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The impact of 3 months workout on cardiovascular capacity of a female amateur cross country skier. Case study

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ABSTRACT

The efficiency in cross-country skiing commit considerable physiological challenges posed by the combined upper- and lower-body effort of varying intensity and duration. Extremely important for the effectiveness of the work is the ability to draw energy from the processes of aerobic and anaerobic metabolism maintenance work as low as possible during prolonged exercise. The workout should increase maximal aerobic power and the metabolic potential of the muscles. High-intensity exercise is the most important to initiate this change, while low- and moderate-intensity effort allow appropriate muscle adaptation. Monitoring and evaluation of these physiological changes is mandatory in the process of training, in amateur cross-country skier too. Amateur marathons are becoming increasingly popular. This has been an impulse for analyzing the results obtained by the amateur athlete during the preparatory period. The purpose of this retrospective case study was to describe changes in cardiovascular capacity for three months period of an amateur cross-country skier (age = 39, BMI = 20,9). This study based on analysis of source materials, obtained from conducted individually by the athlete registration process of training, the results from test to refuse and the results of measurements of body composition performed in the laboratory functional studies for three months period (preparation period). The results show inter alia increase in maximal oxygen uptake, lactate threshold shift towards higher loads and decrease body weight. This parameter was significantly lower than the performance in highly qualified competitors, but individual changes between the first measurement and the second one was similar. This review summarizes research on amateur cross-country skier. We have the chance to improve our understanding of the impact of various exercises on the human body by analyzing the results from workout monitoring of endurance athletes.

Keywords**:** cross-country skiing, cardiovascular capacity, amateur, oxygen uptake

1. INTRODUCTION

Competitive cross-country (XC) skiing has traditions extending back to the mid-19th century and was included as a men's event in the first Winter Games in 1924 [1]. Since then, changes in equipment, designation track and its preparation, and physiological knowledge about training have stimulated increases in XC-skiing speeds. The popularity of this sport has also increased too, most of all in amateur group and races. Worldloppet races are becoming increasingly popular. Vasaloppet in Sweden, in among Birkenkeinerrenet in Norwegian, LaSgambeda and Marcialonga in Italy, belongs to the elite of this racing. The main start in Vassalopet involved almost 16 000 participants. Only about 2,000 of them are professionals. Seems to be interesting that females had a more even pacing profile than that of males with the same finish time, start group, age, and race experience [2]. This result shows how important are non-professional participants, whose annual capacity increases are increasing from season to the next one. The best competitions are still Scandinavians, but it is having been change. The sharing knowledge from them gives chance to increase endurance possibilities to another amateur competitor from other countries. This group divided leisure time for rest, family, and training, but work is still the most important for them and it takes the most time during the day. Despite this, the fundamentals of the macrocycle are not different from the professional ones. They trained as much as possible, with increased intensity during the autumn, while less work but more ski-specific training and competitions were done during the start season. Until the 1970s, few XC skiers were women, whom coaches believed tolerated less training than men did [3]. The impact of both science and the systematic approaches of former athletes and coaches have gradually taught XC skiers to adopt smarter, more goal-oriented training practices. Although the very high VO2max of world-class XC skiers has remained the same since the 1960s, new events in modern XC skiing have additionally required superior upper-body power, high-speed techniques, and tactical flexibility [4]. These elements also emerge in the training of today amateur. This review summarizes research on amateur, woman cross-country skier. Women's participations in marathon races is steal growing. The physiological capacities and training routines especially seem to have improved significantly so it seems very important to know and describe these changes.

2. MATERIAL AND METHODS

Participant

The women was 39 year old and she training incessantly from two years. In the past, when she was 15 years old, she was a competitor and she attended school athletic. When she was 20 years old she stopped train, and re-launched as an amateur at the age of 37. The participant was the owner of your own business. This gave the opportunity for constructive adaptation of the training plan for everyday life. The main assumptions of the season were the best participation in marathon starters and especially at Masters World Cup 2017. In this competition, she was 5th on 10 km classic race and 7th on 30 km classic race. The training volume describe preparation period in macrocycle 2016/2017.

Training load

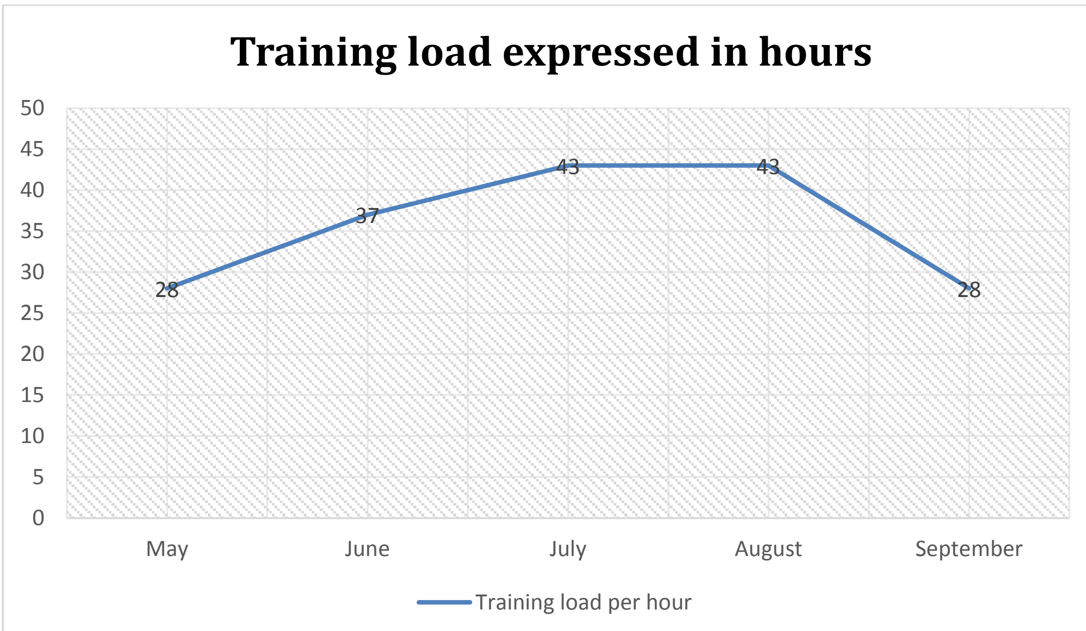

Figure 1. Size of training load parameters in hours in months

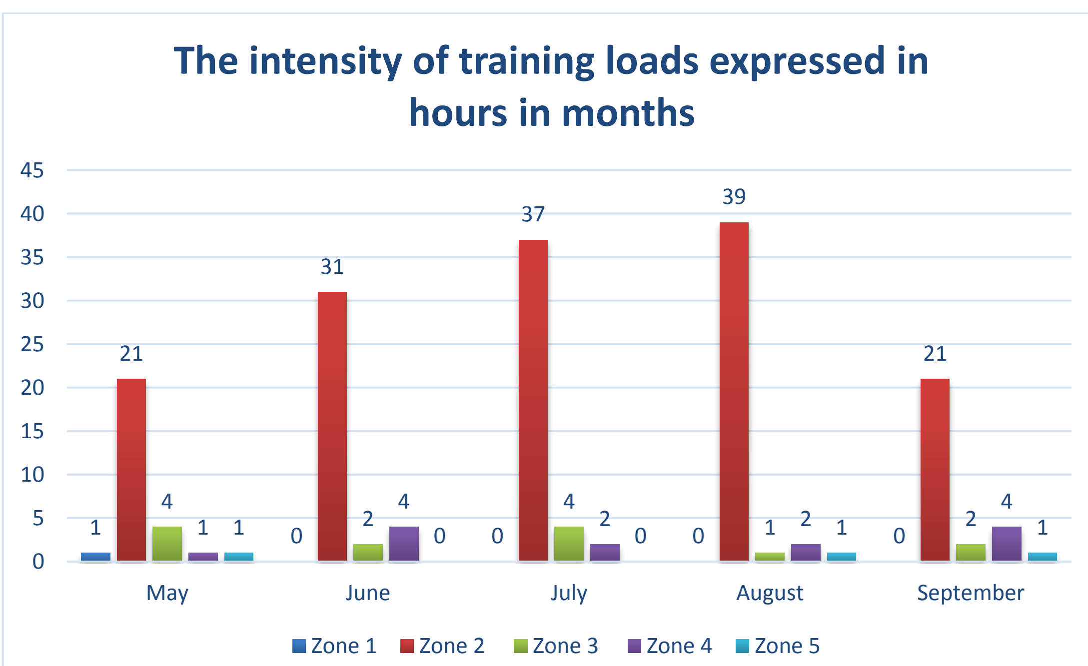

Figure 2. The intensity of training loads expressed in hours in months

The source materials acquired the run individually by the competitor recording the training process and results of tests endurance and body composition measurements carried 19.06.2016 and 27.09.2016 during the exhaustion trial in physiology laboratory. The summary included training volume and intensity of loads, their specificity due to the character of measures workout.

Table 1. Size of training load parameters for individual exercise zones determined based on individual fitness test after the exhaustion trials

The effort zone	Heart rate per minute after 1st test	Running Speer after 1st test Km/h	Heart rate per minute after second test	Running Speer after second test Km/h
First zone - AR **Active regeneration**	125 - 144	8 – 10	128 - 153	8-10
Second zone - LI **Low intensity**	145 – 156	10 – 11	153- 164	10- 11,5
Third zone- MI **Moderate intensity**	157 – 167	11 – 12	164- 176	11,5- 13
Fourth zone - HI **High intensity**	168 – 173	12 – 13	176- 182	13-15
Fifth zone- VHI **Very high intensity**	More than 173	More than 13	More than 182	More than 15

In the first zone was executed active regeneration workout, for example: swimming, stretching, core stability training. In the second and third zone were performed jogging, strength training, roller ski, cycling on moderate intensity. In the fourth zone were done exercise wit high intensity, for example: workout above anaerobic threshold (interval, competitions). In the very high zone participant performed intensive interval.

Body weight measurement

Body composition was measured by using impedance weight Tanita Body Composition Analyzer BODY IN 220 consisting of 8-point tactile electrode system. The survey was carried out before the start of each exercise. Measurements: weight, water content, minerals, vitamins, body fat (% and kg) and SMM (Slimm mass muscle in% and kg) indicators WHR (waist this hip ratio) and BMI (body mass index). This article include weight, BMI, body fat mass in kilogram and percent. Athlete joined the exercise test after completing the measurements.

The exhaustion trials

The exhaustion trial was performed on a treadmill using HP COSMOS CPET equipment and ergospirometr Cosmed Quark/k4B2 two times. First one was on May and the second one was on September. The output load was speed of 8 km / h. Every 3 minutes speed increased for another 1 km / h, with an interval of 30 seconds to draw blood. The test lasted until the refusal of effort. The physiologist made the collection of capillary blood from the fingertip in order to determine the concentration of lactate (LA) in the blood with the analyzer Biosen Dr Muller Super GL during the test. Before starting an exercise, test parameters were determined rest of the test. To determine the resting blood lactate level (pHsp) determined its level before and after the exercise test. On the rest were monitored: heart rate (HRsp), blood pressure, minute ventilation (VE) and the volume of oxygen consumption (VO2). After completing the measurements of resting athlete joined the exhaustion trial. During exercise measured the following parameters: speed (km / h), the load on the threshold of anaerobic - AT (km / h), oxygen uptake - VO2 (L / min), maximal minute oxygen uptake - VO2max (ml / kg / min), minute oxygen uptake on the lactate threshold - VO2 AT (ml / kg / min), the percentage of maximal minute oxygen uptake on the threshold of change oxygen -% VO2max on the threshold AT, the maximum minute ventilation - VEMAX (l / min). ratio respiratory exchange - RERmax (VCO 2 / VO 2), maximum heart rate - HRmax (thigh / min), the heart rate at the threshold of alternating aerobic - HR AT (ud / min), stroke volume - O2 / HR (ml), changes in the acidification acidification maximum - LA max (mmol / l), concentration change ΔLA lactate (mmol / l) and a change of acidity after 12 minutes after the end of exercise ΔLA res 12 '.

3. RESULTS

The first exhaustion trial took place on 19.05.2016. The investigator continued the effort to 16 minutes. Maximum speed reached at 15 km / h. Maximum ventilation was 127 l / min. It was obtained with a breathing volume of 2.9l. The respiration heart rate was 56 breaths per minute. Heart rate at the time of interruption of the exercise test was 184 bpm. The anaerobic threshold (AT) was reached after 10 min of exercise, at a speed of 12 km / h. Oxygen uptake at the anaerobic threshold was 45 ml / kg / min, while the heart rate at 167 bpm. Alternating aerobic threshold (LT) was obtained at a power of 10 km / h and heart rate of 144 bpm. Maximal oxygen uptake of VO2 on the aerobic threshold reached 38 ml / min / kg. The second exhaustion trial took place on 27.09.2016. The investigator continued the effort for 16 minutes. Maximum speed reached at 15 km / h. Maximum ventilation was 106,6 l / min. It was obtained with a breathing volume of 3,0L. Heart rate at the time of interruption of the exercise test was 182 bpm. Maximal oxygen uptake of VO2 on the aerobic threshold reached 44,5 ml / min / kg. The average parameters were slightly different. Maximal speed was 15 km/h, speed on AT- 12,5 km/h, Vo2max 50,25 ml/kg/min (table 2) and body weight 58,95 kg and fat tissue (%) 15,5. The largest decreased were recorded in fat tissue (%) and maximal ventilation (table 1 and 2). The largest increases were recorded in Vo2 on AT, and smaller in Vo2max and HR on AT. There were no significant changes in the maximal speed parameters.

Area 3% decrease were observed changes in body weight and BMI. Speed on AT and Vo2max on AT rose. The test results and body composition were shown on the Table 1-2.

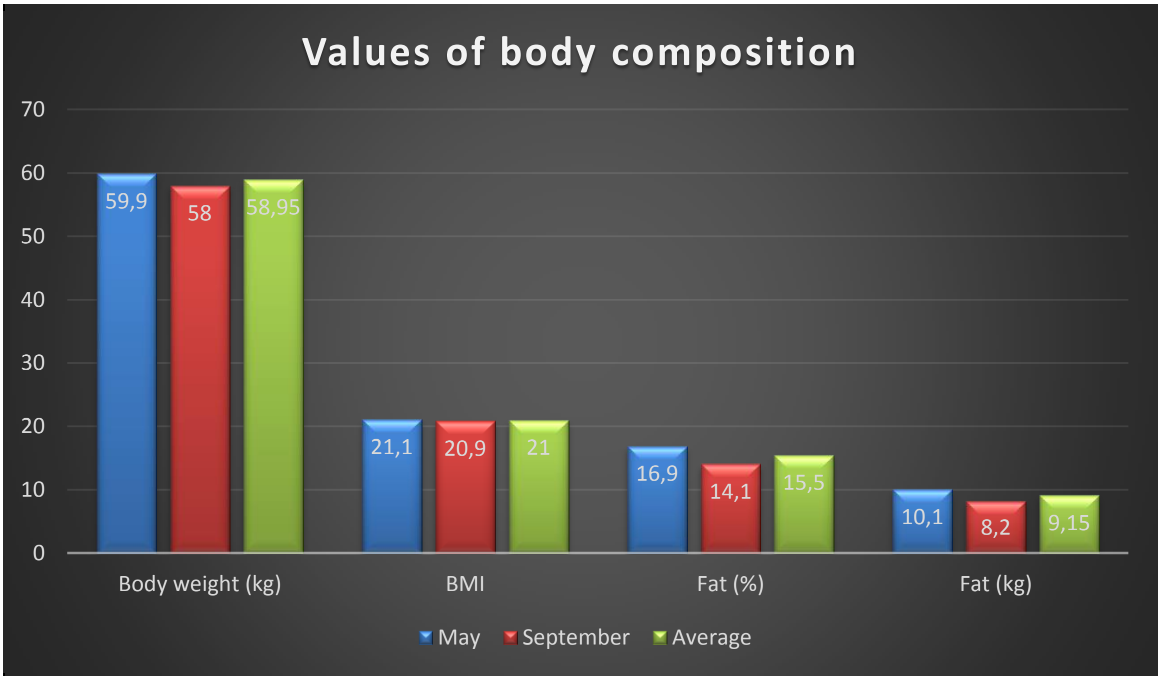

Figure 3. Values of body composition and anthropometric indices

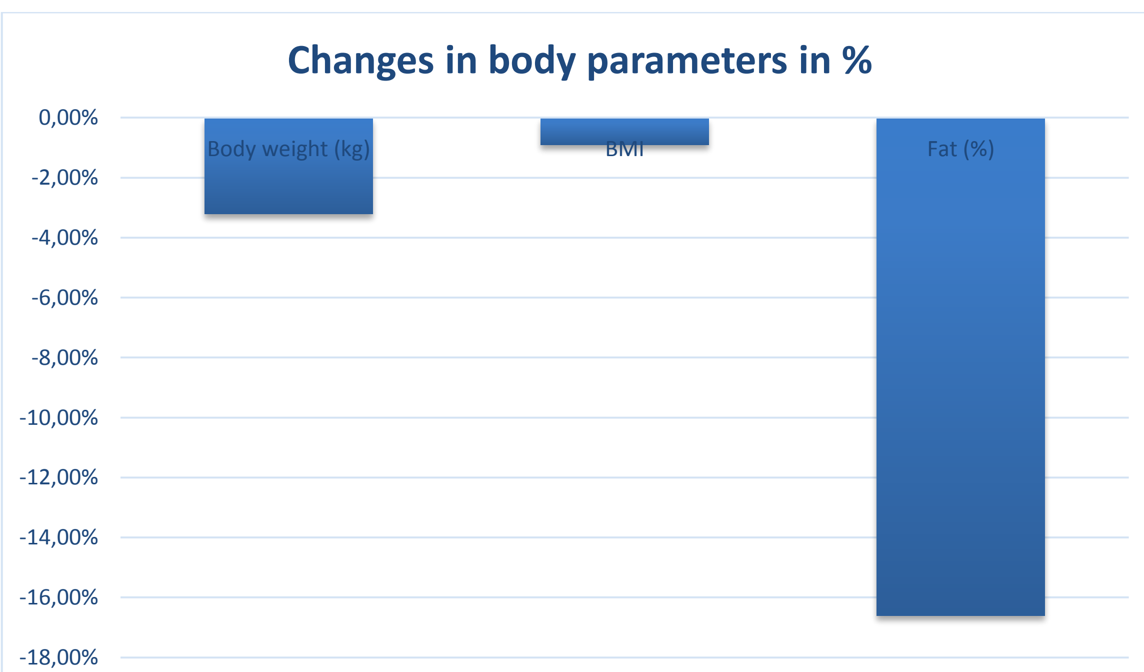

Figure 4. Changes in body parameters in %

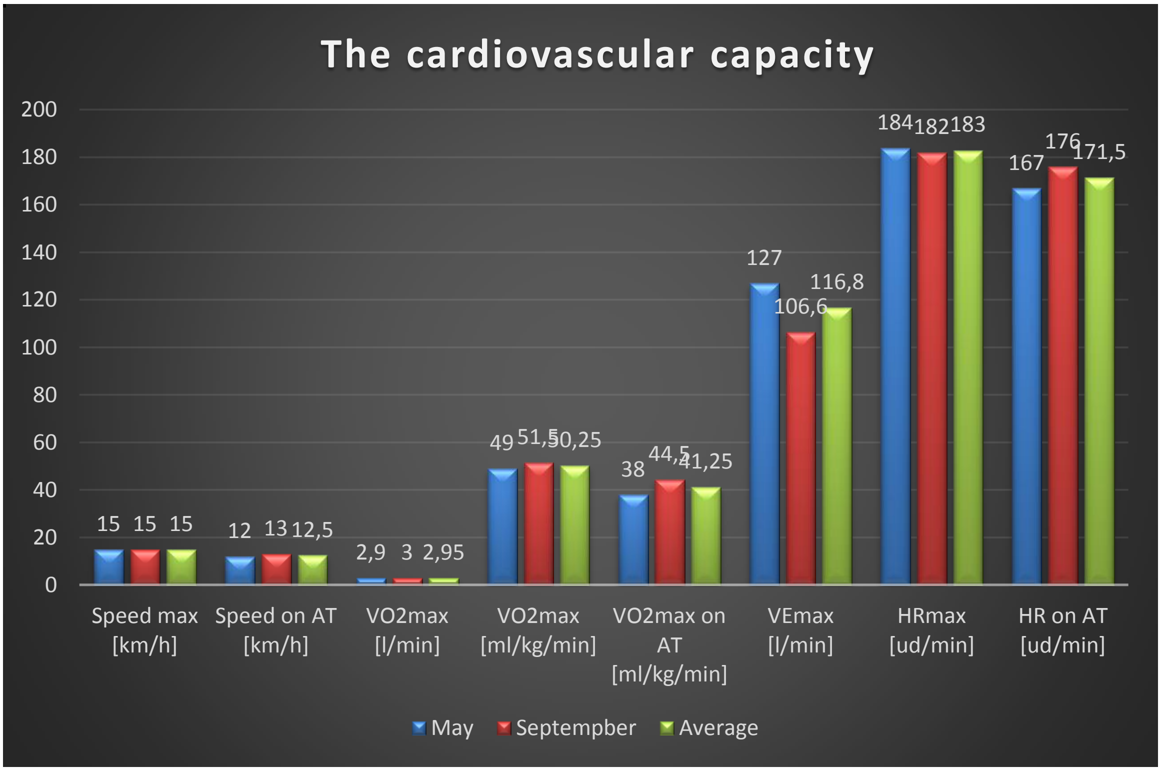

Figure 5. The cardiovascular capacity parameters and run speed

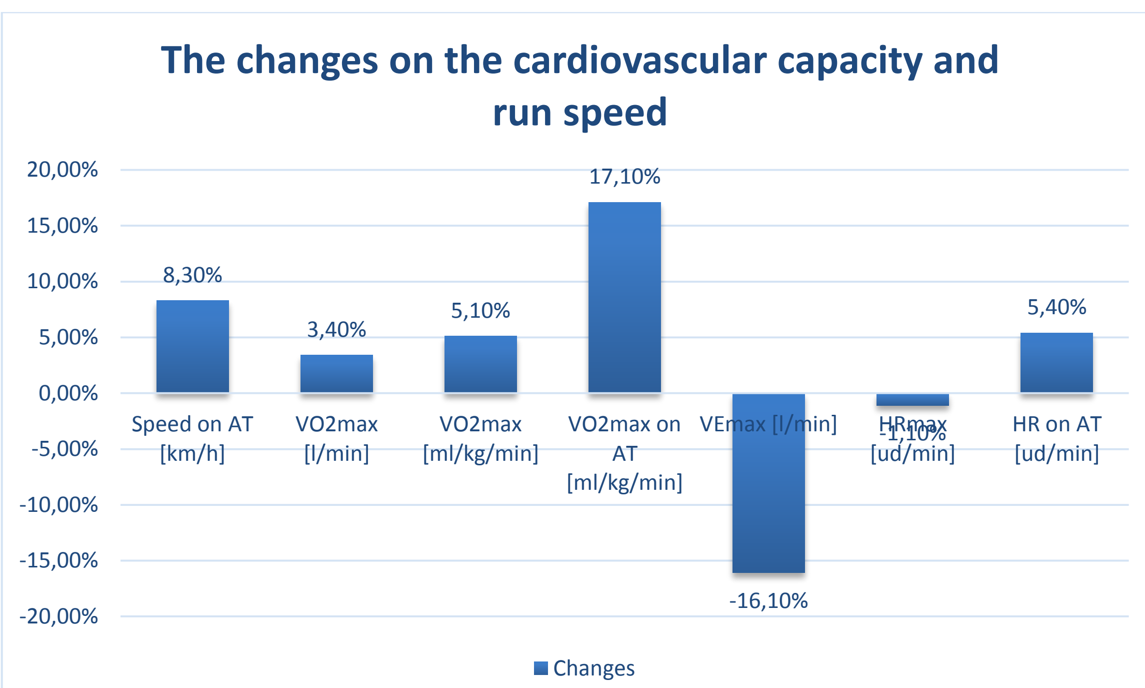

Figure 6. The changes on the cardiovascular capacity and run speed

VO2max - maximal oxygen uptake, VEMAX - maximal minute ventilation, RERmax - the maximum respiratory exchange rate, HRmax - maximum heart rate, HR - heart rate

4. DISCUSSION

The output value of the first test

The VO2max value achieved by the test of 49 ml / min / kg can be attributed to good values in amateur group. But it was significantly slower than in professional group, where average Vo2max reached 71.5 ±6.4 $mL \cdot min^{-1} \cdot kg^{-1}$ [5]. Elite cross-country skiers exhibit exceptionally high aerobic power, both absolute (L/min) and relative (mL/kg/min) and, indeed, few male skiers have won medals in a major championship with VO2max values of less than 6 L/min or ~80–90 mL/kg/min [6]. Female skiers demonstrate ~10% lower values, some reaching ~75 mL/kg/min [7].

However, the overall adaptation of the body to the effort is, however, assessed as average. Despite good oxygen metabolism capacity, the tester achieved metabolic thresholds at relatively moderate speeds. This is directly related to the high energy cost of the work done. Exceeding the threshold at speeds equal to 10km / h for LT and 12 km/h for the AT starts and intensifying anaerobic processes of acquiring energy already at moderate intensities of work. This causes negative changes that lead to fatigue and end of exercise [8]. The cardiovascular system responded to the load on a regular basis. It showed a linear increase in heart rate. Good level of minute ventilation demonstrates respiratory function (respiratory muscles). The lactate curve confirms the low cost of labor (high cost) [9].

The researcher obtained high concentrations of this metabolite at low absolute load values. Considering the absence of lactate decline in the postprandial period, the researcher has poorly developed mechanisms responsible for its utilization. In contrast, during the post-exercise heart rate normalized efficiently.

The second exhaustion test

The results from the second exhaustion test indicate impact of physical effort on cardiovascular capacity and changes in this aspect. The maximum oxygen saturation (VO2max), which is one of the indicators of aerobic performance, was 3.0 l / min (global value), the relative value of this indicator (values per kilogram body weight) was 51 51 ml / kg / min, which is a very good level for age and gender for ACSM trainees. Professional players tolerate workout at the level of intensity up to 95% VO2max [10]. In the test, there was a 5,1% increase. Norwegian researchers give the opportunity to 8% VO2max value changes in time so the results are similar [11].

Maximum ventilation (VE), which is one of the indicators of respiratory fitness, was 106.6 l / min. It decreases in comparison with the first results. It is not typical and it could be results of illness or accumulation of mucus in the lungs. The maximum heart rate (HRmax) was 182 tpm. Endurance effort should reduce this value. It this research results decrease on 1,1%, the same as in T. Losnegard study [12].

Oxygen threshold (LT) is characterized by an effort load of 86% VO2max. It significantly increases on 17,1%. The increase in lactate thresholds has implications for the subsequent use of anaerobic energy substitutes, such as glycogen and phosphocreatine, and the nature of the resources for aerobic exercise (fatty acids), which in turn increases the body's ability to exercise [13]. The physiological cost of working on the threshold of LT was 271 ml O2 / kg / km per kilometer of distance traveled. This is a high value [14,15].

This indicator characterizes the economics of running, indicating how many milliliters of oxygen per kilogram of body weight gets the body to overcome 1 kilometer distance. For those who practice strength training with a high degree of training, this can be as much as <180 ml O2 / kg / km of distance traveled. People with low running economy gain of >250 ml O2 / kg / km, which means that require large amounts of energy to run [16,17]. Training measures which improve running economy, efforts are mainly performed below the intensity threshold LT, exercise technique and speed to stabilize the trunk.

Body composition

In studies Sperlich and Stoogl [18] showed decrease in body weight in endurance sportsman 3.7% +/- 3%, during the 9-week workout (with VO2max at 62.6 ± 7.1 $mL \cdot min^{-1} \cdot kg^{-1}$). Body weight of researched woman fell by almost 3% and the fat tissue (%) decrease from 16,9 to 14,1. These results were similar like Sperlich and Stoogl but different like in Grzebisz [19]. Significant changes have occurred in the level of body fat (15.1% - 8.2%) in research Grzebisz, so it was a much greater decrease than the study. An average adipose tissue in Grzebisz research was 12.5%.

It was smaller than in this result (15,5%). The difference may be due to the amateur and professional survey, but in the Greek's female skiers had 14.2±1.9% body fat [20]. Long-term training with moderate intensity affects too fat loss and increases the maximum oxygen level. It could help protect the society from obesity and overweight [21]. It is also an effective means to reduce body fat and to protect sportsmen before the restrictive diets and eating disorders [22].

5. CONCLUSIONS

These findings indicate the weight of the body and the endurance component of the results of cross-country skiing. In addition, exhausted test predicts the results of cross country skiing also amateur. The analysis showed improvement in respiratory-respiratory parameters. The consequence of endurance training is to increase the maximum oxygen uptake of oxygen and lactate in the direction of larger loads. The exercise load applied improved the exercise capacity of the test by increasing VO2max and VO2 to the lactate threshold. Body composition decreases by reducing adipose tissue. This may influence VO2max. Approved methodology and type of research may be a practical and useful guide to evaluating VO2max for both professionals and amateurs. The methodology of these tests is easily accessible for and widely used in many countries. Despite it's more desirable to be specific tests for cross-country skiing or skiing on roller skis. Their advantage is the exploration of exercise capabilities in a specialized effort. Due to the growing popularity of amateur skiing, this knowledge can be increasingly sought. Long-term training with moderate intensity affects too fat loss and increases the maximum oxygen level. This knowledge can also be used in the prevention of obesity and overweight.

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