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The relationships between squat and countermovement jump heights and knee/ankle angles of 15-17 age swimmers

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Abstract

The aim of this study was to investigation of the relationship between knee and ankle angles and squat/countermovement jump heights at the age group of 15-17 swimmers. 10 girls (mean age 15.30±0.48yrs, mean height 165.00±5.33cm, mean mass 49.60±5.10kg) and 13 boys (mean age 16.00±1.00yrs, mean height 178.00±7.32cm, mean mass 64.31±7.35kg) were participated to this study as voluntarily. 10min dynamic dryland warming time were given and after that reflective markers were placed on the lower extremity joints. The wand calibration method was used for calibrated to the area. Fusion Sport Smart Jump matt was located in the area to calculated swimmers' jump heights. Swimmers performed three squat jump (SJ) and countermovement jump (CMJ) trials which were recorded at a frequency of 120Hz using seven high-speed cameras (Oqus 7+). The results were analyzed by Qualisys Track Manager program. Both knee and ankle angles and jump heights relations were calculated. Pearson Correlation and Mann Whitney-U was used in SPSS 21.0 program for analysed. There were no significant relations between SJ and CMJ performances and angles (p>0.05). There were significant differences between boys and girls in both jump heights (p<0.05). For correct jump performance, it is recommended to position the joints according to the recommended optimal angular values.

Keywords: Swimming, Knee Angle, Ankle Angle, Squat Jump, Countermovement Jump.

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1. Introduction

1.1. Introduce the problem

Swimming can be carried out in pools of international standards (50 meters, 8 lanes), each athlete in his lap with different styles (freestyle, backstroke, butterfly and breaststroke) and distance (50m, 100m, 200m, 400m, 800m, 1500m) is a competition that they apply individually or as a team (Mooney et al., 2016). Actually, each fascia requires that the muscles of the legs, the body and upper body act in a harmony (Salo and Riewald, 2008), and when it is realized with the right mechanics due to this adaptive behavior, it faces the researchers as a determining factor of overall performance and attracts attention (Kjendlie et al., 2006; Toussaint et al., 2006; Bulgan et al., 2020).

It is stated that it is important to understand the behaviors of the athletes in the competition and to determine and improve the results to be obtained in the future; In this way, it is important to carry out the performance analyzes of the athletes objectively from a scientific point of view. The markers used in swimming performance analysis increase hydrodynamic friction; therefore, it has been stated that swimming analyzes performed both in training and in races have greater difficulty compared to the sports performed on land (Gonjo and Olstad, 2021; O'donoghue, 2009; Washino et al., 2019).

In competitive swimming, swimmers are ranked in seconds, and races are won or lost by small margins. Swimmers work to gain a competitive advantage. A swimmer's performance depends on the final time, technical components, speed, stroke mechanics, spin and finish (Galbraith et al., 2008). Competing with these elements is very important in swimming. Swimmers improve their strength and endurance during training, but the technique of the swimming style, the quality of starting, turning and finishing can make a difference in the ranking of swimmers (Dassoff et al., 2017). Having these elements well can give swimmers an advantage in races. Starts account for about 10% of the total time in 50m swimming events and about 5% in 100m swimming events (Blanksby et al., 2002; Maglischo, 2003). Hay (1986) estimated that the start for the 50m freestyle accounted for 11% of the total race time (Thanopoulos et al., 2012; Bingul et al., 2015).

Even though a swimmer performs only one start each race compared with numerous turns and even more swimming strokes, some practice time set aside for work on starts is well warranted. Even if the starts work is not extensive, swimmers can work on them without even getting on the blocks. Every time they push off the wall, they can practice quick reactions, powerful and streamlined underwater kicks, powerful and horizontal breakout strokes, and so on. Some swimmers get consistently crushed on turns, and others gain a clear advantage. Good turns are simple, with only a few fundamentals; whereas poor turns are often artificially complicated, with the swimmer adding things that don't belong and that take up time. Fast turners see walls as a attack mode whenever they approach a wall. Slow turners never have a sense of urgency, so their turns are lazy and powerless (Brooks, 2019).

Total body strength is important, but the fastest swimmers are typically those who can create an effective body position in the water, while at the same time able to effectively generate and maintain balance with the arms and legs. Similar to most spores, the core condition development along the trunk is critical for swimming performance. In sports made in the field, the ground reaction forces are transmitted through the kinetic chain in the lower extremity. A swimmer needs not only to effectively engage the core muscle system to connect the upper body to the lower body, but also to maintain the stability of the spine, which will create a base on which to apply the correct stroke mechanics (Willardson, 2018).

For this reason, it is important that the exercises that improve the jump and push characteristics that will support the performance of the athletes in the water are included in the dryland training. The strength exercises performed by the players on the land usually include weight training, medicine ball exercises, jumping exercises, and core exercises. In addition, platinum works, squat and countermovement bounces are performed with different variations of the jumping exercises applied during the training. Correct application of these variations also improves the lower extremity strength of the athletes and thus improves their performance in water. Similarly in the dryland training, applying the correct angles at the right position can provide more effective performance.

It is believed that the vertical jump from the dryland training of the thrust force in the water is influenced by the knee and ankle angles, and that the deep-squat athlete has reached a higher jumping height and can also perform further thrust in the water. In this study, it was aimed to determine squat jump (SJ) and countermovement jump (CMJ) heights performed in swimming groups of 15-17 age group and relation of knee and ankle angles at jump.

2. Method

2.1. Participants

Thirteen male swimmers (mean age 16,00±1,00yrs; mean height 178,00±7,32cm and mean weight 64,31±7,35kg; training experience 6,69±0,95yrs) and ten female swimmers (mean age 15,30±0,48yrs, mean height 165,00±5,33cm, mean weight 49,60±5,10kg; training experience 6,90±0,88yrs) from Istanbul Technical University and ENKA Sport Clubs participated to this study as voluntarily. The swimmers had not experienced any upper and lower extremity injuries before. The study was conducted consistent with the recommendations of the Declaration of Helsinki. The swimmers were asked to refrain from caffeine intake on testing day and to avoid food consumption in the 2 hours before testing.

2.2. Data collection tool

The data collection was done in Halic University, School of Physical Education and Sports Laboratory, Istanbul. Tests were carried out during off-season for the preparation of the competition strategy. The subjects had 14-hour training session per week. Before the tests, 15 minutes warm up time were given followed by dynamic stretching in dry land.

The reflector markers which 3cm diameter were attached to participants selected joints of right and left lower extremity such as trochanter major, patella lateral condyle, lateral malleolus, distal phalange. These markers were applied to the participants with double-sided tape.

The test area is defined by the Wand calibration method. To calculate the three SJ and CMJ heights of the swimmers using Fusion Sport Smart Jump on the floats. The performances were recorded with 7 cameras (Oqus 7+) at 120hz. The results were analyzed with the Qualisys Track Manager (V.2.12) program and both knee-ankle angles were calculated.

2.3. Data Analysis

The data of angular kinematic variables from swimming trials were statistically analysed using SPSS 18.0 (SPSS Inc., Chicago, IL, USA) program. The results were presented as Means± SD. Mann Whitney-U test was utilized to identify any differences between girls and boys. Also, Pearson Correlation analysis was used to evaluate relationship between jump heights and angular kinematic parameters. The statistical significance level was set at 0.05.

3. Results

Table 1. Kinematic Parameters and Jump Heights as Means±SD and Mann Whitney-U Results

	SJ			CMJ		
	Girl	Boy		Girl	Boy	
	Means±SD	Means± SD	p values	Means± SD	Means± SD	p values
Right Knee Angle (°)	84.55±8.07	83.22±12.60	0.42	86.64±8.58	80.57±7.44	0.12
Left Knee Angle (°)	85.68±7.89	86.31±14.78	0.76	86.29±8.67	82.80±10.52	0.32
Right Ankle Angle (°)	28.64±4.18	25.06±3.49	0.03*	27.92±2.95	26.13±3.84	0.29
Left Ankle Angle (°)	25.83±5.41	24.80±4.13	0.26	20.73±12.42	25.79±3.88	0.50
Jump Height (cm)	18.84±4.30	28.66±5.24	0.01*	20.17±4.97	31.39±6.22	0.01*

*p<0.05

As a result, statistically significant differences were found between girls and boys in both SJ and CMJ height values ($p < 0.05$). In addition, a statistically significant difference was found between the boy and girl swimming in the right ankle angle applied to SJ performance ($p < 0.05$) (Table 1).

Results of the Pearson Correlation analysis, there was no statistically significant relation between height of SJ and CMJ and right and left knee and right and left ankle angles of male and female swimming patients ($p > 0.05$).

4. Discussion

In this study, we investigated the relationship between young swimmers and the jump height of the knee and ankle joints at SJ and CMJ. In Marcora and Miller, 2000 study, 14 healthy male university students with a mean age of 25.4±2.2 years had different knee angles; squat and countermovement jump heights were calculated as 47±0.06cm and 51±0.03cm respectively; the squat and countermovement jump heights of the participants with the lowest jump height were 34.0±0.03cm and 36±0.02cm respectively. In another study, the 11-year-old squat jump height was 26.0cm in male elites; 23.5cm in the elite; girl is 22.0cm in elite; and 23.0cm in the non-elite (Bencke et al., 2002). The result of this study is that squat jump heights in girls and boys are 18.84±4.30cm and 28.66±5.24cm, respectively; The countermovement jump heights were found to be 20.17±4.97cm and 31.39±6.22cm in females and males respectively and parallel to the literature.

The jump height varies depending on the different levels of crouching depth (Gheller et al., 2015). The squat and countermovement bounce motion was found to be higher when the work was done with a deeper squatting position. Moran and Wallace (2007) reported that the countermovement jump height was greater in the 90° knee flexion than the 70° knee flexion. In addition, in Salles, Baltzopoulos and Rittweger (2011), a lower jumping height was calculated when the countermovement jumping movement was performed with a 50° knee flexion compared to a 90° knee flexion. McBride et al. (2010), Kirby et al. (2011) analyzed the effect of six different tier levels of jumping performance on squat and countermovement jumping performance. Jo de Ruiter et al. (2010), the squat jump height at the knee angle of 120° was 21.0±3.2cm with the dominant leg; dominant leg was found to be 21.3±2.6cm (Jo de Ruiter et al., 2010). Also in football, drop vertical jump was 23.6±2.1° and 26.7±0.8° in females and males respectively. knee angle in girls and 84.0±1.9° and 79.2±2.3° in males, respectively; the jump height was calculated as 36.8±1.1cm and 48.3±1.1cm respectively in females and males (Ford et al., 2005). Gheller et al. (2015), when the squat and countermovement jumped at the start, the jump height would be higher when the knee flexion angles were smaller than 90°. Countermovement sprains 90° in small knee flexion angle athletes, 49.39±5.96cm; squat sprue had the highest jump values at 45.02±5.43cm at a 70° knee flexion angle. The results of the literature studies indicate that the jumping height increases with increasing squatting depth. As a result of this study, the swinging movements of the swimmers resulted in knee angles of 70° to 110°; the ankle angles are between 60° and 75°. The best SJ performance was 78° in women with knee angle and 29° in ankle angle; men had a knee angle of 92° and an ankle angle of 27°; the best CMJ performance was 84° in knee angle girls and 27° in ankle angle; in men the knee angle was 88° and the ankle angle was 26°. There was no statistically significant relation between the jump heights of the male and female swimmers and the right-left knee and right-left ankle angles ($p > 0.05$); Significant differences were found in these parameters depending on sex ($p < 0.05$).

5. Conclusions

In conclusion, it is believed that the difference is due to the fact that the age of the swimmers is not high and their angular parameters are close to each other. Also their performances development is still continue. Apparatuses and materials should be developed that will enable working in these angle ranges in training models. These equipment should be used in education and training. In addition, athletes can train with this equipment for long periods of time both in water and on land at correct angle ranges. For accurate jump performance, it should be ensured that the joints are positioned according to the recommended optimum angular values.

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