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RELATIONSHIP BETWEEN THE VERTICAL COUNTERMOVEMENT JUMP AND THE SIMULATED PERFORMANCE OF THE INITIAL 15 METERS OF CRAWL SWIMMING PERFORMED BY ADOLESCENT ATHLETES

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ABSTRACT

Background: The start in swimming occurs via a jump that propels the swimmer into the pool. The relationship of the power generated by the start jump to first 15-m performance in swimming events is not yet known. Objective: Verify the correlation of the countermovement vertical jump (CMJ) with the simulated start performance of the crawl swimming. Materials and Methods: The present research was observational pilot study. The sample consisted of 12 Brazilian swimmers aged between 12 and 16 years (male). The CMJ was analyzed by a specific Platform for Jump Testing. Afterward, the athletes were directed to an Olympic swimming pool and positioned themselves in the starting block. Then, at the sound signal (whistle), they swam the first 15 meters of the pool in crawl style at the highest possible speed to simulate the start of the competition of swimming. Results: Thus, the study showed a negative correlation of the CMJ with the simulated start of 15 meters in the crawl style (r =-0.816; p=0.001). The analyses indicated that the CMJ contributes 66% ($F_{(1.10)}$ = 19.92; p=0.001) for the performance of 15 meters during the simulated start of the crawl stroke. It was shown that for every 1 cm increase in CMJ height, there was an improvement of 0.0885 milliseconds in swimming performance. Conclusion: CMJ is associated with the variation of the sprint time during the simulated start of a swimming test in the crawl swimming style.

Key words: Performance. Sport. Swimming. Vertical Jump.

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RESUMO

Relação entre o salto vertical com contramovimento e a realização simulada dos 15 metros iniciais de natação crawl realizada por atletas adolescentes

A largada na natação ocorre por meio de um salto que impulsiona o nadador para dentro da piscina. A relação entre a potência gerada pelo salto inicial e o desempenho dos primeiros 15 m em eventos de natação ainda não é conhecida. Objetivo: Verificar a correlação do salto vertical com contramovimento (CMJ) com o desempenho simulado de largada do nado crawl. Materiais e Métodos: A presente pesquisa foi um estudo piloto observacional. A amostra foi composta por 12 nadadores brasileiros com idade entre 12 e 16 anos (masculino). O CMJ foi analisado por uma Plataforma específica para Jump Testing. Em seguida, os atletas foram encaminhados para uma piscina olímpica e se posicionaram no bloco de largada. Em seguida, ao sinal sonoro (apito), nadavam os primeiros 15 metros da piscina em estilo crawl na maior velocidade possível para simular o início da competição de natação. Resultados: Assim, o estudo mostrou correlação negativa do CMJ com a largada simulada de 15 metros no estilo crawl (r=-0,816; p=0,001). As análises indicaram que o CMJ contribui com 66% (F (1,10) = 19,92; p=0,001) para o desempenho de 15 metros durante o início simulado do estilo crawl. Foi demonstrado que para cada aumento de 1 cm na altura do CMJ, houve uma melhora de 0,0885 milissegundos no desempenho da natação. Conclusão: O CMJ está associado à variação do tempo de sprint durante o início simulado de um teste de nado na modalidade crawl.

Palavras-chave: Desempenho. Esporte. Natação. Salto Vertical.

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INTRODUCTION

Power is an important skill for sporting success and is linked to the high performance of elite athletes, Suchomel Nimphius, Stone (2016).

In swimming, power is associated with the propulsive capacity of swimmers and, consequently, with the increase in speed during movement in the liquid medium, Nikšić et al., (2019).

It is noteworthy that, in swimming, the placements of medalists in sprint events are decided by milliseconds.

For example, during the 2016 Olympics in Rio De Janeiro, swimmer Anthony Ervin was champion of the 50-meter freestyle event with one-thousandth of a second ahead of second-place, Fédération Internationale de Natation (2016).

In this sense, for Pendergast et al., (2003), swimming performance is determined by the propulsive capacity of the upper and lower limbs, estimating that the contribution of propulsive efficiency in the crawl swimming technique is approximately 50% of the lower limbs and 50 % of upper limbs.

Later, in a study carried out with freestyle swimming, Ribeiro, Figueiredo, Sousa (2015) demonstrated that swimming performed with propulsion only with the lower limbs contributes to 12% of the propulsion of swimming performed with both limbs.

However, the study by, Ribeiro, Figueiredo, Sousa (2015) used the exit from inside the pool, removing the block exit.

However, in a pioneering study, it was demonstrated by, Cossor Blanksby, Elliott, (1999) that the starting time considering the departure from the starting block contributes up to 30% of the total swimming time.

It is noteworthy that the starting block in swimming can be decisive for the athlete to become champion; thus, understanding which factors may be associated with the starting block is fundamental for sporting success in the modality, Schulkin (2017).

Therefore, it is important to look for factors that may be associated with swimmers' block exit performance.

Thus, the present study hypothesizes that the jumping ability is associated with the ability to exit in the lanes in the swimming event.

Given the above, the present study aimed to analyze the correlation of the countermovement vertical jump (CMJ) with the simulated start performance of the crawl swimming.

MATERIALS AND METHODS

Observational pilot study with a cross-sectional design, with a sample of 12 male swimming athletes (aged between 12 and 16 years, Stature: 165.5 ± 8.0, Weight: 50.1 ± 12.2, BMI: 19.0 ± 2.0).

The sample was recruited from a sports club in the city of Natal, Rio Grande do Norte, Brazil. We adopted as inclusion criteria that athletes have been swimming for at least two years, uninterruptedly, and train an average of 5 times a week for a minimum period of 2 hours a day.

All athletes had to compete at the regional and state level and be enrolled with the state swimming federation.

As exclusion criteria, we adopted that athletes could not present limitations (osteoarticular clinically diagnosed) for the proposed physical tests or have performed vigorous physical activities in the 48 hours before data collection in this study.

Ethics

This study was previously approved by the Ethics and Research Committee of the Federal University of Rio Grande do Norte - Brazil (ID: 3,552,100), strictly respecting the national and international ethical principles defined by the World Medical Association, Johannes, Van Delden Van de Graaf (2017) in the Declaration of Helsinki, as well as complying with the international requirements of the STROBE checklist, Von Elm et al., (2014).

Study Design

Initially, the athletes and their guardians were informed about the risks and benefits of participating in the research. Later, they signed the free and clear term accepting to participate in the research.

The evaluations took place on a Monday at the athletes' training center (ambient temperature of 24°C). We requested that individuals not perform vigorous activities 48 hours before the physical tests.

Thus, the participants performed the CMJ test and, later, there was a simulated start of swimming competition in the crawl swimming style. The athlete was instructed to position himself in the starting block and, upon hearing the sound signal emitted by a whistle, jump start in the pool and swim as quickly as possible in the crawl style (see figure 1). We adopted a distance of 15 meters of swimming to simulate the start.

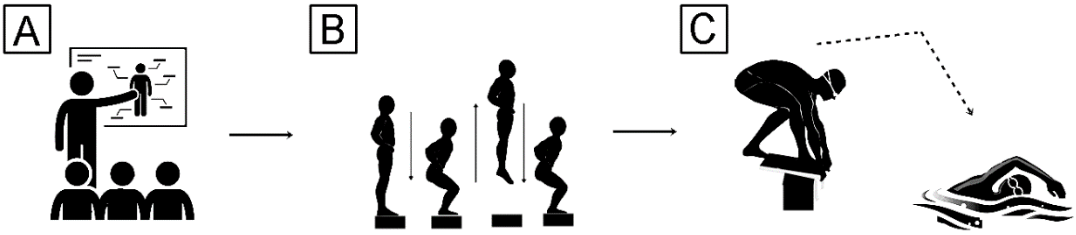

Figure 1 - Study design. A: Explanation of research procedures. B: Countermovement vertical jump analysis. C: Simulated crawl swimming competition start.

Blinding

The evaluators performing the jump and pool tests were unaware of the outcome of the present study.

The sample of the present study was informed that they would be submitted to a session of swimming-related evaluations without being informed of the main outcome of the present study (correlating performance of countermovement vertical jump with 15-m swimming).

Data processing was performed by an external research collaborator who had no knowledge of the outcome of the present study. Thus, the present study was blinded with regard to evaluators, participants, and data processing.

Countermovement Vertical Jump Analysis

The height of the CMJ was evaluated using a platform with interruption system for jump test (CEFISE®, São Paulo, Brazil).

The CMJ was performed as follows: the athletes stood, with their knees extended 180°, with their hands fixed on their waists and, at the sound signal emitted by the evaluator, they crouched and jumped as fast as possible and had to land with the entire foot on the platform, if they landed on the toes, the jump would be invalidated, and the athlete would jump again.

Athletes were instructed that they should be barefoot, with appropriate clothing for the jump, and jump as high as possible, Komi (2008).

Three attempts were allowed (with the passive recovery of 15 seconds between them), and the average value of the jumps was adopted for further analysis.

Simulated Start

The simulated start of a crawl-style swimming competition was performed with the athlete positioned on the starting block in an Olympic swimming pool (50 meters).

At the sound of a whistle, the athletes jumped from the starting block and swam as fast as possible at a distance of 15 meters. The evaluations were carried out individually, and the time was independently timed by two evaluators. Mean values were used for further analysis.

Statistical analysis

Data normality was verified using the Shapiro-Wilk test. The association between CMJ and 15-m crawl time during the simulated start was performed using the Pearson correlation coefficient, the adopted magnitude was: Small: 0.1 to 0.2; Medium: 0.3 to 0.4; Broad: 0.5 to 0.7; Very broad: ≥ 0.8 (Cohen, 1992). Subsequently, a simple linear regression was performed to indicate the contribution of the CMJ concerning the simulated start performance.

Descriptive statistics were used to indicate the mean reduction of milliseconds concerning the increase of 1 cm in CMJ; for this, the data were observed individually. The intraclass correlation coefficient (ICC) was used to analyze the reliability of the measures reported by the two timekeepers. The adopted magnitude was: Absence: <0; Bad: 0-0.1; Weak: 0.2-0.3; Moderate: 0.3-0.5; Substantial: 0.6-0.7; Almost perfect: ≥0.8., Miot (2016). The technical error of measurement (TEM) was calculated for the swimming performance variable. All analyzes were performed using the

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Statistical Package for the Social Sciences software (IBM ®, version 20.0, University of Chicago, United States), considering the significance of $p<0.05$.

RESULTS

There was a correlation between the height of the CMJ and the sprint time of 15 meters during the simulated start of the crawl. The 15-m performance was negatively correlated with the CMJ test ($r = -0.816$; $p=0.001$). In addition, the linear regression analysis indicated that the CMJ provides a contribution of 66% ($F_{(1.10)} = 19.92$; $p=0.001$) for the performance of 15 meters during a simulated crawl start (Figure 2).

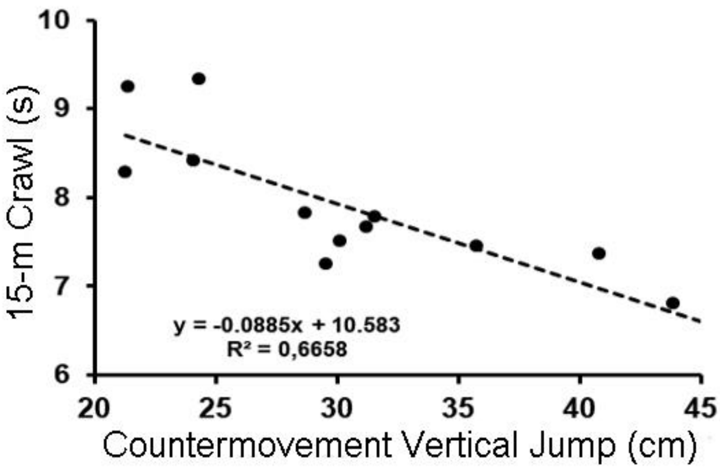

Figure 2 - Simple linear regression between countermovement vertical jump height and 15-meter sprint time. -m: Meters. (s): Secounds. (cm): Centimeters

We emphasize that, through descriptive statistics, the present study observed that for each increase of 1 cm in the height of the CMJ, there was an improvement of 0.0885 milliseconds in swimming performance. An almost perfect agreement was reported for the time measures recorded by the two evaluators (ICC = 0.987; $p<0.001$; 95%CI -CCI = 0.955; 0.996). In addition, the technical error of measurements (TEM) was 0.02.

We performed the post-hoc sampling power analysis for the finding regarding the correlation of the CMJ with the simulated start performance. Thus, we used the open-source software G* Power® (Version 3.0; Berlin, Germany), in the statistical configuration for the "T family" test for correlations, with an $\alpha = 0.05$. Thus, a strong sampling power of 0.98 ($t_{(10.0)} =1.81$) was indicated.

Subsequently, we performed the post-hoc analysis for the sampling power of the linear regression analysis. We used the same software in the statistical configuration for the "T family" test for linear regression, with an $\alpha = 0.05$, indicating a strong sampling power of 0.89 ($t_{(10.0)} = 1.80$). Thus, the preliminary findings of the present study can be relied upon to inform more complex research on the topic.

DISCUSSION

The present study aimed to verify the correlation of the countermovement vertical jump (CMJ) with the performance of the simulated start of the crawl swimming.

Thus, this research had as main results a negative correlation between the CMJ and the 15 meters of crawl performed during a simulated start, indicating a contribution of 66% of the CMJ for the performance of the simulated start in crawl swimming, suggesting that the greater vertical jump height, the shorter will be the swimmer's start time.

In this sense, the goal of competitive swimming is to complete the running distance as quickly as possible so that swimmers reach their highest average speed for that distance, Schulkin (2017).

Several studies have tried to find ways to indicate the best performance in a swimming event, such as the study by Hawley (1996), which proposes that muscle power predicts the performance of freestyle swimming. In this way, the study by Nikšić et al., (2019) highlights that the motor coordination of the upper limbs associated with muscle power are indicative of a better performance in swimming. Thus, the results of the present study corroborate those of Hawley et al. (1996) and Nikšić et al., (2019).

Furthermore, it was observed in the present study that for each increase of 1 cm in the height of the CMJ, there was a reduction of 0.0885 milliseconds in the swimming performance, suggesting that a better CMJ performance may indicate a better performance during the start of the crawl.

This can be justified by the fact that the CMJ produces a high power of lower limbs, which favors the athlete's exit from the starting block in the competitions, contributing to the reduction of the total competition time, Komi (2008), Kováčová, Broďáni (2019).

It is known that power is an increase in force per unit of time in a short period, Komi (2008).

According to Kováčová, Broďáni, (2009), the power of the lower limbs is the main determinant for the initial start performance in swimming.

In addition, previous studies showed that the role of muscle strength and power are determinant for the results in the swimming competition and that by increasing these physical capacities, athletes tend to be able to reduce the time of the competition, Awatani et al., (2018a - 2018b); Mujika, Crowley (2019).

Veliz et al., (2015) suggests that improvements in swimming performance were associated with increases in lower limb power when leaving the starting block, which can be interpreted as a greater application of force in the water.

Gourgeulis et al., (2014) state that the kick in swimming influences an improvement of up to 13% of the competition time, this is due to the inclination of the body and the increase in propulsive forces in the body, showing the importance of these limbs for the reduction of time in the swimming test.

In light of the discussion, it is highlighted that the swimming test is composed of several phases, including the start, which can significantly contribute to the final result of the test, Schulkin (2017).

Highlights, limitations and suggestions for further studies

Thus, the highlight of the present study was that it has been shown that a simple CMJ assessment can help coaches concerning interventions to improve the start time of young swimmers.

However, the present study has the limitations of the study design being of the observational type, which did not allow establishing a cause-and-effect relationship concerning the improvement in the height of the CMJ and the improvement in the starting performance in swimming, in addition to the fact the sample was composed only of young male athletes aged between 12 and 16 years; thus, when considering female athletes or from other age groups, the results may diverge from those found in the present study.

Thus, we suggest that future studies should experimentally analyze the effect of lower limb power on initial first 15-m performance in swimming considering athletes of different age groups and both sexes.

Practical application

The present study suggests as a possible practical application the realization of plyometric training of inferior members with the intention of increasing the height of the CMJ in adolescent swimming athletes, thus favoring the initial performance of the first 15-m in sporting competitions.

CONCLUSION

The present study results allow us to conclude that the variance in the Countermovement Vertical Jump is correlated with the results of the 15-meter sprint time during the simulated start of a crawl swimming competition, which may explain approximately 66% of the sprint performance of 15 meters crawl swim.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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