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THE EFFECT OF FITNESS EXERCISE ON ANAEROBIC POWER AND AEROBIC POWER

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Abstract. *There are many discussions about how to increase anaerobic power and anaerobic power capacity in cross-country skiing. Many scientists research the possibilities of increasing anaerobic power and anaerobic power capacity in this sport. The aim was to research the possibilities of increasing anaerobic power and anaerobic power capacity. A pilot study was carried out. Two BJSS "Arkādija" cross-country skiing specialization participants (15 years old girl (G) and boy (B)) participated in the study. The following methods were used in the study: test exercises (bench press, leg press, push up, pull down, pull up), WO2 max, Skierg Concept-2, Skierg Thorax and mathematical statistics. Fitness exercises used one month after that three month period of endurance exercise and last month fitness exercises again. The results: having stated the result difference before fitness exercises and after it. The participant G and B results difference in anaerobic power test was 48,7% and 37,1% and aerobic power test results was 39,8% and 32,4%. Conclusions: the obtained data from both BJSS "Arkādija" specialization participants prove that after the fitness exercise periods the results have improved. The results testify significant improvement of double pooling results on skiergs, what is showed by the difference of the mean results.*
Keywords: *anaerobic power, fitness, skiers.*

Introduction

The fastest stride of locomotion in cross-country skiing is double-poling, which is also the most economical, it is believed that maximum oxygen consumption (Vo_2 max) is reduced by about 20% for arms, but athletes can only develop a very high speed only for a short duration of time. This means that the muscles of the arms, the shoulder girdle and back muscles get tired fast and are unable to produce high-intensity sustained power of push-off (Stöggl, Lindinger, & Muller, 2007; Stöggl & Muller, 2009; Holmberg, Lindinger, Stöggl,

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Björklund, & Müller, 2006; Lindinger, Stöggl, Müller, & Holmberg, 2009; Camenisch, 2007). Studies have been carried out to compare the speed of movement on an even terrain and while ascending a hill, as well as were found the physiological changes due to the relief of the terrain and how it affects the speed of locomotion.

The maximum consumption of oxygen in the classic style of skiing ascending a hill increases per 5% compared to the even terrain, while in the glide step, both on the even terrain and ascending a hill, the maximum oxygen consumption is equal, although it is higher than the maximum consumption skiing in classic style on even terrain. It has been proven by many scientists (Mygind, Andersen, & Rasmussen, 1994; Holmberg et al., 2006). At the same time, Swedish scientists Berg and Forsberg believe that there is no difference in the maximum consumption of oxygen in classical style and glide step (Bergh & Forsberg, 1992). Swedish scientists carry out research on ski biomechanics and physiology in snow conditions, with rollers, and on a skiing exercise unit – "double poling ergometer". Research is still being carried out on various strides of locomotion to obtain data on the speed of the strides of locomotion, moving at maximum speed, changes in physiological parameters, performing each stride separately, and have been found various affirmations.

The speed of locomotion is believed to depend on the speed of the cycle, under the condition that the length of the cycle is kept. In order to achieve the maximum speed in stride of locomotion, the athletes change the subtleties of the correct stride technique, the consequences being that the movements are not economical (Lindinger et al., 2009; Camenisch, 2007). Particular attention is paid to the work of the hand and leg of the swing: the shorter the time of the swing, the faster the next push-off can be performed, as the result the speed of locomotion will increase. However, to be able to cover the distance at a constant speed as long as possible, it is necessary to improve the power of the push-off, respectively, to train muscle strength.

Several authors have also drawn attention to the work of relaxation and contraction of various muscles by studying integrated neuromuscular activity of the upper body during the push-off. At present, in order to develop strength and the manifestations of its power, more and more fitness workouts are being used in the training process, and as coaches tend to consider - general physical fitness.

Material and methods

Two 15-year-old twins took part in a pilot study: a male and a female. The male was 168 cm tall with a weight of 55kg, but the female was 170cm tall with a weight of 54.5kg on 20.05.2018. In its turn, during the second measurement on 20.06.2018 the male's height was 172cm, and weight was 59.2kg, but the female's

height was 171cm and weight - 57.8kg. The third measurement was performed on 15.10.2018, the male's height was 174cm and weight - 60kg, and the female's height was 172cm and weight - 58.8kg, but during the last measurement session on 11.11.2018 the male's height was 174cm and weight - 61kg, but the female's height and weight remained the same.

Both teenagers with ski sports have been engaged in sports school and outside for 4 years. In order to increase the work capacity in power expressions and in endurance, a program was developed at the beginning of summer for 3 weeks and in autumn for 1 month. In order to determine the strength indicators of both adolescents, test exercises were carried out: bench press, leg press, push up, pull-down and pull-up, as well as specialized tests for skiing on Concept-2 SkiErg: maximum aerobic power, maximum power and 100m sprint.

The test exercises were repeated several times to make sure that the result have increased. At the beginning of the summer period, a 3-week fitness workout was carried out, with a total of 9 training sessions of 90 minutes (see Table 1) and 12 training sessions of 90 minutes were held in the autumn.

Table 1 ***Summer and autumn training session program***

Training session	**Training1**	**Training 2**	**Training 3**	**Test Exercises**
Week 22	GPF 50% of the maximum	GPF 70% of the maximum	GPF 80% of the maximum	
Week 23	GPF to exhaustion	GPF 50% of the maximum	GPF to exhaustion	Test exercises
Week 24	SPF maximal, submaximal	GPF 80% of the maximum	SPF submaximal	Test exercises
Week 42	SPF and GPF submaximal	SPF and GPF submaximal	SPF and GPF submaximal	Test exercises
Week 43	SPF and GPF submaximal	SPF and GPF submaximal	SPF and GPF submaximal	Test exercises
Week 44	SPF and GPF submaximal	SPF and GPF submaximal	SPF and GPF submaximal	Test exercises
Week 45	SPF and GPF submaximal	SPF and GPF submaximal	SPF and GPF submaximal	Test exercises

** The legends used in the table: GFS - General Physical Fitness and SPF - Special Physical Fitness.*

For each of the adolescents, an appropriate load was adjusted by calculating the dose and weight required from the maximum result. In order to determine the increase in endurance, the maximum consumption of oxygen was also determined - VO_2 max both before and after fitness classes.

Results

To determine the maximum oxygen consumption of adolescents - VO_2max, it was determined by starting fitness trainings at the LSPA functional test laboratory on the Thorax SkiErg ergometer. The first time VO_2 max for the male was 64 mL/kg/min, but for the female - was 58 mL/kg/min. But the second time on the Monark bike ergometer the VO_2 max for the male was 61 mL/kg/min, but for the female - 49 mL/kg/min.

In the first test the aerobic threshold and the anaerobic threshold for the male were 148 bpm and 179 bpm, respectively, and in the second test - 139 bpm and 167 bpm, respectively. The female's results in the tests were more similar, in the first test the aerobic threshold was 141 bpm and in the second test- 139 bpm, while the anaerobic threshold in the first test was 177 bpm and in the second test - 171 bpm.

Table 2 ***Dynamics of results as a result of fitness training for the male***

Date **Test exercise**	**20.05.**	**04.06.**	**11.06.**	**20.06.**	**15.10.**	**02.11.**	**11.11.**
Bench press	45	52	57.5	60	60	67,5	70
Pull - down	70	-	-	80	80	85	90
Leg press	140	150	160	160	160	180	185
Pull up	10	12	15	16	16	15	16
Push up	26	31	38	41	41	53	57
Concept2- SkiERG max	369w	-	-	458w	458w	506w	506w
Concept2- rowingERG	431w	448w	486w	537w	576w	601w	644w
Thorax SkiERG	233w	243w	252w	289w	351w	-	411w

Upon starting fitness training, youngsters performed test exercises, as well as repeated them during training sessions to determine the dynamics of the results, thus accurately calculating the load in each training session, see Tables 2 and 3. The results show that strength in the test exercises has increased more for the male.

Examining the test results in the bench press was found that the male has the increase from the first time when the weight lifted was 45 kg and the male's weight was 55 kg has lifted weight has risen to 70 kg and the male's body weight has also risen to 61 kg. For the female, the increase in the results in the bench press was from 30 kg to 42.5 kg, whereas the initial weight of the female was 54.5 kg and the last weighing it reached 58.8 kg. Therefore, both the adolescents showed increased indicator of relative strength.

Table 3 ***Dynamics of results as a result of fitness training for the female***

Date **Test exercise**	**20.05.**	**04.06.**	**11.06.**	**20.06.**	**15.10.**	**02.11.**	**11.11.**
Bench press	30	30	30	35	35	40	42,5
Pull - down	50	-	-	55	55	60	65
Leg press	110	110	120	120	120	130	-
Push up	10	12	16	21	21	30	35
Concept2- SkiERG max	240w	-	-	298w	298w	337w	357w
Concept2- rowingERG	337w	379w	385w	392w	401w	389w	420w
Thorax SkiERG	166w	174w	185w	200w	202w	-	219w

Similar results were obtained also in other test exercises: pull-down, leg press, push up. Determining the increase of the results on Ski Ergometers, was found an increase in power on both Concept2 - SkiErg and Thorax SkiErg, as well as the increase of the results on Concept2 - SkirowingErg. For the male, the increase in results on Concept2- SkiErg is from 369W (watts) to 506W, while on Thorax SkiErg the increase of the results is from 233W to 411W. On the Concept2-rowingErg the results increased from 431W to 644W. Also, for the female was observed the increase in the results after fitness training sessions. Performing a test on Concept2- SkiErg for the first time the female's result was 240W, but during the last time it was 357W, and performing the test on Thorax, the SkiErg, was observed the increase of the results from 166W to 219W. Determining the difference in results with Concept2-rowingErg, it was found to be from 337W to 420W. The results show that fitness training sessions with the developed program for adolescents - skiers has had a positive effect on strength indicators and power expressions in skiing tests.

Discusion and conclusion

Numerous scientists, e.g., (Berg & Forsberg, 1992) have paid their attention to the possibilities of increasing the speed of locomotion in cross-country skiing. Most studies are based on maximum oxygen consumption and other physiological characteristics during load. However, little attention has been devoted to the development of strength, although various studies have been carried out to determine the subtleties of the technique of foot and arm action on the tracks with different reliefs and the manifestations of strength. Many studies show that the speed of locomotion depends on the length of the stride cycle. The highest speed skiers show moving in double-pole stride, where the speed of locomotion is determined by the strength of the muscles of the hands and the subtleties of the technique. Therefore, muscle strength plays a particularly important role in cross-country skiing.

Based on J. Nilsson and other studies, it can be concluded that, depending on the different biomechanical structural changes in locomotion technique, the push-off with skis and poles is one of the determining factors in increasing the speed of locomotion. Regular physical exercises - physical activities are very important activities to ensure the health of children and adolescents (Krauksts, 2006). Many authors believe that relative strength increase occurs during pre-pubertal, pubertal, and post-pubertal periods.

It is considered that during preparatory period increases fitness training - or GPF training endurance per 50%, maximum strength - per 30% and flexibility with coordination even per 20%. The obtained data show that with the improvement of the fitness test exercise results, improve also the results in the tests on specialized ski ergometers.

Conclusions: Using a fitness training program with strength loads, were improved both the GPF results for both adolescents, as well as SPF indicators on various specialized ergometers, suggesting a possible improvement on skis in cross-country ski tracks.

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