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Influence of Warm-Up Intensity on Submaximal Exercise Oxygen Uptake in Iranian Female National Futsal Players

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Abstract

The purpose of this study was to examine the effects of warm-up intensity on total oxygen uptake and VO_2 kinetics (time constants) during submaximal exercise in the Iranian national female futsall player's. The participants of this study were ten Players of Iranian futsal national team (mean±SD: age, 22.5±3.2yrs; weight, 56.04±6.17kg; height, 163±3.68cm; body fat%, 23.5±3.8; BMI, 21.07±2.22kg/m^2; VO_2max, 46.05±4.61 $ml.kg^{-1}.min^{-1}$). After measuring of VO_2max and LT in first session, the subjects performed two protocols of warm up (moderate and heavy intensity) and one protocol with-out warm up before sub maximal exercise (80%LT) in three separated sessions. Respiratory gas exchange measured by Gas Analyzer during the exercise. Repeated measures ANOVA and LSD test were applied for statistical analysis. Total oxygen uptakes were not significant difference after three conditions. After moderate and heavy warm up, third time constants significantly reduced in compare to without warm-up ($p<0/05$). Also oxygen uptake/time ratio in third time constants significantly increased after moderate and heavy warm up respect to without warm-up ($p<0/05$). The results suggest that warm up causes reducing the time of reaching to steady state of O_2 uptake in sub maximal exercise and this effect is independent to warm up intensity.

Keywords: VO_2 total; Intensity of warm up; Sub maximal exercise

Introduction

Oxygen uptake during submaximal exercise (VO_2) and maximal exercise (VO_2max) have an important role in physical performance [1]. Augmentation of whole body O_2 consumption (VO_2) has been proposed to result from acceleration of rate-limiting oxidative phosphorylation reactions, enhanced O_2 delivery associated with increased muscle blood flow, and a temperature-induced facilitation of oxyhaemoglobin dissociation [2]. During the transition from rest to exercise, muscle O_2 uptake increases with a finite time course, the nature of which may give valuable insights into the underlying control mechanisms of energy production. With respect to exercise intensity, the pulmonary oxygen uptake VO_2 on-transient has been characterized by two or three phases [3,4]. The initial delay is usually ascribed to the cardio dynamic phase mainly linked to an increased pulmonary perfusion [3] while the subsequent fundamental phase has generally been reported to closely reflect (within 10%) the oxygen consumption at the muscle level [5]. However, the rate-limiting steps of VO_2 are still not clearly defined. Oxygen uptake kinetics is more important in explanation of sport performance [5] than other parameters of aerobic fitness (VO_2 max, LT) Because in the endurance performance, earlier attainment of the required VO_2 not only reduce the accumulation of metabolites that might impair performance but also 'spare' some limited amount of available anaerobic energy for use later in the race [1]. Several investigators have reported beneficial effects of preliminary (warm-up) exercise during subsequent exercise in human athletes and have attributed these improvements in performance to a variety of mechanisms [6]. More specifically, it has been proposed that warm-up bouts can accelerate the rate-limiting steps in oxidative reactions and improve release of oxygen from haemoglobin and myoglobin [1].

It has also been suggested that warm-up exercise could decrease the initial oxygen deficit and limit the involvement of anaerobic metabolism at the onset of exercise [2]. A warm-up that has enough intensity to elevate blood lactate concentration to approximately 2-4mM/lit can profoundly alter VO_2 kinetics and

has the potential to enhance exercise performance. Because the accumulation of several by-products of high-intensity exercise, including lactic acid, will increase muscle blood flow and thus make more O_2 available to muscle [7,8]. These studies proposed that a metabolic acidosis is necessary for the VO_2 response profile to be altered in the second exercise bout. But Koppo, Bouckaert [8] showed a prior sub maximal exercise similar the prior heavy exercise VO_2 response was reduced during the second bout of exercise [9]. The purpose of this study was to examine the effects of prior (warm-up) exercise on pulmonary oxygen uptake at the end of sub maximal exercise in elite female futsal players.

Materials and Methods

Subjects

10 female national team Iranian futsal players volunteered and complete written informed consent to participate in this study. Their physical characteristics are presented in Table 1.

Table1: Participant's Physical characteristics, (M±SD).

Number	10
Age(years)	22.5±3.2
Weight(kg)	56.04±6.1
Height(cm)	163±3.6
BMI(kg/m^2)	21.07±2.2
VO2 max($ml.kg^{-1}.min^{-1}$)	46.05±4.6
Fat percentage (%)	23.5±3.8

Experimental Design

The subject's referred to the national Olympic academy of Iran on four days which was separated by 48h. Exercise testing was performed at approximately the same time of day for each subject and they inhibited of heavy exercise for at least 24h prior to testing. In the first day subjects performed a graded exercise test to volitional fatigue for the determination of maximal oxygen uptake (VO_2 max) and lactate threshold. The first stage time of test was 3min for warm up at work rate 6km/h and then increased incrementally by 1km/h every 1min until the subjects were unable to continue. In three subsequent next days's subjects performed two warm up protocols (moderate and heavy intensity) and without warm up randomly (cross design) before sub maximal exercise training (6min at 80% VO_2 at LT). The heavy intensity warm up was running on treadmill by 6min at 50% of the difference between the VO_2 at LT and VO_2 max [LT+ 50% (VO_2 max - LT). The moderate intensity warm up was running by 6min at 80% the VO_2 at LT [10]. The both two protocol of warm up was continued by 3min running at 3km/h before the sub maximal exercise is performed. Pulmonary gas exchange was measured breath-by-breath throughout all tests by Gas Analyzer (k4b2, Italy).

Data Collection

In this study for determination of third time constant of VO_2 kinetics (time of reach to 95% of total oxygen uptake) was used [11]. Also because the total oxygen uptake was not similar after three warm up protocols, we calculated VO_2 to time of reach in third time constants ratio.

Statistical Analysis

The effect of prior exercise on the VO_2 responses was compared using one-way repeated measures Analysis of Variance (ANOVA). When a significant difference was detected, this was further examined by post hoc LSD test. A P value of 0.05 was considered statistically significant. All statistical analyses were performed with using SPSS 16 soft were (Statistical Package for Social Science).

Result

The total oxygen uptake and third time constant values (O_2uptake, time of reach to third time constant and VO_2/t) are presented in Table 2. The result showed, total VO_2 uptake were not significant difference after three conditions (p=0.055). Third time constants significantly reduced due to without warm-up (p<0/001). also oxygen uptake/time ratio in third time constants increased significantly after moderate and heavy warm up due to without warm-up (p<0/011)(Figure 1).

Table 2: Oxygen uptake kinetics (Mean ± SD) in different stage of test.

		Without warm up	Moderate intensity warm up	Heavy intensity warm up	P value
Total oxygen uptake (ml)		1759.5±116	1757.9±158	1628.4±102	0.055
Time constant 3	O_2 uptake(ml)	1674.5±113	1670±150.3	1547±97.8	0.059
	Time to reach (second)	227±69	123.1±28.5*	129±18.9*	0.001
	O_2uptake/time of reaching	7.37	13.56*	11.99*	0.011

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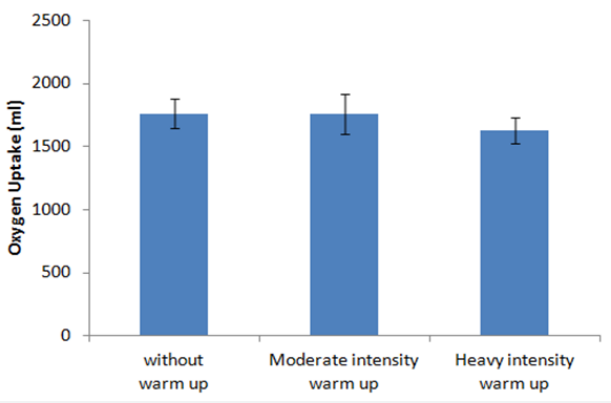

Figure 1: Total Oxygen Uptake after No Warm Up, Moderate Intensity and Heavy Intensity Warm-Up.

Discussion

The present study demonstrated that oxygen uptake in the end of sub maximal exercise after heavy intensity warm up was reduced, but was not significant difference after three conditions (p=0.055). The endurance players reduced oxygen uptake in the end of exercise case improved performance. Warm-up exercise resulted in a reduced O_2 deficit. A lower O_2 deficit implies a smaller requirement for energy production from anaerobic sources and is consistent with the lower rate of accumulation of blood lactate measured in sub maximal exercise [1]. Regarding to results of the present study can be said to reduction in time constant significantly have reduced oxygen deficit and accumulation of metabolites and phosphorylate substrate. This expression can be supported, because total oxygen consumption was reduced at the end of exercise after heavy intensity warm up than moderate intensity warm up and without warm up. So heavy intensity warm up probably is caused reduction in oxygen consumption and improvement in movement economy in sub maximal training. Because total oxygen consumption wasn't quite the same in three warm up condition, in this study we used the oxygen consumption time constant ratio (O_2 uptake/ time of reaching), in fact these results confirmed findings what be related to time constant and also previous results that warm up can reduce time to steady state phase of VO_2, and slope of diagram of VO_2 was faster and in the less time more oxygen can be consumed. So O_2 delivery to active muscle may be was one of the restrictions VO_2 kinetics during acute training, and warm up faster of the VO_2 kinetics through increased the muscle blood flow and oxygen availability [12]. Then the effects of warm up on the acceleration of VO_2 kinetics can be vasodilatation; improve blood flow, right ward shift of the O_2Hb dissociation curve, improved O_2 off-loading from haemoglobin and improving the diffusion gradient for O_2 between the capillary blood and the mitochondria of the exercising muscles [13]. Increase in oxygen availability at the beginning of exercise due to warm up cause faster stability of the intracellular and better metabolic control [14,15]. There is also evidence that warm-up exercise reduces the magnitude of phosphocreatine depletion during high exercise and increased mechanical efficiency of working muscle consequent to an elevated muscle temperature [12]. Also warm up reduced of accumulation lactate due to increase of oxygen available [8]. Therefore this study showed that warm up without intensity improved VO_2 kinetics and oxygen uptake, and author decrease O_2 deficit and improved performance.

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