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Some physiological markers in elite male indoor rock climbers

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ABSTRACT

Rock climbing has increased in popularity as both a recreational physical activity and a competitive sport. The determinants of climbing performance are not clear but may be attributed to physiological variables rather than specific anthropometric characteristics. So the main purpose of this paper was to determine some physiological markers of elite male indoor rock climbers. 20Iranian national team rock climbers (age 23.2 ± 2.02 yrs, body mass 62.44 ± 5.73 kg, height 174.8 ± 4.75 cm, body fat p ercentage 6.92 ± 0.96, national team background 3.5 ±2.4 yrs, screening climb rated ~5.14 on the Yosemite decimal scale (YDS)) who participated in national preparation camp for Asian championship were selected for this research. Physiological variables such as aerobic and anaerobic power, muscle strength and endurance weremeasured and analyzed by SPSS 16 software for compare means. Results showedthat aerobic power (53.4±1.46 ml/kg^{-1}/min^{-1}), anaerobic power (618±85 watts), muscle strength (42.7±2.94 kg) and muscle endurance (17.9 ± 2.4 reps) in Iranian elite indoor rock climbers are acceptable. This paper reported that physiological factors in elite rock climberswere completely specific to individuals and related to amount of trainings background.

Keywords: Elite rock climbers, physiological markers, aerobic power, anaerobic power, muscle strength, muscle endurance.

INTRODUCTION

Sport climbing has grown tremendously in popularity in the past few years, and standards of difficulty have continued to rise along with the number of competitions. Climbers of all abilities who are interested in improving would benefit from research into determinants of sport climbing performance (1). One of the first studies of the physiology of rock climbing performance was by Williams et al (1, 2). Since then, the focus of research has shifted from outdoor rock climbing to indoor sport climbing, which has given researchers better control over extraneous variables. This shift coincides with the emergence of sport climbing as a competitive event (1, 3).Although climbers are characterized by low body fat, exceptional power to weight ratios and forearm circulatory adaptations favoring the performance of isometric work, the physiological factors related to sport climbing remain essentially undefined (1, 4). Despite the increased research in this area, there is still some debate, as well as conflicting evidence, in the climbing literature about which physiological and anthropometric factors are important in determining climbing performance (1). Mermieret al examined the physiological responses during rock climbing and found a non-linear relation between heart rate and oxygen consumption (Vo2), which suggests that Vo2 may have a small role in determining climbing performance (1, 5). Billatet al concluded that the overall percentage of maximum Vo2 required is relatively small during climbing (1, 6). However, in a recent study by Booth et al, moderately difficult climbing was shown to elicit a significant portion of climbing specific peak Vo2 in elite climbers (1, 7). Other studies have attempted to identify specific physical characteristics present in elite climbers (1, 3, 8). Watts et al concluded that climbing performance is best predicted by percentage body fat (%BF) and strength to body mass ratio in elite sport climbers (1, 3). Grant et al found that elite climbers differ from recreational climbers and active

non-climbers on measures of leg span, %BF, flexibility, and muscular strength and endurance (1, 8). It is evident that the determination of components related to climbing performance needs further investigation (1).The goal of this research was to determinewhich anthropometric and physiological componentsuseful for rock climbing performance in Iranian rock climbers.These procedures should allow us to achieve a greater understanding of the relations among components of climbing performance, which can be used by those who wish to improve their climbing ability. Therefore the purpose of this research was to determine which anthropometric and physiological components best explain the variability in climbing performance.

MATERIALS AND METHODS

20 male indoor rock climbers selected in this study which was approved by the University Clinical Research Ethical Committee. They were also required to complete a general health questionnaire and were excluded if any medication had been taken during the 4 weeks prior to the study and if symptoms of any infections had been experienced in the 4 weeks prior to the study. Moreover, at the time of the study, all subjects were involved in normal training. The climbing history questionnaire was used to obtain information about the length, frequency, and type of climbing experience (sport, traditional, ice, aid, etc), self-reported ratings (defined as highest level consistently climbed), and the specific training programs for climbing for each subject. These variables were used to quantify the training and experience of the subjects. Subjects' characteristics are presented in Table 1.

Table1. The general features of the participants, the data are given based on the mean and standard deviation

screening climb (YDS)	national team background (years)	BMI (kg/ m^2)	body fat percentage	Height (cm)	Body mass (kg)	Age (year)
~5.14	3.5±2.4	20.53±1.54	6.92 ± 0.96	174.8 ±4.75	62.44 ± 5.73	23.2 ± 2.02

Physiological measures

After selection procedure, subjects were asked to assess the physiological characteristics refer to the University sports physiology laboratory. Subcutaneous fat using caliper (model YAGAMI) with instructions based on an eight-point, Body mass index (BMI) using a body composition analyzer (model biospace) making South Korea were measured by specialist operator. Muscularstrengthwas measured using the dominant hand. A hand dynamometer (Jamar, Asimov Engineering, and Los Angeles, California, USA) was used for all measurements and adjusted so that the middle phalanx lined up with the handle. For assessing muscle endurance, 1RM was measured by dynamometer for each subject then 70% RM was determined, the frequencies of each 5 second trials isometric contraction were noted. The more frequency, the more muscular endurance. Aerobic power was measured by Bruse test that greatly used for this purpose. It's compounded 7 stages with different speed and gradient in each stage. Lower body anaerobic power was assessed by RAST test, Subjects were instructed to complete a five minute warm up with no resistance. Subjects then rested for about five minutes to recover from any fatigue associated with the warm up. Anaerobic power was assessed using the previously described RAST testing protocol. Aerobic power also assessed by running on treadmill with Bruse testprotocol (9). Muscle strength and endurance also measured by Quaine hand grip test (10).Temperature approximately 20 ° C and humidity about 55% was calculated.

Statistical Analysis

Statistical Analysis First normal data distribution and homogeneity of groups in order to test the Kolmogorov – Smirnov and Leuven was determined. All statistical calculations were performed using SPSS version 16 for group means with their standard errors.

RESULTS AND DISCUSSION

Table 2 displays descriptive characteristics of the climbers. All participants presented a climbing experience of at least 3 years and a climbing frequency in season of at least 3 days per week. Descriptive data was reported in separate figures. Data showed Aerobic power (figure1a) in Iranian elite indoor rock climbers was in a same range compare to world champions (53.4 ± 1.46 $ml.kg^{-1}.min^{-1}$).Anaerobicpower (figure1b) (618±85 watts), muscle strength (figure1c) (42.7±2.94 kg) and muscle endurance (figure1d) (17.9 ± 2.4 reps) in Iranian elite indoor rock climbers are acceptable.

Table2. The physiologic characteristics of the participants, the data are given based on the mean and standard deviation. (n=20)

muscle endurance (reps)	muscle strength (kg)	Anaerobic power (watts)	Aerobic power ($ml.kg^{-1}.min^{-1}$)
17.9 ± 2.4	42.7±2.94	618±85	53.4 ± 1.46

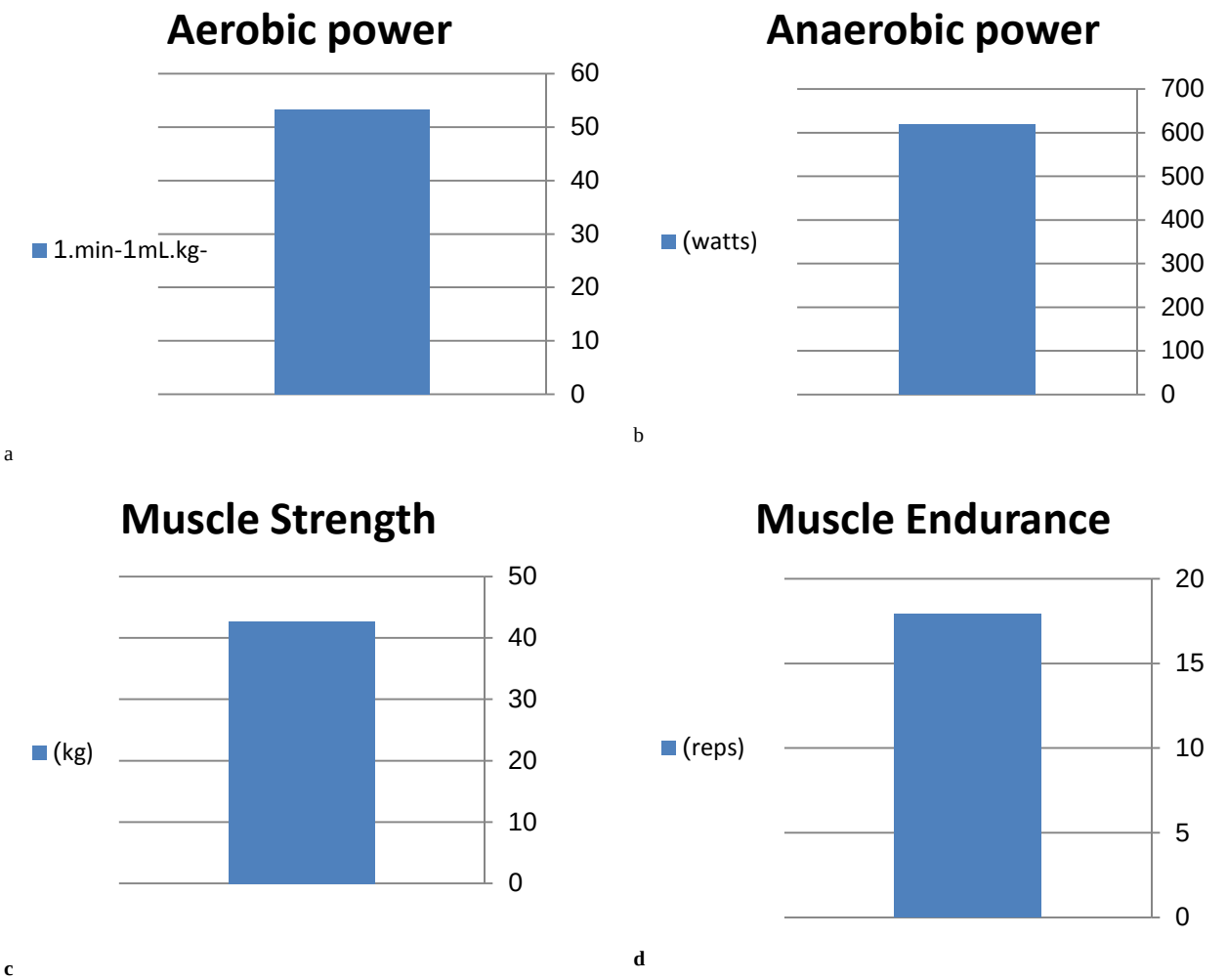

Figure 1. aerobic power(a), Anaerobic power(b), muscle strength(c) and muscle endurance(d) in indoor elite male rock climbers

Much of the scientific literature on climbing focuses on climbing injuries and their prevention. A few recent studies have examined physiological variables related to climbing (1). So, the focus of this study was an investigation of some physiologic factors such as aerobic power, anaerobic power, muscle strength and muscle endurance in elite male indoor rock climbers.Descriptive data showed that aerobic power in rock climbers was in a good range compare to billat et al(54.8 $mL.kg^{-1}.min^{-1}$)(6), booth et al(43.8 $mL.kg^{-1}.min^{-1}$)(7),Wilkins et al(50.7 $mL.kg^{-1}.min^{-1}$)(11) and Phillip B. Watts(55 mL.kg-1.min-1)(12) and it showed Iranian elite rock climbers had an acceptable statue in aerobic capacity. This capacity related also to physical fitness levels, training background and importantly to the type of rock climbers (1). For example, rock climbers who participate in lead type had better aerobic power because of duration and intensity of trainings compare to bouldering and top rope rock climbers. Surprisingly, anaerobic power is reverse from type of rock climbing and rock climbers in top rope and bouldering type have better anaerobic power than lead climbers because of short duration and high velocity of those climbs. We showed values of Anaerobic power in Iranian male rock climbers (618±85 watts) and it seems it was the same as Birute et al (13) results(639±97 watts). In previous study we investigated maximal anaerobic power, minimal anaerobic power, mean anaerobic power and fatigue index in 3 types of rock climbing concluded that anaerobic power depends on any other factors such as age, sex, rate of difficulty and also biochemical variables. Indeed it seems that lead is more intensified than bouldering may be because of isometric contractions in different angles (14). On the other hand, isometric contractioncauses local fatigue of forearm in rock climbers and this factor is very crucial for rock climbing performance. Muscle strength and endurance have important role in being elite in climbing sports. In this study, muscle strength in elite male rock climbing was significantly different from other study (13, 15) (42.7±2.94 kg vs. 48.3 kg). Although when they compared to their body mass, they were not different to each other. This difference may be due to types of trainings and equipment in our study. According to our study, muscle endurance was measured by hand grip test protocol (10) and data showed that values of our study indoor rock climbers were lower compare to elite champion rock climbers (17.9 ± 2.4 reps vs. 19.1 reps)(1). These differences may be because of Iranian training protocols and thus must be changed to get better results.

CONCLUSION

In conclusion, our data indicated that Iranian elite rock climbers had an acceptable statue compare to international elite rock climbers. Indeed, physiological factors were dependent to training protocols and using equipment.

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