THE LEVEL OF EXPLOSIVE STRENGTH OF LOWER LIMBS OF SLOVAK REPUBLIC REPRESENTATIVES IN SWIMMING

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ABSTRACT

The aim of the study was to detect the current level of explosive strength of lower limbs. Results were compared with the best individual personal performance which is evaluated through FINA points. 10 male and 14 female junior representatives in swimming (n=24; height = 178.7 ± 7.59 cm; weight = 67.5 ± 7.76 kg) and 10 male and 8 female senior representatives in swimming (n=18; height = 179.8 ± 5.54 cm; weight = 72.6 ± 8.32) from the Slovak Republic participated in testing. The explosive strength of lower limbs was measured by standing broad jumps and by the diagnostic device Myotest where CMJ and SJ tests were used. The results were compared by Pearson correlation coefficient with the best point performance of a particular proband. The average height of the junior representatives in the SJ test was 33.0 cm and of the senior representatives was 40.9 cm. The average height of the junior representatives in the CMJ test was 36.0 cm and the value of the senior representatives was 45.9 cm. The average value of junior representatives in the standing broad jump test was 220.0 cm and in senior representatives was 269.3 cm. Senior representatives achieved better results in all tests. The average point performance in junior representatives was 708.0 points and in senior representatives was 761.7 points. Percentual difference between the groups was detected in tests at values from 18.1% to 21.6% and the difference in FINA points was 7.1%. Pearson correlation coefficient showed high and medium values on statistical significance of 1% between tests of explosive strength, although, it showed the low values between the explosive strength tests and value of FINA points. The explosive strength of the lower limbs is one of the factors of sports performance that affect swimming performance. However, its level of impact needs to be verified by further research.

Keywords: comparison; Jump height; junior representatives; swimming performance; senior representatives; testing

Introduction

A structure of sports performance in swimming is constructed on the definition of factors which influence the performance itself. The speed-strength performance is dominant in swimming, of course, it is influenced by the length of the discipline and choice of swimming stroke. Ružbarský & Turek (2006) stated that the improvement of strength abilities is irreplaceable in swimmer´s training preparation but the swimmer´s individuality must be taken into consideration. The explosive strength of upper and lower limbs is a limited factor of the performance in the shortest swimming disciplines. Mutual dependencies between explosive strength of lower limbs and swimming performance were confirmed by Pupišová (2013), whose research focused on performance of senior

representatives in swimming. Fast and explosive strength is determined by the force´s intensity and time period that the athlete achieves a certain percentage of maximal strength. It is partially determined by the intensity of maximal strength and intramuscular and intermuscular mechanisms (Sedláček & Lednický, 2010). The explosive strength can be characterized as a dynamic strength ability which grants the largest acceleration to the organism and its parts thanks to the creation of fast muscular effort, which can be seen during kick realization in particular swimming strokes, starts and turns in swimming (Kasa, 1995). Take-off and its follow-up jump height is a precondition of effective realization of the following task which is coordinately difficult in swimming. Swimming turn or take-off are the most difficult tasks which are connected with another function after water entry (Zemková & Hamar, 1999, Zemková & Hamar, 2006). Two phases are distinguished in the push off technique. The first phase is characterized by rapid extension of knees and hips towards the wall prior to contact (i.e., no countermovement), and the active phase where the swimmer glides into the wall, letting the wall flex the knees in an approximate countermovement or eccentric phase (from shrug of lower limbs, ends with flex up to fingers of the feet). It is important to be able to pass quickly from a compliant regime of muscles´ work to a surpass regime. It is called reactive ability of muscle apparatus (Kremnický, 2005; Kremnický, 2014, Kremnický Kremnická, 2016). In swimming, it is demonstrated by realization of the first swimming kicks during the time when the whole body is under the water. Wendi et al (2019) stated the following: ,,During the eccentric phase, the water would aid the swimmer in slowing the movement toward the wall, and during the concentric phase the drag would provide increased resistance“. In a freestyle flip-turn, the eccentric phase consists of the initial wall impact and any countermovement when the swimmer is still moving towards the wall. The countermovement considered for this study was flexion of the knees and hips in addition to dorsiflexion at the ankle joints. The active force production phase consisted of the concentric contraction of the plantar flexors, quadriceps, and hip extensors in order to create velocity away from the wall.” (Weimar et al. 2019). This phase is composed of a forceful extension about the knees and hips and plantar flexion at the ankles in the horizontal direction, which in turn, would provide the swimmer more force during the push-off than during a no countermovement push off technique. The preloading in the muscle and associated tissue permits a faster contraction with a greater force than for a muscle that has not been pre-stretched.

The explosive strength of lower limbs improvement is influenced by specific water environments (water) in swimming. The resistance swimming aids (resistance swimsuit, kickboards, swimming flippers, etc.) are mainly used in training. The improvement does not have to be realized only in a water environment but also it is very effective to realize some exercises for strength improvement on a „dry place“ and subsequently, to transfer them to movements in the water. Wilson et al. (1993), Kent (2006), Garrido et al. (2010a), Morouco et al. (2011) and Potdevin, Alberty, Chevutschi, Pelayo & Sidney (2011) recommend the use of traditional training programmes as the most frequent training methods. Training programmes use resistance, plyometric exercises as well as the combination of traditional methods with resistance use and plyometric training.

The level of explosive strength of the lower limbs should be improved and diagnosed during the whole sport preparation. The need for diagnosis is inevitable mainly during preparation and race periods when we have to detect the current state of explosive strength level in the beginning of the preparation period, and, to select an appropriate method, way of improvement, volume, degree, and intensity of selected exercises and then diagnose. Regular measurements are required to detect the changes in selected physical skill and analyze the level of their impact on the performance.

Previous researches (Garrido et al. (2010b); Tonhauserová (2010); Tonhauserová (2011); Pupišová (2013); Pupišová, Pupiš, Giničová, Sýkora, Brunn & Pavlović (2018)) focus on the fact that the current level of swimmers´ explosive strength in the lower limbs is shown in Squat jump tests on levels from 3,6% to 16,1% and in standing broad jump tests on levels from 4,6% to 8,5%. The level is, of course, influenced by the age and the performance of the monitored sample. We can see the increased demands on performance quality in the swimming pool as well as on limited factors of sport performance, where there is also the explosive strength of upper limbs as a dominant factor.

Methods

Experiment sample

The sample consisted of 42 Slovak republic representatives (n = 42) in swimming where there were 10 male and 14 female junior representatives (n = 24; height = 178.7 ± 7.59 cm; weight = 67.5 ± 7.76 kg) and 10 male and 8 female senior representatives (n = 18; height = 179.8 ± 5.54 cm; weight = 72.6 ± 8.32).

Organization

The study focused on the explosive strength of the lower limbs of Slovak republic representatives in swimming. The second aim was to detect the best performance of particular swimmers, which were correlated with achieved results in explosive strength tests. We wanted to know the mutual dependence with realized tests of explosive strength. The research was realized in January 2017 with senior representatives and in January 2019 with junior representatives. We focused on detection of the current level of best performance (evaluation through the achievement of FINA points) and on detection of the explosive strength of lower limbs by using Myotest® PRO device. Three tests were realized: standing broad jump, squat jump (SJ) and countermovement jump (CMJ). Results presented the best tries, while each proband was performed for three tries. The testing was realized after a collective warm-up which lasted for 20 minutes. Results were evaluated in average values. We compared the junior and senior team´s results and we looked for the connection and mutual dependence between the best performance of particular swimmers and the explosive strength results. Results also present min and max achieved performance values in particular tests, standard deviation, and median. The statistical analysis was realized by statistical program Statistica 20, where we realized a Pearson correlation.

Results

Results section presents particular scores in all realized tests. Results also present min and max values, average values of particular samples, median, and standard deviation. We also present detected values of proband´s best performance (junior and senior samples), which were monitored because of the difference of swimming strokes and swimming disciplines of probands by FINA points. Test results are presented on Tables 1–4.

Table 1 *Results of Squat Jump test (JS)*

cm	Juniors	Seniors
Min	23.1	35.3
Max	43.7	50.8
Average	33.0	40.9
Median	32.1	39.4
Standard Deviation	5.69	4.74

Table 1 presents detected results in the Squat Jump test. We can see that better results were achieved by senior representatives, where the average performance was on the level of 40.9 ± 4.74 cm. The average performance of junior representatives was detected on the level of 33.0 ± 5.69 cm. The difference in average values was on the level of 7.9 cm (19.3%). The best performance was achieved by senior representatives, who also achieved the best point performance (100 m breaststroke discipline).

Table 2 *Results of Countermovement Jump test (CMJ)*

cm	Juniors	Seniors
Min	24.1	40.5
Max	50.0	56.9
Average	36.0	45.9
Median	35.6	44.3
Standard Deviation	6.63	5.13

Senior representatives also achieved better results in the countermovement Jump test. The average performance value was on the level of 45.9 ± 5.13 cm. The average performance of junior representatives was on the level of 36.0 ± 6.63 cm. The difference between average values was 9.9 cm in favor of senior representatives (21,6%). Senior representative T.K. achieved the best performance in the test again (FINA body = 909).

Table 3 *Results of standing board jump*

cm	Juniors	Seniors
Min	166.0	228.0
Max	274.0	294.0
Average	220.6	269.3
Median	214.0	276.5
Standard Deviation	27.61	18.72

Table 3 presents results of the standing board jump test, where senior representatives achieved better results again. Their average performance was 269.3 ± 18.72 cm. The performance of junior representatives was detected on the level of 220.6 ± 27.61 cm. Sample´s difference was on the level of 48.7 cm in favor of senior representatives (18.1%).

Table 4 *Point performance of probands*

points	Juniors	Seniors
Min	642	634
Max	822	909
Average	708	762
Median	69.5	754
Standard Deviation	50.2	78.6

Table 4 presents the most valuable proband´s performance in points. A minimum value presents that junior representatives have more valuable point performance (642 points). A maximum value presents that senior representatives have more valuable performance (909 points). Difference in average values is 54 points between the senior sample (762, SD = 78.6) and the junior sample (708, SD = 50.2) in favor of the senior representatives (7.1%).

Figure 1 presents percentage differences between junior and senior samples in particular tests. Senior representatives achieved 19% better results in average values of the squat jump test and they achieved 21.6% better results in the countermovement jump test. Senior representatives also achieved 18.1% better results on the standing broad jump test. The seniors achieved better average results by 7.1% when we recalculated their performance to FINA points.

Discussion

The explosive strength of lower limbs is important not only in cyclic movement of legs during kicks realization but also in starting technique (starts) and turns.

Our study focused on the explosive strength of the lower limbs by using 3 tests which were not realized in a water environment: (Squat jump, Countermovement jump and standing board jump). The main aim of the study was to detect the current level of the selected physical ability´s state and to compare samples of junior and senior representatives. The second aim was to detect if there is a mutual difference between the level of explosive strength of the lower limbs in swimmers and their most valuable performance. According to the difference in swimming discipline, we took into consideration a recalculation of the performance on FINA points.

Results have shown that senior representatives achieved better values in squat jump test by 19.3%, in countermovement jump test by 21.6%, and in standing board jump by 18.1% when compared with the junior samples. The senior representatives also achieved better average results by 7.1% when FINA points were recalculated. According to mentioned results, we expected a more significant difference between average values of swimmers in swimming performance (FINA points).

Statistical analysis has shown that there are medium and high values of correlation coefficients between explosive strength´s results (r = 0.6–0.89). Although, we detected small values of correlation coefficients between points score and explosive strength. The medium dependence was detected only in the senior sample between the standing board jump test and FINA points. According to this fact, we can state that there was not any significant impact on swimmers´ performance.

Conclusion

According to the mentioned results, we state that the better values of explosive strength of the lower limbs were measured in senior representatives, which is what we expected, but the difference between the best swimming performance was not significant (due to differences in selected explosive strength tests).

Finally, the explosive strength is not as determinative as we expected from the point of view of a specialized level of swimmer's performance. Despite this fact, we assume that the level of monitored physical performance can have an impact on swimmers´ performance. It can be minimally monitored in chosen parts of the swimming performance (starts, turns and kicks of lower limbs). The next research will focus on the explosive strength of the upper limbs and we suppose that its impact will be more significant on swimmers´ performance.

Despite this fact we can state that the level of the explosive strength is a limited factor for the movement of the lower limbs of swimmers, which can be monitored in kicks during the realization of all swimming disciplines as well as in turns and starting performance.

Practicing exercises which are focused on the explosive strength of the lower limbs is limited and it is effective to train it in a dry place. Researches by Tonhauserová (2010), Pupišová (2013), Pupišová, Pupiš, Giničová, Sýkora, Brunn & Pavlović (2018) etc. confirmed the positive impact of plyometric exercises on the explosive strength of the lower limbs and its current transfer to swimming performance, but the point is that the research was not focused on the improvement of the explosive strength of the lower limbs.

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