Khayrov RSh. Evaluation of functional reliability of sportsmen according to indices of metabolic processes in human organism. Sports Science Bulletin. 2018;(1):44-48. (in Russian).

[10] Svannshvili RA, Sopromadze ZG, Kakhabrishvili ZG, Svannshvili TR, Maskhuliia LM. Athletes' physical working capacity. Georgian Medical News. 2009 Jan(166):68-73. (in Russian)

[11] Vykhodets IT. Didur MD, Kargashina AS. et al. Clinical recommendations for the diagnosis and treatment of general and specific overstrain syndromes of the central nervous system, cardiovascular system, musculoskeletal system, immune system and fatigue in highly qualified athletes. Clinical recommendations. Ed. prof. V.V. Uiba. – Moskow: FMBA of Russia, 2018. 94 p. (in Russian).

[12]Xianglin K, Diachenko A. Development of fatigue and means to compensate for it in the course of training and competitive activity of rower athletes. Nauka v olimpijskom sporte. 2018;(1):18–27. (in Russian).

ИССЛЕДОВАНИЕ ФИЗИЧЕСКОЙ РАБОТОСПОСОБНОСТИ СТУДЕНТОВ-СПОРТСМЕНОВ С ПОМОЩЬЮ ТЕСТА PWC$_{170}$

Рафига Мазахир кызы Багирова

Азербайджанская государственная академия физической культуры и спорта, Баку, Азербайджан

Основной целью работы было определение влияния спортивных физических нагрузок на регуляторные и адаптационные возможности сердечно-сосудистой системы организма студентов. С помощью теста PWC$_{170}$ оценивали функциональное состояние сердечно-сосудистой системы студентов-спортсменов. Проведенные исследования показали, что как у спортсменов единоборств (циклических), так и игровых видов спорта (ациклических) уровень физической работоспособности, определяемый по показателям велоэргометрического теста PWC$_{170}$, у большинства испытуемых находился на среднем уровне. Следует отметить, что достаточно высокий процент студентов-спортсменов Азербайджанской государственной академии физического воспитания и спорта имел средний уровень работоспособности. Однако очень небольшое количество испытуемых имели ниже среднего и высокие баллы PWC$_{170}$. Результаты исследования позволили оценить анаэробную работоспособность и адаптационные возможности спортсменов как средние. Способность системы кровообращения к восстановлению была ниже средней.

Ключевые слова: физическая нагрузка, работоспособность, сердечно-сосудистая система.

PWC$_{170}$ TESTİNDƏN İSTİFADƏ EDƏRƏK TƏLƏBƏ-İDMANÇILARIN FİZİKİ İŞ QABİLİYYƏTİNİN ÖYRƏNİLMƏSİ

Rəfiqə Məzahir qızı Bağırova

Azərbaycan Dövlət Bədən Tərbiyəsi və İdman Akademiyası, Bakı, Azərbaycan

İşin əsas məqsədi tələbələrin orqanizminin ürək-damar sisteminin tənzimləmə və adaptiv imkanlarına fiziki yükün təsirini müəyyən etmək idi. PWC$_{170}$ testindən istifadə edərək, tələbə-idmançıların ürək-damar sisteminin funksional vəziyyəti qiymətləndirilmişdir. Tədqiqatların nəticələri göstərdi ki, həm təkmübarizlik (tsiklik), həm də idman oyunları (asiklik) idmançılarında PWC$_{170}$ veloergometrik testinin göstəriciləri ilə müəyyən edilən fiziki iş qabiliyyətinin səviyyəsi idmançıların əksəriyyəti üçün orta səviyyədə olub. Qeyd etmək lazımdır ki, Azərbaycan Dövlət Bədən Tərbiyəsi və İdman Akademiyasının idmançı tələbələrin kifayət qədər yüksək faizi orta göstəricilərə malik olub. Bununla belə, çox az sayda idmançıların fiziki iş qabiliyyəti ortadan aşağı və yüksək PWC$_{170}$ ballarına malik idi. Tədqiqatın nəticələri idmançıların anaerob fiziki iş qabiliyyətini və uyğunlaşma imkanlarını orta səviyyədə qiymətləndirməyə imkan verdi. Qan dövranı sisteminin bərpa qabiliyyəti orta səviyyədən aşağı idi.

Açar sözlər: fiziki yük, fiziki iş qabiliyyəti, ürək-damar sistemi.

Received: 25 July 2023
Sent for revision: 15 August 2023
Accepted: 22 December 2023
Published: 31 December 2023