Medicina Sportiva, Vol. 9 (2): 66-69, 2005
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FUNCTIONAL CHARACTERISTICS OF ELITE BASKETBALL PLAYERS AND BODYBUILDERS

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Abstract

Introduction: Peformance in endurance sports is dependent on oxygen transport capacity, while sports, such as tennis, basketball, volleyball depend on speed, power and anaerobic capacity. Power development and load toleration determines the response to the exercise.

Aim of the study: Bodybuilding and basketball require endurance, but the nature of the stresses differ between sports. This study examined and compared the physical working capacity and function capacity of oxygen transportation system of elite basketball players and bodybuilders.

Methods: 12 elite basketball players and 12 elite bodybuilders, involved in the final stage preparatory period before competition, participated in the experiment. Maximal power output (P_{max}), anaerobic threshold (AT), power at AT (P_{AT}), oxygen consumption at AT (VO_{2AT}) and the relative index of metabolic and exterior power (METW) were determined during a veloergometric exercise test.

Results: P_{max} was lower in bodybuilders than basketball players ($p<0.05$). P_{AT} was 174.5 ± 28.9 W (Mean ± SD) in the basketball players and 132.4 ± 23.8 W in the bodybuilders. P_{AT} and VO_{2AT} were highly related ($r=0.91$) and reflected the potential for functional power in basketball players and bodybuilders. METW developed by both groups of athletes, particular basketball players, were higher than in non-athletes.

Conclusion: This study was a comparative analysis of functional power of athletes in two different sports. The training of bodybuilders builds muscular endurance but contributes little to the development of aerobic capacity. The indices of anaerobic threshold in both groups of athletes, bodybuilders in particular, were not high, so physical training loads contributing to the increase of the anaerobic threshold should be recommended.

Key words: Maximal power, anaerobic threshold, functional adaptation, aerobic potential, maximal oxygen consumption, relative index of metabolic and exterior power.

Introduction

The benefits of moderate physical exercise to health and quality of life are well-known. (1,2). Intense physical loads and psycho-emotional tension, however, may be risk factors of certain diseases. The type, intensity, and volume of the sports training process is of critical interest to athletes, coaches, and recreational exercisers alike. (3, 4) Understanding power output capacity and the threshold of overtraining is also of interest (5, 6). General and specific physical training of athletes is a multifaceted process that strengthens health and improves the motor, physical, and psychic capacities of athletes. During the last century many researchers studied the adaptation responses to physical loads (7-9). Nobel prize winners A. Krogh, A. Hill and O. Meyeroff did important seminal work in the field almost 100 years ago, and the volume of research in this field has increased almost geometrically in the years that followed.

Metabolic, cardiorespiratory control, physical responses are just a few ways to describe the physiology of exercise. Examples include power output, the load tolerated and the resulting response of the human organism, metabolic changes, and changes in pulmonary ventilation and cardiorespiratory activity. The maximal consumption of oxygen ($\dot{V}O_2max$) is one of the most significant indices characterizing the level of training. Likewise, changes in $\dot{V}O_2max$ are indicative of the training effect (3, 6, 8, 10-12) Good physical fitness is determined by the condition of the cardio respiratory system (4, 10-12). Performance in sports such as skiing, cycling and long-distance running is greatly dependent on the functional capacity of the cardiorespiratory system, whereas performance in sprinting, tennis, basketball, volleyball and sports that require speed and power, is associated with the production of anaerobic energy (13, 14). It is of great interest to conduct comparative research in physical working capacity and functional capacity of oxygen transportation systems of elite basketball players and bodybuilders, as well as persons engaged in different kinds of sports. Research of this kind might be useful for the estimation of indices of functional adaptation of athletes engaged in different kinds of sports. Also, the functional indices of oxygen transport capacity and power output in bodybuilders are scarce.

Material and methods

Subjects

Twelve elite basketball players (BP) and 12 elite bodybuilders (BB) served as subjects. Respective age, height and weight of the subjects were 23.8 ± 3.97 and 30.9 ± 7.14 yr (mean ± SD); 197.3 ± 8.49 and 181.2 ± 5.2 cm and 94.3 ± 14.0 and 93.5 ± 6.7 kg. The research was conducted during the final stage of the preparatory training period in each sport.

Research methods

Height was measured with a Soehle 500 electronic height measuring device and weight was measured with a SOENLE-F20-27609 medicinal weighing scale. Body mass index (BMI) was calculated according to the formula BMI = weight (kg) · height $(m^2)^{-1}$.

Veloergometry was conducted using a ERGO 900 cycle ergometer the included measurements of the electrocardiogram and oxygen consumption (Marquette VMAX229). Oxygen concentration was determined with a VMAX type paramagnetic analyzer and CO_2 with an infrared CO_2 analyzer. All the subjects performed a veloergometric exercise test at 60-70 revolutions per minute at progressively increasing exercise intensities using an adaptation of the method suggested by Jones. The exercise continued to exhaustion; maximal oxygen consumption was regarded as achieved if it did not increase for 1 min during the test or if there was no increase in mechanic efficiency (this has been programmed in the VMAX system).

The anaerobic threshold (AT) was determined using the method of intersecting straight lines (V-slope) from the ratio of the volume of carbon dioxide produced and the volume of oxygen consumed (programmed in the VMAX system).

Physical working capacity was estimated according to the power developed (External work, Pmax) and the power developed at the moment of reaching the anaerobic threshold (P_{AT}). The relative load power (P_{relat}) was the ratio of the maximal power developed to body mass (W·kg^{-1}). Other measurements included metabolic and external power (METW), heart rate at maximum oxygen uptake (HR_{VO2max}), and heart rate at anaerobic threshold (HR_{AT}). Statistical analysis was accomplished using the Microsoft Excel V7 computer program.

Results and Discussion

Morphological characteristics of the athletes are presented in Table 1.

BMI of basketball players corresponded to the 'normal' category of 20-25 kg·m^{-2}, while those of they bodybuilders were slightly higher (Merck manual, 2000). The bodybuilders were also significantly older. We can infer from these data that basketball players achieved elite proficiency at a younger age than bodybuilders.

The physical capacity of the athletes was represented by the indices of maximal power (P_{max}) developed at the level of anaerobic threshold (P_{AT}). P_{max} indices of basketball players totaled 346.35 ± 45.0 W with reliable intervals of 317-375 W, and their relative indices were 3.70 ± 0.50 W. The corresponding indices in the bodybuilders were 245.28 ± 30.2 W and 214-276 W, 2.75 ± 0.62 W, and 2.10-3.40 W respectively and were significantly lower than the basketball players ($p<0.005$).

Healthy people, even those engaged in hard physical work, achieve a relative power of 3 W·kg^{-1} body weight and 2.5 W·kg^{-1} body weight for sedentary people or those engaged in light work (1,15). A relative working capacity of 1.5 W·kg^{-1} body weight is adequate to perform everyday activities, while 1 W per kg of body weight is sufficient to meet personal needs, such as dressing and toilet (15). In this study, the elite basketball players developed a relative power exceeding 3.39 W·kg^{-1} body weight and working capacity exceeding 4.02 W·kg^{-1} body weight. Other studies found that P_{max} of elite cyclists were 511.7 ± 13.4 W (12,16), skaters were 364.0 ± 19.3 W (17,18), and long distance runners were 383.4 ± 46.4 W (9).

Table 1. *Selected characteristics of the athletes*

		Basketball players	Bodybuilders
BMI (kg·m^{-2})	Mean	24.3	26.6
	Standard deviation	2.6	3.0
	95% confidence interval	22.6 – 25.9	24.7 – 28.4
Age (yr)	Mean	23.8	30.9
	Standard deviation	3.9	7.1
	95% confidence interval	21.3 – 26.4	26.4 – 35.4

Table 2. *Functional indices of bodybuilders and basketball players*

Index	Subjects	Mean	Median	SD	CI 95%
HR_{AT}	BB	122	132	28	118-138
(bpm)	BP	124	129	15	115-134
$HR_{\dot{V}O2max}$	BB	163	163	15	148-178
(bpm)	BP	174	177	22.5	163-191

CI – confidence interval

The functional adaptation by different kinds of athletes was reflected by the differences of physical power indices. Thus, the characteristics of the indices of the power developed depend on the nature of the sport and the maximum load and intensity practiced during the activity. For example, the power developed by elite men rowers was 460-480 W with its relative indices amounting to 5.3-6.0 $W \cdot kg^{-1}$. Women rowers achieved a relative power of 4.5-5.2 $W \cdot kg^{-1}$ (19). Irrespective of the higher relative power developed, athletes in anaerobic sports develop this power at the same levels of $\dot{V}O_2max$, cardiac output, and pulmonary minute volumes. This is indicative of the fact that a better- developed potential of anaerobic energy is characteristic of these kinds of sports (4). This may be conditioned by a better readiness for anaerobic work, due to adaptations such as enhanced lactate clearance capacity. Therefore, in estimating the level of physical fitness a relative estimation of the functional power of athletes would be appropriate.

The power developed by basketball players at the anaerobic threshold (P_{AT}) was174.5 ± 28.9 W, while bodybuilders achieved 132.4 ± 23.8 W. According to some investigators (20) this index, as demonstrated by triathletes, amounts to 287.4 ± 9.5 W and is nearly twice as high as those achieved by athletes in the present study. This shows the training for bodybuilding does not include physical loads that contribute to the development of aerobic capacity. This assertion is supported by indices of aerobic capacity of these athletes: $\dot{V}O_2max$ of 38.2 ± 8.02 $ml \cdot min^{-1}$ and VO_{2AT} of 21.6 ± 8.12 $ml \cdot kg^{-1} \cdot min^{-1}$. The respective indices of basketball players were 51.64 ± 5.97 $ml \cdot kg^{-1} \cdot min^{-1}$ and 26.4 ± 4.6 $ml \cdot kg^{-1} \cdot min^{-1}$. The indices were highly related (P and VO_{2AT}, r= 0.91) and reflect the potential of the functional power of the human organism. In other studies, the $\dot{V}O_2max$ of elite cyclists was 67-82 $ml \cdot kg^{-1} \cdot min^{-1}$ (16,21,22); football players was 55-69 $ml \cdot kg^{-1} \cdot min^{-1}$ (23); long distance runners was 62-70 $ml \cdot kg^{-1} \cdot min^{-1}$ (24); sprinters was 52-56 $ml \cdot kg^{-1} \cdot min^{-1}$; and throwers was 44-48 $ml \cdot kg^{-1} \cdot min^{-1}$ (24). We may infer from the results of the present study that since these aerobic indices in both groups of athletes are not high (bodybuilders in particular), physical loads contributing to the increase of the anaerobic threshold should be recommended.

The indices of heart ratete at anaerobic threshold (HR_{AT}), heart rate at maximum oxygen uptake ($HR_{\dot{V}O2max}$) and maximum heart rate (HR_{max}) during the last minute of increasing power of the athletes studied are presented in Table 2.

Theses data indicate no difference in $HR_{\dot{V}O2max}$. In the case of both groups of athletes load tolerance was limited by the functional potential of cardiac output, but in the case of basketball players this took place at a different level of load intensity. It could be assumed that in the case of athletes engaged in bodybuilding $HR_{\dot{V}O2max}$ was lower, since the training program does not attempt to increase aerobic capacity, which is not the case in basketball players. Aerobic loads applied in bodybuilding are not sufficient to stimulate the adaptive changes necessary for developing oxygen transport capacity. An anonymous questionnaire of the bodybuilders suggested that these athletes frequently used adrenergic preparations, which may decrease the sensitivity of adrenergic receptors, i.e. over-stimulation of adrenergic receptors may cause subjective sensation of heaviness and reluctance to perform intense training loads.

The relative index of metabolic and exterior power (METW) was 1359 ± 275.5 W in basketball players and 1074 ± 211 W in bodybuilders. These indices are related to exterior power (W) and interior metabolic capacity, i.e. the capacity to uptake oxygen as it relates to power output. In healthy subjects the METW index is approximately 1000 (4), while various athletic groups are about 1332. The results of this study indicate that the power developed by both groups of athletes, basketball players in particular, are higher than non-athletic people. No data are available in the literature to estimate physical working capacity using the METW index. Still the application of this method is sure to increase.

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Received: June 18, 2004
Accpeted: January 24, 2005
Published: June 15, 2005

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