Influence of exercises on land on strength abilities, mobility and swimming endurance in long distance swimmers

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Abstract: This paper focuses on the research addressing the situation in the field of sports educology. Authors verify the effectiveness of the impact of exercises on development of strength abilities and mobility on land, their impact on the level of the swimming endurance, as an option of sport training for swimmers. The object of the investigation were 17-24-year endurance swimmers of swimming club SPK Spa Piestany. Changes in the level of power skills and mobility on land was diagnosed by standard motor tests of strength, mobility and swimming endurance test of 800 meters freestyle.

Keywords: strength abilities, mobility, swimming endurance, effectiveness and impact, testing

1 Introduction

In this paper we analyze in detail the effectiveness and impact exercises to development of strength and mobility for swimming endurance in long distance swimmers. Experiment conducted the first of the three authors in cooperation with Radoslav Suchanek, head coach of swimming club SPK Spa Piestany. Scientific knowledge of the structure of sport performance in swimming confirmed that the limiting factor is the high level of fitness abilities. Means of basic fitness, sport and aerobic gymnastics are applied in different sports in order to develop strength, aerobic and anaerobic endurance, and mobility, which are developed in isolation, by targeted exercises and by complex physical activity of sport - gymnastics character, in which is practices the interaction of individual fitness components of the movement (Štulrajter, Zrubák, Jánošdeák, 1998; Berlanský 2002, 2013; Maglischo, 2003 Macejková, 2005; Strešková, 2008; Putala, Macejková, Matúš, 2010; Holas, 2010; Berlanský, Psalman, Ružičková, 2011; Luha, Berlanský 2012, 2013; Berlanský, Luha, 2013, 2014; Berlanský, Luha, Suchánek, 2014). In our experiment, we analyzed the short-term and long-term impact of exercises for development of strength abilities and mobility by using on land training for long distance swimmers to improve their swimming endurance.

2 Methods

Special exercises as supplement of dry preparation expressed a positive increase of training as well as special (race) endurance, resulting in an increase of performance for long distance swimmers, but also for swimmers - sprinters. All tested persons swim their best personal performances, specifically Tomáš Vachan in the current year broke the Slovak record in 5km race three times (2 times in 50 m and once in 25 m pool). The preparation was carried out in the autumn, therefore at the beginning of the year training cycle, in its first macrocycle. In the group were included swimmers from 17 to 24 years, including one woman aged 22.

The preparation during this period was focused on general endurance respectively building aerobic capacity. Swimmers have done 8 or 9 training sessions a week in water with average intensity from 3.0 to 3.2 km/h. Training load represented 13 to 14 hours per week. Land training for swimmers completed 30 minutes a day, content was running in the field condition, body exercises, swimming gymnastics, specifically prescribed exercises assembly of fitness exercises on dry land – press ups, 3 sets of 15 reps; crunches with hands behind the

head, legs lifting from lying position, 2 sets of 15 repetitions; legs and hands lifting from lying position, 2 sets of 15 repetitions; legs and hands lifting from lying face down position, 2 sets of 15 repetitions, each phase lasts 1 second; squats on the whole feet, 2 sets of 15 repetitions; pause between sets is 30 seconds, total exercise time of strength eercises was established 15 minutes. Application was before each workout in water (Kyselovičová, 2012). Before training in the water we add isometric stretching, during training in the water - alternating stretching and after training in the water - alternating stretching, completed with exercises for development of mobility.

Effect of strength exercises and exercises for mobility on land, their inclusion in the content of the training units in a group of five long-distance swimmers were followed for four weeks. As a warm-up, we used the method of postisometric stretching from the PNF system, this was followed by strength training component on land - set of fitness exercises with the own body weight using the force of gravity. After the swimming part of the training we have used exercises for the development of mobility by the method of intermittent stretching and after the training in the water each swimmer practiced the final training unit of calming exercises for development of mobility by the method of gradual stretching.

All exercises for the development of strength and agility of the tested swimmers were performed out of pool. Effect of strength exercises and exercises for the development of mobility after their inclusion in the training process, in each training unit in the pool during our experiment (duration 4 weeks) was checked by the test of swimming endurance - 800 meters freestyle swimming. Standard tests of dynamic power - hand dynamometer, dynamometer for back muscles, throw with 2 kg ball in two-handed way, throw with 1 kg ball using just one hand and jump from standing position. Tests of mobility - forward bending, bending sideways, width between the legs in extended sideways, stretch of arms backward with grip, frontal stretch with arms backward.

The subjects completed testing each Monday. Tests of strength abilities and mobility on land, we realized at the gym from 3 to 5 p.m. Land testing started with 10 minutes warming up. Swimming endurance was tested in the same day in the indoor pool (water temperature of 26 ° C) from 6 to 7 p.m. Before testing in the water we applied free swimming in low intensity for 10 minutes as warming up, after testing we followed with the similar low intensity swimming as cooling down process for 5 minutes. For the measurement of the swimming endurance performance at the start of the experiment (entry), repeated measurement (after 1 week), and at the end of the experiment (after 4 weeks) was used variable: the swimming endurance test - Swimming FS_800_m (s).

3 Statistical analysis of achieved results

For the presentation of achieved results, we have used average values for group of swimmers - individual parameters for 3-phase experiment (entry - after 1 week - 4 weeks). Although the file has investigated belongs to small populations, the results of statistical analyzes give a good view of the parameters changed during the experiment. To express the parameters examined for the various phases of the experiment, we used the non-parametric Friedman test and nonparametric Wilcoxon test for paired comparison.

The results are statistically significant if the P-value of the test is less than 0.05. Summary results of the survey are presented in table 1.

Table 1 Average values of tested parameters in different phases of the experiment and P-values of statistical tests

Phase	entry	after_1_week	after_4_weeks	Friedman	Wilcoxon Entry - after w1	Wilcoxon after w1 – after w4
Hand dynamometry Right hand	458	460	462	**1.000**	**1.000**	1.000
Hand dynamometry Left hand	422	436	444	**0.278**	**0.375**	0.250
Dynamometry of back muscles	1 580	1 668	1 680	**0.056**	**0.250**	0.625
Standing jump	232.8	231.4	237.4	**0.270**	**0.875**	0.188
Throw with 2kg ball – both hands	974.2	966.0	976.0	**0.465**	**1.000**	0.375
Throw with 1kg ball – right hand	1 344	1 336	1 312	**0.954**	**0.500**	0.500
Throw with 1 kg bal – left hand	957	958	1 015	**0.124**	**1.000**	**0.063**
Forward bending	-12.42	-14.40	-15.70	**0.002**	**0.125**	**0.063**
Bending sideways – right side	45.24	45.14	44.70	**0.954**	**1.000**	0.813
Bending sideways – left side	43.80	43.92	43.16	**0.465**	**0.625**	0.625
Width between legs	179.2	178.4	185.6	**0.012**	**0.750**	**0.063**
Width between legs – right half	87.48	87.00	91.00	**0.259**	**0.750**	0.188
Width between legs – left half	93.32	91.40	94.60	**0.241**	**0.250**	0.125
Stretch of arms backward - right	3.94	4.24	2.92	**1.000**	**0.625**	1.000
Stretch of arms backward - left	-2.06	-1.62	1.50	**0.085**	**0.375**	**0.063**
Frontal stretch – right half	34.52	35.40	43.60	**0.024**	**1.000**	**0.063**
Frontal stretch – left half	36.8	37.4	42.6	**0.954**	**0.625**	0.313
Free style 800 m (s)	574.44	558.50	538.76	**0.001**	**0.063**	**0.063**

3.1 Strength abilities tested out of water

In the test of hand dynamometry - right hand subjects achieved average values 458 N, after one week 460 N and after four weeks 462 N. After one week there was an improvement of 2 N, after four weeks there was an improvement of another 2 N. Results of Friedman non-parametric test (P = 1.000), were not statistically significant. P-values of the Wilcoxon non-parametric test after one week (P = 1.000) were not statistically significant and after four weeks (P = 1.000), were not statistically significant too.

In the test of hand dynamometry - left hand subjects achieved average values 422 N, after one week 436 N, after four weeks 444 N. After one week there was an improvement of 14 N, after four weeks, it became better in 12 N.

Results of Friedman non-parametric test (P = 0.287), were not statistically significant. P-values of the Wilcoxon non-parametric test after one week (P = 0.375) were not statistically significant, after four weeks (P = 0.250), were not statistically significant. For each phase of the experiment, we recorded an improvement in the static strength of the right and the left hand.

In the test – dynamometry of back muscles tested subjects achieved average values 1580 N, after one week 1668 N and after four weeks 1680 N. For each phase of the experiment, we observed improvement in static strength of back muscles. After one week there was an improvement of 68 N and after four weeks there was an improvement of 22 N. Results of Friedman non-parametric test (P = 0.056), were at the border of statistical significance. P-values of the Wilcoxon non-parametric test after one week (P = 0.250) were

not statistically significant and after four weeks (P = 0.625), were not statistically significant too.

At the start of the experiment in standing jump test tested subjects reached average measured values 232.8 cm, after one week 231.4 cm and after four weeks 237.4 cm. Regarding each phase of the experiment, there was recorded worsening in explosive force of the lower extremities in the first week of 1.4 cm, but after four weeks there was an improvement of 6.0 cm. Results of Friedman non-parametric test (P = 0.270), were not statistically significant. P-values of the Wilcoxon non-parametric test after one week (P = 0.875) were not statistically significant and the same appeared after four weeks (P = 0.188).

Test – throwing the 2 kg ball throw with both hands showed at the start of the experiment average measured values 974.2 cm, after one week 966.0 cm and after four weeks 1140 cm. For the individual types of phase of the experiment was recorded worsening after the first week of 8.2 cm, the improvement of 10.0 cm came after the fourth week, which was based on the explosive force development of the upper limbs. Results of Friedman non-parametric test (P = 0.465), were not statistically significant. P-values of the Wilcoxon non-parametric test after one week (P = 1.000) were not statistically significant after four weeks (P = 0.375), were not also statistically significant.

Throwing the 1 kg ball with dominant right hand – in this test subjects achieved at the start of the experiment average measured values 1344 cm, after one week 1336 cm and after four weeks 1312 cm. This means the decrease of 8 cm after one week and 24 cm after four weeks. Results of Friedman non-parametric test (P = 0.954), were not statistically significant. P-values of the Wilcoxon non-parametric test after one week (P = 0.500) and after four weeks (P = 0.500), confirmed not significant statistical differences.

The same test with undominant left hand recorded average measured values 957 cm (at the start of the experiment), after one week 958 cm and after four weeks 1015 cm. After one week there was an improvement of 1 cm and 57 cm after four weeks. Results of Friedman non-parametric test (P = 0.124), were not statistically significant. P-values of the Wilcoxon non-parametric test after one week (P = 1.000) were not statistically significant, but after four weeks (P = 0.063) were at the border of statistical significance.

3.2 Mobility tested out of water

The forward bending test recorded folowing average values: -12.42 cm at the start of the experiment, -14.40 cm after one week and -15.70 cm after four weeks. We have seen the improvement of 1.98 cm after one week and 1.30 cm after four weeks. Results of Friedman non-parametric test (P = 0.002) were statistically significant. P-values of the Wilcoxon non-parametric test after one week (P = 0.063) were at the border of statistical significance. The same statistical significance happened also after four weeks (P = 0.063).

In the test bending sideways, bending to the right side were achieved average measured values 45.24 cm (at the start of the experiment), 45.14 cm after one week and 44.70 cm after four weeks. After one week there was the improvement of 0.10 cm and after four weeks even higher (0.64 cm). Results of Friedman non-parametric test (P = 0.954), were not statistically significant. P-values of the Wilcoxon non-parametric test after one week (P = 1.000) were not statistically significant, after four weeks (P = 0.813), were not statistically significant. Test of bending to the left side showed average measured values 43.00 cm (at the start of the experiment), 43.92 cm (after one week) and 43.16 cm (after four weeks). Results of Friedman non-parametric test (P = 0.465), were not statistically significant. P-values of the Wilcoxon non-parametric test after one week (P = 0.625) were not statistically significant, after four weeks (P = 0.625) were not statistically significant.

In the test, the width between the legs in extended sideways were average measured values 179.2 cm (at the start of the experiment), 178.4 cm (after one week) and 185.6 cm (after four weeks). After the first week we have seen a worsening of 0.8 (cm), after the fourth week we have seen an improvement of 7.2 (cm). The results of Friedman non-parametric test (P = 0.012) were statistically significant. P-values of the Wilcoxon non-parametric test after one week (P = 0.750) were not statistically significant but after four weeks (P = 0.063) were at the border of statistical significance. From lateral point of view, tested persons achieved following average results: right side of leg extension 87.48 cm (at the start of the experiment), 87.00 cm (after one week) and 91.00 cm (after four weeks); left side of leg extension 93.32 cm (at the start of the experiment), 91.40 cm (after one week) and 94.60 cm (after four weeks). All results of Friedman and Wilcoxon tests were not statisticaly significant.

In the test stretch of arms backward with grip recorded the right arm of tested subjects average measured value of 3.94 cm (at the start of the experiment), 4.24 cm (after one week) and 2.92 cm (after four weeks). The results of Friedman non-parametric test (P = 1.000) were not statistically significant. P-values of Wilcoxon non-parametric test after one week (P = 0.625) and after four weeks (P = 1.000) were not statistically significant. The same test for left arm recorded following average values: -2,06 cm (at the start of the experiment), -1,62 cm (after one week) and 1,50 cm (after four weeks). The results of Friedman non-parametric test (P = 0,085) were not statistically significant. P-values of Wilcoxon non-parametric test after one week (P = 0,0375) were not statistically significant but after four weeks (P = 0,063) were at the border of statistical significance.

Test - frontal stretch of arms backward – right arm brought following average values: 34.52 cm (at the beginning), 35.40 cm (after one week) and 43.60 cm (after four weeks). Results of Friedman non-parametric test (P = 0.024) were statistically significant. P-values of the Wilcoxon non-parametric test after one week (P = 1.000) were not statistically significant but after four weeks (P = 0.063) were at the border of statistical significance. In case of left arm we recorded average values: 36.80 cm (at the beginning), 37.40 cm (after one week) and 42.60 cm (after four weeks). All results of Friedman and Wilcoxon tests were not statisticaly significant.

3.3 Swimming endurance

The swimming test 800 m freestyle completed average measured values 574.44 s (at the start of the experiment), 558.50 s (after one week) and 538.76 s (after four weeks). After one week was recorded improvement of 15.86 s and after four weeks was improvement of 19.54 s. Results of Friedman non-parametric test (P = 0.001) were statistically significant. P-values of the Wilcoxon non-parametric test after one week (P = 0.063) were at the border of statistical significance and after four weeks (P = 0.063) were also at the border of statistical significance.

Scientific knowledge of the structure of sport performance in swimming documented that the limiting factor is the high level of fitness abilities. Means o basic, fitness, sports and aerobic gymnastics are applied in different sports in order to develop strength, aerobic and anaerobic endurance and mobility. All above mentioned is developed in isolation, by using targeted exercises, as well as complex of physical activity of gymnastic character, in which is the interaction of individual components of sport movement (Štulrajter, Zrubák, Jánošdeák, 1998; Berlanský 2002, 2013; Maglischo, 2003; Macejková, 2005; Strešková, 2008; Putala, Macejková, Matúš 2010; Holas, 2010; Berlanský, Psalman, Ružičková, 2011; Luha, Berlanský 2012, 2013; Berlanský, Luha, 2013, 2014; Berlanský, Luha, Suchánek, 2014)).

It was confirmed that short-term application of exercises for development of strength abilities and mobility on land in the content of the training units in group of long distance

swimmers brought the positive impact on the level of the swimming endurance. More significant improvement was recorded after four weeks. It was confirmed the correctness of a training unit for long distance swimmers in order: warming up by method of postisometric stretching from the PNF system, followed by training of strength component out of water - set of fitness exercises with own body weight, after the swimming training were used exercises for development of mobility by method of intermittent stretching from the PNF system and after the training in the water, the final part included calming exercises to develop mobility by method of gradual stretching. All exercises for development of strength and mobility of the swimmers were realised on land. We found a positive effect and impact of strength exercises and exercises for the development of mobility on land after their inclusion into the each training unit, their impact on the development of strength abilities and mobility on land, and consequently their positive effect on swimming endurance of long distance swimmers.

3 Conclusion

Our study monitored changes in the level of motor skills, strength abilities, mobility and the swimming endurance level of 17 to 24-years old top long distance swimmers in swimming club ŠPK Spa Piestany. As a result of the experimental representative, specific exercises for strength and stretching before, during and after swimming training and exercises for the development of mobility before, during and after swimming training, occurred significant short and long term changes in the level of the swimming performance, which was recorded at the border of statistical significance. An important part of the structure of sport performance in swimming is the physiological performance of the swimmer and swimming biomechanics. The movement of the body in the aquatic environment is influenced by physical laws, valid for each body and biological laws that are characterized for living organisms.

The movement is the result of interaction and mutual influence of the internal and external forces. Physical movement is the resultant of two forces of the swimmer: propulsive (driving) and braking. The reason of both of them is the resistance that occurs when moving in water. It is the result of the aquatic environment, such as the density of water, gravity force, hydrostatic buoyancy force and relation between action and reaction. Important is the correct training routines which integrate more motor units in the muscles during swimming, participate weaker muscle groups, which are in chosen training methods in swimming.

The results of our experiment and monitoring is recommended in the training process and practice applied in training for long distance swimmers in addition to the completed training in water and on dry land exercises to develop strength abilities and mobility. We also recommend using exercises for development of strength abilities and mobility into the preparation to the other sports and as part of rehabilitation and recovery. It can be stated that the exercises are very suitable complement for the preparation of swimmers with the aim of development of strength, but also mobility and quality of development of individual muscle groups. In practice these exercises brought to our tested subjects positive results and we advise these training methods to extension of method of recovery and rehabilitation.

5 References

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Appendix