DRYLAND VERTICAL JUMPING ABILITIES IN YOUNG COMPETITIVE SWIMMERS

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Abstract

The purpose of the study was to assess the vertical jumping abilities in young competitive swimmers and apply these findings to swim starts, especially to the block phase of the kick start from OSB12. The sample included 9 male and 6 female young competitive swimmers whose average age was 17.4 ±1.8 years and 16.2 ±1.3 years, respectively. We used the Optojump system to determine the jumping abilities of swimmers who performed 5 vertical jumping tests: SJ, CMJ, CMJa, CMJarl, and CMJall. To determine differences in the particular dryland vertical jumping tests and vertical jumping abilities, we used the Mann-Whitney U test. We found that male swimmers showed a significantly higher levels of vertical jumping abilities than their female counterparts. The highest value of vertical jump was found in the CMJa test. There were significant differences ($p < .05$) in the CMJ and CMJa tests. When assessing the differences in jumping ability during right- and left-legged tests, we found that the swimmers performed better when taking off from the right leg. We found that the differences in jumping ability during right- and left-legged tests in female swimmers were statistically significant ($p < .05$).

INTRODUCTION

Takeoff is a one-time motor act in which the entire musculoskeletal system is active, especially the lower-body muscles in conjunction with their joint system [Gallahue 2002]. This movement is considered a fundamental motor skill. Jumping tests, such as vertical jump, are included in various test batteries in different sports [Suchomel et al. 2016; Seitz et al. 2014], where they are used to evaluate lower-body strength. The positive aspect of this test is its simplicity in terms of material equipment and test administration, so it is widely used by trainers [Duthie 2006]. Other reliable and valid tests for evaluating jumping abilities are the countermovement jump and squat jump tests [Markovic et al. 2004]. From a biomechanical point of view, the jump height is limited by the takeoff force impulse, on which the initial takeoff velocity in conjunction with the maximum jump height depends. The jump height correlates with the explosive force [Bosco, Viitasalo 1982], speed [Wisloff et al. 2004], agility [Barnes et al. 2007], and performance [Tricoli et al. 2005]. In swimming, correlations between dryland tests and swimming performance have been reported in particular for short-distance races because maximum strength and power (i.e., in 50m freestyle r= .91) prevail over aerobic power [Morouco et al. 2014]. To enhance their strength and performance levels, swimmers perform strength exercises such as bench press, squat, etc. [Morouco et al. 2012]. It is assumed that these regularly used exercises could improve swimming performance [Aspenes et al. 2009]. Since all swim races begin with a swim start, lower-body explosive strength is considered an important factor, especially in short-distance races [Tor et al. 2014]. Performance in these races is determined by swim start performance (first 15 m) [West et al. 2011; Barlow et al. 2014].

The purpose of the study was to assess the vertical jumping abilities in young competitive swimmers and apply these findings to swim starts, especially to the block phase of the kick start from OSB12.

MATERIALS AND METHODS

Participants

The sample included 9 male and 6 female young competitive swimmers whose average age was 17.4 ±1.8 years and 16.2 ±1.3 years, respectively.The swimmers participated regularly in the Slovak regional swimming championships and Slovak swimming championship, having competed in particular in sprint races and freestyle races. When tested, all swimmers were healthy and did not report any health problems before the testing. Each tested person read an information leaflet about testing and gave his or her written consent.

Dryland test

1. Squat Jump (SJ) - Evaluation of explosive force of lower limbs. Test which involves a single jump from a squatting position (angle of 90° at the knee) with hands on hips and without counter movement. Parameters acquired - height reached from center of gravity.
2. Counter Movement Jump (CMJ)- Test which involves a single jump starting from an upright position with hands on hips and with counter movement - rest hands on hips (to measure leg performance instead of arm performance); stand straight up for 1-2 seconds; jump as high as you can; land with normal flexion and stand still in neutral position for 1..2 seconds. Single jump starting with straight legs and performing a natural flexion before takeoff. In the counter movement jump during the breaking phase elastic energy is stored in the muscles and tendons and then utilized in the following propulsion (concentric) phase. Parameters acquired - height reached from center of gravity.
3. Countermovement Jump (CMJa) with arm swing
4. Countermovement Jump (CMJarl) with arm swing, right-legged
5. Countermovement Jump (CMJall) with arm swing, left-legged.

Testing protocol

The Optojump photoelectric cells, which consist of two parallel bars (one transmitter and one receiver unit, each measuring 100×4×3 cm, 1.5 kg weight), were placed at the extremities of the force platform without touching it, in a parallel and horizontal position to one another at a distance of 92 cm. The transmitter contains 32 light-emitting diodes, which are positioned 0.3 cm from ground level at 3.125 cm intervals. Optojump bars were connected to a personal computer, and the Microgate software (version 1.12) allowed jump height quantification. The Optojump system measured the FT of vertical jumps at 1000 Hz [Microgate S.r.l. 2009-2020].

Statistical analysis

To assess normality of data distribution, we used the Shapiro-Wilk test. To determine differences in the particular dryland vertical jumping tests and vertical jumping abilities, we used the Mann-Whitney U test. The statistical software used was Statistica 12.0.

RESULTS

Mean vertical jump height achieved by male swimmers was: SJ 30.6±2.5 cm, CMJ 34.2 ± 2.7 cm and CMJa 41.2±2.8 cm. The difference between mean jump heights in CMJ tests with and without arm swing was 7 cm. In the CMJa single-legged test, swimmers showed higher levels of jumping abilities when taking off from their right leg. Despite this finding, the mean difference was minimal (0.7 cm) (Table 1). There were statistically significant differences ($p < .05$) between SJ – CMJ, SJ – CMJa, and CMJ - CMJa. We found no statistically significant differences in the left-legged CMJa test (Table 2).

Mean vertical jump height achieved by female swimmers was: SJ 26.8±3.8 cm, v CMJ 29.3±2.5 cm, and CMJa 33.8±1.7 cm. The difference between mean jump heights in CMJ tests with and without arm swing was 4.5 cm. In the CMJa single-legged test, female swimmers showed higher levels of jumping abilities when taking off from their right leg. The differences between mean CMJa single-legged test was 1.7 cm (Table 1). There were statistically significant differences ($p < .05$) between CMJ - CMJa and SJ – CMJ. We found statistically significant differences ($p < .05$) between the left-legged and right-legged CMJa tests (Table 2).

Male swimmers showed significantly higher levels of jumping abilities in all vertical jumping tests. The gender differences in the particular tests were: SJ test – 3.8 cm, CMJ test – 4.9 cm, CMJa – 7.4 cm, CMJarl – 3.4 cm, and CMJall – 4.4 cm. These differences were statistically significant ($p < .05$) in all tests except for the SJ test (Table 3).

Table 1. Descriptive statistics for the vertical jumping tests

		SJ (cm)	CMJ (cm)	CMJ a (cm)	CMJarl (cm)	CMJall (cm)
Men	*M*	30.6	34.2	41.2	21.5	20.8
	SD	2.5	2.7	2.8	2.9	2.6
Women	*M*	26.8	29.3	33.8	18.1	16.4
	SD	3.8	2.5	1.7	2.1	2.2

Note: SJ- squat jump; CMJ - countermovement jump; CMJa - countermovement jump with arms, CMJarl – right-legged countermovement jump with arms; CMJall - left-legged countermovement jump with arms

Table 2. Differences in the vertical jumping tests

		CMJa - CMJ	SJ - CMJ	SJ - CMJa	CMJarl - CMJall
Men	Z	-2.668	-2.666	-2.666	-.280
	Asymp. Sig. (2-tailed)	.008*	.008*	.008*	.779
Women	Z	-2.201	-1.782	-2.207	-2.207
	Asymp. Sig. (2-tailed)	.028*	.075	.027*	.027*

Note: *(p < .05); SJ- squat jump; CMJ - countermovement jump; CMJa - countermovement jump with arms; CMJarl – right-legged countermovement jump with arms; CMJall - left-legged countermovement jump with arms

Table 3. Gender differences in the vertical jumping tests

	CMJ	CMJa	SJ	CMJarl	CMJall
Mann-Whitney U	5.000	0.000	14.000	7.000	6.500
Z	-2.593	-3.185	-1.533	-2.357	-2.422
Asymp. Sig. (2-tailed)	.010*	.001*	.125	.018*	.015*

Note: *($p < .05$); SJ- squat jump; CMJ - countermovement jump;
CMJa - countermovement jump with arms;
CMJarl – right-legged countermovement jump with arms;
CMJall - left-legged countermovement jump with arms

DISCUSSION

Performance in explosive vertical jumps is highly associated with neuromechanical capacities (i.e., muscle strength and power). Multiple studies have dealt with the testing of jumping abilities in a variety of sports. For instance, female basketball players showed lower levels of jumping abilities in the SJ and CMJ tests [Bouteraa et al. 2018] than swimmers who participated in our study. In the studies dealing with soccer players, boys performed better in the SJ and CMJ tests [Mario Alves et al. 2010; Comfort et al. 2014; Hammami et al. 2018] than swimmers who participated in our study. The difference in the jump height ranged from 6 to 14 cm and 3 to 12 cm for the SJ test and CMJ test, respectively. Findings similar to those of our study have been reported in handball [Daneshfar et al. 2018] and taekwondo [Yousfi et al. 2018]. In one study [Garcia Ramos et al. 2015], the swimmers achieved jump height lower by 1.8 cm than that recorded in our study. In another study [Loturco et al. 2016], swimmers achieved SJ higher by 6.9 cm and CMJ by 7.1 cm. Despite these findings, the test scores recorded in our study were more homogeneous as shown by standard deviation which was 2.5 time lower.

In swimming, certain correlations were reported between the tests of jumping abilities and the swim start, start and swimming performance, respectively. For example, in a study by Garrido et al. [2010], there was a low correlation relationship (r = .15; -.20) with swimming performance at 25 and 50 m. Also, low correlations were observed between the post-turn performances (2-4 m) and in the SJ, CMJ and CMJa tests [Cornin et al. 2007]. Another study [Keskinen et al. 2007] showed a moderate correlation (r = .55) between the the CMJ height and the swimming velocity over 200 m distances, which were repeated in five series. Higher degree of correlation (r = .75 and .76) between total work in the countermovement jumping test and 25 and 100 meters swimming speeds were reported in the study by Strzala and Tyka [2009]. As reported in another study [Sioutas et al. 2010], there was a low correlation (r = .29) between the performance in vertical jump and the body’s velocity during the phase of fly after the start.

In addition to looking for relationships between jumping tests with selected swim start parameters, more attention should be paid to the basic position on the starting block during the block phase, as this phase is the initial one. The performance in the phases above the water must be transformed into the underwater phase and the first swimming movements. In the basic position on the starting block, it is necessary to determine which lower limb is to be placed on the front edge of the starting block and which on the kick plate of the OSB starting block.

According to one study [Slawson et al. 2011], placing the right leg on the front edge of the starting block had a positive effect on swim start performance. However, authors of this study did not attempt to determine whether the right leg placed on the front edge of the block was more dominant in jumping tests than the left one. In another study [Barlow et al. 2014], regular starting position across participants was determined. Six out of 10 swimmers placed their right leg on the front edge of the starting block. However, the study did not deal with the limb dominance and foot positioning on the starting block either.

CONCLUSION

The present study deals with vertical jumping abilities in young competitive swimmers, aiming to apply the findings to the basic starting position on the OSB12 starting block. We found that male swimmers showed a significantly higher levels of vertical jumping abilities than their female counterparts. The highest value of vertical jump was found in the CMJa test. There were significant differences ($p < .05$) in the CMJ and CMJa tests. When assessing the differences in jumping ability during right- and left-legged tests, we found that the swimmers performed better when taking off from the right leg. We found that the differences in jumping ability during right- and left-legged tests in female swimmers were statistically significant ($p < .05$). In the future, we would like to compare the results of vertical jumping tests with the horizontal ones to precisely assess limb dominance in both directions. As the swim start is both a vertical and horizontal movement, we assume that the leg positioning on the starting block is crucial (dominant leg forward or backward).

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