

Comparing the trend of changes in oxygen pulse (RH/VO²) during maximal exercise after severe and moderate warming in women basketball players

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Abstract

As an indicator that carries oxygen through the circulatory system, oxygen pulse has recently been considered in clinical and exercise studies. There is no a lot of information about performance of the cardiovascular evaluator index. This study aims to compare trends of oxygen pulse (VO² / RH) during maximal exercise after moderate and severe warming in women basketball players. For this purpose, there were purposely selected seven women basketball players among players of basketball teams in League 1 of Tehran with average age of 21±1.52 years old, mean height of 166.8±3.72 cm, weighing average of 60.85±5.76 kg, body mass index of 21.71±1.72 kg/m² and peak VO² of 44.1±3.40 mL/kg/min with average of 6 years' experience in basketball. After seven minutes of stretching exercises, each subject performed two warm up protocols before maximum exercise on two different days with 72 hours pause. The indicators of oxygen volume and oxygen pulse were measured using the device of breath-to-breath analysis. The research results showed that oxygen pulse during maximum exercise after intense warming has higher significant average than mean warming in times 0, 3 and 6. Accordingly, coaches should note that athletes should choose one of warm-up levels based on their physical fitness.

Keywords: Basketball, breathing indicators, consumed oxygen, heart rate, oxygen, warm-up intensity.

INTRODUCTION

Today, coaches, teachers and athletes must be familiar with subcategories of sport sciences to be success. They should use the information to improve their performance. Physical education has achieved much progress by emphasizing on sciences such as physiology, biomechanics, biochemistry and nutrition and found some factors affecting success in various sport fields. Practice principles are the most important of the subdivisions. An interesting matter for athletes, coaches and even those who only simply exercise to maintain their health is that how to start sporting activities, training or race is important. Although in the past decade, it was recommended that athletes spend a few minutes for warming or basic training, before starting heavy training session or race, but results of

some studies have made that there is no consensus about severity and duration of preliminary activities (2). Today, athletes consider warming up as a part of their profession and believe that warming up in training and competition helps them to act with better physical and mental fitness and prevent injury during exercise. Warming up the body is one of the most important factors in improving exercise performance(9). The main purpose of warming is to increase general body temperature and deep muscles. Physiologically, it has been proven that raising body temperature increases releasing oxygen from hemoglobin, Myoglobin, increasing blood flow to muscles, increasing sensitivity of nerve receptors and speed of nerve impulses, reducing oxidation energy in fuel reactions and reducing muscles' viscosity (6).

Warming up increases body core temperature, performance in blood circulation and respiration systems and metabolic processes (2). Metabolic acidosis caused by severe warming up is necessary to change oxygen consumption graph (VO_2) in main training. The remained acidosis after intense preliminary exercise causes vasodilatation and increasing muscle release (perfusion) and compensates lack of available oxygen at the beginning of next exercises (6). Importance of the consumed oxygen volume as indirect indicator of cell respiration, energy cost and movement economy has caused that many researchers study factors affecting quantity (volume) and quality (rate) (15). Several studies have shown beneficial effects of severe warming up in exercise among athletes. They reported that warming up improves performance through variety of mechanisms including stimulating blood flow, increasing oxygen consumption, increasing maximum heart rate, increasing coordination between motions, increasing muscle temperature and muscle metabolism process (15).

Warming up increases oxygen consumption of the body entirely, oxidative phosphorylation reaction, oxygen delivery, blood temperature and flow and facilitates oxyhemoglobin analysis (5). Warming up before main exercises increases muscle temperature, stimulate mitochondrial respiration and physical activity respond to oxygen reduction because of increasing blood flow (6).

The research results showed that daily physical activity and exercises have a close relationship with cardio-respiratory. Cardio-respiratory fitness is related with various factors such as age, gender, genetics, risk factors for cardiovascular disease, some medications, quantity and quality of daily physical activities, smoking, obesity and nutrition (11). In recent years, exercise tests to estimate the maximum oxygen pulse and VO_{2max} are valid ways to assess performance of the suggested cardiovascular- respiratory system (1). The maximum oxygen pulse is a precision method to measure functional capacity of the cardiovascular system. It is an index that has been recently introduced in clinical studies. The oxygen pulse is an index that is studied beside other factors of measuring cardiovascular function. The maximum oxygen pulse refers to rate of the transferred oxygen volume through blood and intake by peripheral tissues (muscles)

during sub-maximal and maximal exercise activity, which it is calculated using the ratio of maximum oxygen consumption to maximum heart rate when performing a specific activity (14). Association and other authors reported that oxygen pulse for healthy people at once physical work is 10-15 ml, while it is more than 20 ml for the trained athletes (16).

Studies on oxygen pulse are related about its relationship with athletes' performance or merely its measurement in non-athletes, especially the middle-aged and elder people as an indicator of cardiac fitness. Given the importance of oxygen pulse to determine the consumed oxygen and due to the importance of cardio-respiratory fitness and obesity index in inflammatory factors, it seems that conducting a research on oxygen pulse is necessary (8). Given the multiple achievements of researchers about warming effects on how to implement exercise and due to the focus of the studies on physiological and metabolic states as well as lack of sufficient attention to its severity and effect on athletic performance, the necessity of warming up before main activity and suitable type of program to warm up improve oxygen delivery to the trained muscles. It has been considered as a subject matter by researchers, coaches and athletes.

As a result, it is attempted that studies show evidence about the best type of warming up for specific types of exercise such as long-term maximal exercise, severe short-term exercise, and exercises that require correct motion control. Examining the effect of warming up intensity with different patterns on respiratory parameters can explain new dimensions of effects of the activities in exercise implementation.

MATERIALS & METHODS

Subjects

In this study, there were purposely selected seven women basketball players among players of basketball teams in League 1 of Tehran with average age of 21 ± 1.52 years old, mean height of 166.8 ± 3.72 cm, weighing average of 60.85 ± 5.76 kg, body mass index of 21.71 ± 1.72 kg/m² and peak VO_2 of 44.1 ± 3.40 mL/kg/min with average of 6 years' experience in basketball.

Research Tools

To ensure athletes' health, there was prepared and distributed a questionnaire among them. Respiratory indices were measured using respiratory gas analysis

device ZAN600, made by Germany. To assess body composition, there was used In Body composition device, version Venus 5.5, made by South Korea.

Method of Collecting Data

After conducting preliminary works, namely developing a questionnaire, there were described aim of this study and its conducting method for athletes in a separate meeting. Each participant referred to Institute of Physical Education and Sport Sciences for three separate meetings. In the first session, all subjects conducted incremental test on treadmill to the point of exhaustion to determine peak oxygen consumption (VO₂ peak).

In two subsequent refers, after seven minutes strength training, each subject performed two warm-up protocols (moderate and severe warming up) before maximal exercise on two different days (15):

- ✓ *Moderate warming up protocol:* Six minutes running on treadmill with 65% of maximum heart rate;
- ✓ *Severe warming up protocol:* Six minutes running on treadmill with 85% of maximum heart rate

Exercise maximal protocol: Balk & Weir (3) on a treadmill was used to implement maximal incremental protocol. From warming up time to maximal exercise, the subjects walked on a treadmill for three minutes at speed of 3 km/h to prevent effects of increasing heart rate on the main sport. All activities were performed on a treadmill connected to the device of respiratory gas analysis. During exercise, there were collected indicators of breathing and heart rate of subjects at all stages of activity as breath-to-breath. In the three stages of warming up, there were measured active recovery and maximum exercise for all studied variables including oxygen consumption and oxygen pulse.

When performing maximal exercise, the related variables were recorded and compared in three-minute intervals.

Statistical Method

Descriptive statistics were used to analyze the data statistically; t-test was used to compare means. The significance level was considered as p< 0.05 for all calculations.

RESULTS

Table 1. General characteristics of subjects.

Variables	Mean	Min	Max
Chronological age (years old)	21 ± 1.52	20	24
Body mass (kg)	60.85 ± 5.76	50.7	65.8
Height (cm)	166.8 ± 3.72	150	178
body mass index (kg/m ²)	21.71 ± 1.72	18.60	23.70
Peak VO ₂ of mL/kg/min	44.1 ± 3.40	37.9	48

In times of 0, 3, 6 and 24, there are significant differences between changes of VO₂ consumption during maximal exercise after moderate and severe warming up in women basketball players. Meanwhile, in other times, there are no significant differences between changes of VO₂ consumption during maximal exercise after moderate and severe warming up in women basketball players. In other words, oxygen pulse during maximum exercise after intense warming has higher significant average than mean warming in times 0, 3 and 6. However, VO₂ volume in maximal exercise after intense warming has higher significant average than mean warming in time 24.

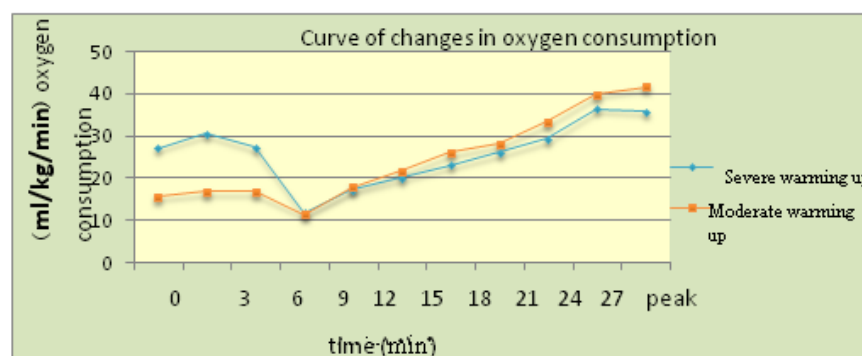


Figure 1. The difference in oxygen consumption at different times after severe and moderate warming up.

Table 3. Descriptive statistics of variable of oxygen pulse in different times after severe and moderate warming up activity.

	Statistics Time	VO ₂ /HR (ML/bpm)	
Warming up	0	51.1 ± 23.12	4.3 ± 3.17
	3	93.1 ± 33.13	75.1 ± 35.18
	6	17.2 ± 33.13	44.1 ± 37.16
Recovery	9	12.10 ± 0.86	90 ± 88.9
	12	58.1 ± 73.13	79 ± 81.12
Maximal exercise	15	95.1 ± 34.15	84.13 ± 12.1
	18	92 ± 32.16	65.15 ± 2.2
	21	77.1 ± 93.16	29.1 ± 35.15
	24	65.1 ± 57.18	63.1 ± 39.16
	27	35.2 ± 4.21	57.2 ± 51.19
	Peak	93.1 ± 64.21	37.2 ± 53.19

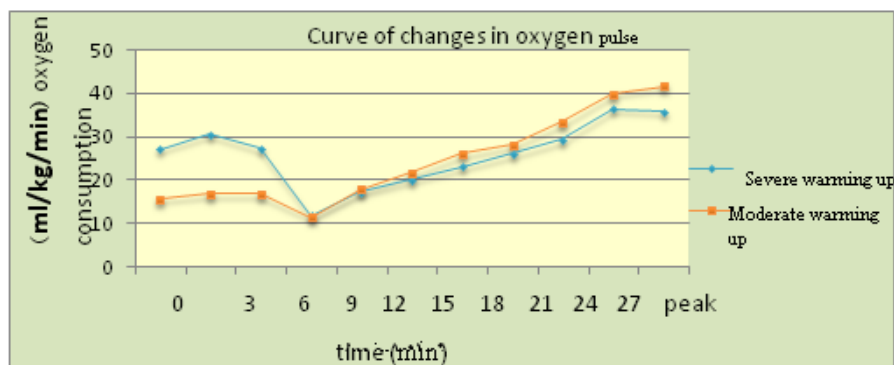


Figure 2. The difference in oxygen pulse at different times after severe and moderate warming up.

Describing Variable of Oxygen Pulse during Exercise Different Times

The time 0 refers to the start time of warming up protocol with the desired intensity. In fact, to achieve the desired intensity, subjects should act on treadmill and when heart rate received to the desired range, protocol of warming up would be started.

The research hypothesis: There is no significant difference between the trends of oxygen pulse (VO₂/HR) during maximal exercise after severe and moderate warming up among female basketball players.

According to p-value and t-value in Table 3, there is a significant difference between times of 0, 3, 6, 21 and 24 in changes of oxygen pulse during maximal exercise after severe and moderate warming in women basketball players. Meanwhile, in other times, there are no significant differences between changes of oxygen pulse during maximal exercise after severe and moderate warming in women basketball players. In other words, oxygen pulse during maximum exercise after intense warming has higher significant average than mean warming in times 0, 3 and 6. However, VO₂ volume in maximal exercise after intense warming has higher significant average than mean warming in times of 21 and 24.

Table 3. Changes in oxygen pulse during maximal exercise after severe and moderate warming up.

	Statistics Time	Moderate warming up	Severe warming up	df	t	p
Warming up	0	12.23 ± 1.51	17.03 ± 3.04	6	-3.57	0.012*
	3	13.33 ± 1.93	18.35 ± 1.75	6	-5.70	0.001*
	6	13.33 ± 2.17	16.37 ± 1.44	6	-3.21	0.018*
Recovery	9	10.12 ± 0.86	9.88 ± 0.90	6	0.4	0.703
Maximal exercise	12	13.73 ± 1.58	12.88 ± 1.59	6	1.305	0.240
	15	15.34 ± 1.95	13.84 ± 1.12	6	1.882	0.109
	18	16.32 ± 0.92	14.65 ± 2.02	6	2.238	0.067
	21	16.93 ± 1.77	15.35 ± 1.29	6	2.490	0.047*
	24	18.57 ± 1.65	16.39 ± 1.63	6	2.820	0.030*
	27	21.04 ± 2.35	19.51 ± 2.57	6	2.303	0.061
	Peak	21.64 ± 1.93	19.53 ± 2.37	6	1.665	0.147

* p < 0.05

DISCUSSION

The research results showed that oxygen pulse during maximum exercise after intense warming has higher significant average than mean warming in times 0, 3 and 6. Warm up with maximum severity has a slightly more impact on indices of $v\text{VO}_2\text{max}$ and VO_2max . Anna Lee et al. did not report a significant difference between warm up and non-warm up protocols in VO_2max (4). Nicole et al reported higher values of VO_2max after severe warming up with 80 percent of maximum heart rates, compared to conventional warming up (13). It seems that high VO_2max after severe warming up is the result of improving transport and delivery oxygen to the skeletal muscle by increasing stroke volume, increasing capillary density and mitochondrial and increasing oxygen uptake by active muscles (4). Bishop et al. examined the effects of warming up with various severities of 60%, 70% and 80% of maximal oxygen uptake compared to warming up body on range of motion and anaerobic performance. They reported higher VO_2max in maximum intensities compared to run without warming up (10). In protocol of the present research, average of oxygen pulse rate during maximum exercise is significantly higher after severe warming up.

It seems that if our purpose is to achieve VO_2max in more favorable $v\text{VO}_2\text{max}$, mechanisms associated with improving endurance performance of warming

up will include reducing interference of anaerobic metabolism at start of practice, increasing lactate threshold, increasing conditioning threshold, improving anaerobic power, increasing consumption of lipids and preventing depletion of glycogen. These findings are consistent with the obtained findings by other researchers on increasing VO_2max in warming up with 70% maximum heart rate (12).

Increasing call of motor units will lead to increase power, higher performance and better muscle coordination. It delays fatigue of athletes and enables them to sustain higher levels of lactate (12). These findings are consistent with the obtained findings by other researchers (2). Oxygen pulse is the ratio between maximum oxygen consumption to heart rate peak that is used in evaluation of cardiac fitness and athletic performance. Factors affecting oxygen pulse include age, height, hemoglobin, blood volume, lean mass, body mass, body size, activity level and physical fitness (16). In their research, Zoladz et al. reported reducing stroke volume in adolescents and young people as the reason of decreasing oxygen pulse (17). The researchers stated that by reducing stroke volume, arterio-venous oxygen difference in low intensity will receive to its maximum value. The conducted studies by Abbasi & Tartibian are consistent with the present research (1). Of course, authors believe that consuming some certain medications, changes in temperature and pressure are effective in this matter significantly.

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