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The relationship between the explosive power of the lower limbs and 15 m freestyle performance among young swimmers (10–13 years)

Mohammed cherif Mahdi^{1*}

¹ Mohamed Cherif Messaadia University, Souk Ahras (Algeria)

m.mohammedcherif@univ-soukahras.dz

Abstract:

This study aimed to determine the relationship between the explosive power of the lower limbs and 15 m freestyle performance among juniors (10–13 years). For this purpose, we used the descriptive method on a sample of 5 swimmers registered in the Youth Sports Club “Amal Souk Ahras” (CASA), selected intentionally. To collect data, we used the Sargent vertical jump test on land (out of water) and a 15 m freestyle swim test. The results concluded that swimmers with higher explosive power had a shorter race time and a higher mean speed. Accordingly, we can say that there is a statistically significant correlation between the explosive power of the lower limbs and 15 m freestyle performance among juniors (10–13 years).

Keywords: explosive power, performance, swimming, juniors.

*Corresponding author / m.mohammedcherif@univ-soukahras.dz

1. INTRODUCTION

The start phase in competitive swimming is one of the most sensitive phases in determining performance, especially in short distances; during it, the highest acceleration values are produced within a very short time. Its effect is often assessed through the time to reach nearby distances such as 5 m, 10 m, and 15 m after the start. Recent studies have confirmed that lower-limb force-production characteristics measured out of the water (dry-land) contribute to explaining performance differences in this phase. Predictive models have shown that force–time variables in the squat jump are among the most important determinants associated with start time up to 15 m in swimmers at national and international levels (Shiqi Thng et al., 2020, p 1).

From a physiological–mechanical perspective, “explosive power” is linked to the ability to produce a large force in a short time, which is evident in ballistic activities such as vertical jumping. Classical literature in muscle mechanics has shown that a jump preceded by a preparatory movement (countermovement) increases mechanical power and mean force compared with a jump without a preparatory movement, supporting the use of vertical jump tests as a practical indicator of fast power/force characteristics of the lower limbs (Bosco et al., 1981, p 135).

Although there is a research trend supporting the role of developing dry-land muscular power in improving in-water performance, generalizing these findings to junior age groups requires scientific scrutiny. In training, plyometric jump training interventions in prepubertal swimmers have shown clear improvements in muscular power indicators (such as CMJ) and improvements in timed swimming tests, including a 15 m swim test with a dive start as part of the measurement protocol, compared with water training alone (Senda Sammoud et al., 2019, p 805).

However, the literature shows an applied gap specifically for the (10–13 years) category, as this stage coincides with developmental changes that may affect the relationship between dry-land physical indicators and in-water technical performance, in addition to differences in measurement tools used across studies (vertical jump/Sargent, CMJ, SJ, force platforms, etc.) and differences in in-water performance indicators (5 m, 15 m, 25 m, and 50 m times).



The relationship between the explosive power of the lower limbs and 15 m freestyle performance among young swimmers (10–13 years)

Among the previous and similar studies that addressed this topic, we find:

The study conducted by Jamal Dahmani and Fateh Mazzari (2020) aimed to identify the relationship between speed-strength and 50 m freestyle performance. The researchers used the descriptive method with a correlational approach on a sample of 8 swimmers aged 9–11 years selected intentionally. The results concluded that there is a significant correlation between speed-strength and 50 m freestyle performance.

The study conducted by Zahia Sabah Abdel Salam (2008), entitled “The effect of varied exercises on developing maximal speed, speed-strength, and 25 m freestyle performance for individuals with mild intellectual disability,” used the experimental method on a sample of 5 players from the national swimming team with a chronological age of 14–16 years and a mental age of 10–12 years, selected intentionally. The researcher concluded that varied exercises in water and on land led to the development of maximal speed and speed-strength and improved 25 m performance for the sample.

Based on the above, the following question can be posed: Is there a statistically significant correlation between the explosive power of the lower limbs and 15 m freestyle performance among juniors (10–13 years)?

The following sub-questions stem from the general question:

- Is there a statistically significant correlation between vertical jump test results and the 15 m freestyle race time among juniors (10–13 years)?
- Is there a statistically significant correlation between vertical jump test results and the mean speed over 15 m freestyle among juniors (10–13 years)?

To answer the above questions, the researcher proposes the following hypotheses:

- There is a statistically significant correlation between the explosive power of the lower limbs and 15 m freestyle performance among juniors (10–13 years).

- There is a statistically significant correlation between vertical jump test results and the 15 m freestyle race time among juniors (10–13 years).
- There is a statistically significant correlation between vertical jump test results and the mean speed over 15 m freestyle among juniors (10–13 years).

The objectives of the study are as follows:

- To identify the correlational relationship between the explosive power of the lower limbs and 15 m freestyle performance among juniors (10–13 years).
- To identify the correlational relationship between vertical jump test results and the 15 m freestyle race time among juniors (10–13 years).
- To identify the correlational relationship between vertical jump test results and the mean speed over 15 m freestyle among juniors (10–13 years).

The importance of studying the relationship between lower-limb explosive power and 15 m freestyle performance among juniors (10–13 years) lies in the process of identifying and predicting talented athletes in the future to achieve good results in short-distance sprint swimming events.

2. Methodological procedures adopted:

2.1. Pilot study:

Before starting the applied part of the research, the researcher conducted a preliminary pilot study on 27 September 2025 to identify the original population sample and to trial and implement the tests correctly. The results of the pilot study indicated the following:

- Identifying the time required to perform the tests.
- The possibility of collecting information by applying the study tests.
- Verifying the suitability of the tools and devices used in the research.
- Identifying potential difficulties that may occur during the implementation of the tests.

2.2. Study domains:

Human domain: swimmers of the Youth Sports Club of Amal Souk Ahras (CASA), aged (10–13 years).

Time domain: the period from 20/09/2025 to 31/12/2025.

Spatial domain: the semi-olympic pool of Baji Mokhtar, Souk Ahras Province.

2.3. Method used in the study:

The descriptive method using a correlational approach was used, as it suits the nature of the research.

2.4. Population and sample of the study:

The study population consisted of all junior swimmers aged 10–13 years in Souk Ahras Province. Our study sample was a single group consisting of 5 swimmers from the Youth Sports Club of Amal Souk Ahras, aged 10–13 years, selected intentionally. The number of years of training for the athletes in the club was not less than 2 years, with an average of 3 training sessions per week, in addition to a high competitive aspect among them, which was the key point in selecting them deliberately, as the researcher believes this represents the original population accurately.

To determine the homogeneity of the sample, the researcher used the coefficient of variation for some variables (age, weight, height).

Table (01) shows the arithmetic mean, standard deviation, and coefficient of variation for the variables (age, weight, height).

Variables	Unit of measurement	Arithmetic mean	Standard deviation	Coefficient of variation
Age	Year	11.5	1.2	10.4
Weight	kg	42.3	2.5	5.9
Height	cm	154.6	7.2	4.6

Table (01) shows that the coefficient of variation is less than or equal to 10 for the variables age, weight, and height, which indicates that the sample is homogeneous.

2.5. Data collection methods:

- Arabic and foreign sources and references.

- Tests and measurements.

Study data collection form.

2.5.1. Tools and devices used in the research:

- Restameter for measuring standing height.

- Medical scale (Beurer) for measuring body weight.

- Stopwatch (chronomètre) for measuring time, SEWAN type, allowing the recording of 08 times.

- Measuring tape (20 meters).

- Whistle.

2.6. Scientific criteria of the tool:

Validity: To calculate the validity of the tests, we relied on self-validity using the following equation:

Self-validity = $\sqrt{(\text{reliability})}$, as shown in Table 02.

Reliability: To calculate the reliability of the tests, the test–retest method was used on the same research sample, repeating the test one week after the first administration, as shown in Table 02.

Table (02) presents the reliability coefficient and the self-validity coefficient for the vertical jump test and the 15 m freestyle swimming test

Statistical methods Physical tests	Unit of measurement	Sample size (n)	Significance level	Reliability coefficient	Self-validity coefficient
Vertical jump test	cm	5	0.05	0.82	0.90
15 m freestyle race test	s	5	0.05	0.88	0.93

Table (02) shows that the reliability coefficient and self-validity coefficient between the first and second administrations for the vertical jump test and the 15 m freestyle race test range between 0.82 and 0.93, indicating that the tests are reliable and valid.

2.7. Field application procedures:

2.7.1. Physical tests:

Sargent vertical jump test:

Purpose of the test: measuring the explosive power of the lower limbs.

Equipment used: colored chalk, a flat wall, measuring tape, recording sheet.

Performance description: To perform the Sargent vertical jump test, warm-up is required first. Then stand next to a wall, raise your arm while keeping your feet fixed on the ground, and mark the highest standing reach point (M1) with chalked fingers. Next, perform the jump by slightly flexing the knees and jumping as high as possible, using an arm swing to increase height, and mark a new point (M2). The distance between the two marks (M2 – M1) is measured. The trial is repeated three times, with rest periods (3–4 min) between attempts.

Recording: the best result is recorded.



The relationship between the explosive power of the lower limbs and 15 m freestyle performance among young swimmers (10–13 years)

15 m freestyle swimming race test:

Purpose of the test: measuring race time.

Equipment used: pool, measuring tape, stopwatch (chronomètre) for measuring time (SEWAN type), whistle, recording sheet.

Performance description: general and specific warm-up is required. The five swimmers start from the starting platform at the “take your marks” signal; at the whistle signal, they dive powerfully into the water, completing the 15 m distance in the fastest possible time. The trial is repeated three times, with rest periods (3–4 min) between attempts.

Recording: the best result is recorded.

2.8. Statistical methods used in the study:

- Arithmetic mean.
- Standard deviation.
- Pearson correlation coefficient.

This was done using the statistical software (SigmaPlot_14.0) to obtain the aforementioned statistical measures.

- Mean speed = distance (meters) / time (seconds).

This was done using Microsoft Office Excel 2013 to calculate mean speed.

3. Presentation, interpretation, and discussion of results:

3.1. Presentation, analysis, and discussion of the first hypothesis, which was stated as follows:

“There is a statistically significant correlation between vertical jump test results and the 15 m freestyle race time among juniors (10–13 years).”

Table (03) presents the results of the first sub-hypothesis.

Variables	Sample	Significance level	Calculated rp value	Tabulated rp value	Statistical decision
Sargent vertical jump test	5	0.05	- 0.97	- 0.805	Very strong inverse correlation
15 m freestyle race time					

Table (03) shows that the calculated value of (rp) is less than the tabulated value of (rp) at the 0.05 significance level. Therefore, there is a statistically

significant correlation between the results of the Sargent vertical jump test and the 15 m freestyle race time among juniors (10–13 years). There is a very strong inverse (negative) relationship between the Sargent vertical jump results and the 15 m swim time: the higher the vertical jump height, the shorter the 15 m freestyle time among juniors (10–13 years). This finding is consistent with the study by Jamal Dahmani and Fateh Mazzari (2020), which concluded that there is a significant correlation between speed-strength and 50 m freestyle performance. It is also supported by Sammoud et al. (2019), who reported that plyometric jump training led to clear improvements in prepubertal swimmers' muscular power indicators (e.g., CMJ) and improvements in timed swimming tests, including the 15 m swim test. This also agrees with what Hdoush Issa et al. (2020) stated: the more an athlete possesses high explosive power, the more it helps them perform skills well and in less time (Hdoush Issa et al., 2020, p. 211).

3.2. Presentation, analysis, and discussion of the second hypothesis, which was stated as follows:

“There is a statistically significant correlation between vertical jump test results and the mean speed over 15 m freestyle among juniors (10–13 years).”

Table (04) presents the results of the second sub-hypothesis.

Variables	Sample	Significance level	Calculated rp value	Tabulated rp value	Statistical decision
Sargent vertical jump test	5	0.05	0.95	0.805	Very strong direct correlation
Mean speed					

Table (04) shows that the calculated value of (rp) is greater than the tabulated value of (rp) at the 0.05 significance level. Therefore, there is a statistically significant correlation between vertical jump test results and the mean speed over 15 m freestyle among juniors (10–13 years). There is a very strong direct (positive) relationship between vertical jump results and mean speed over 15 m freestyle: the greater the vertical jump height, the greater the mean speed over 15 m freestyle among juniors (10–13 years). This finding is consistent with the study by Zahia Sabah Abdel Salam (2008), which found that varied exercises in water and



The relationship between the explosive power of the lower limbs and 15 m freestyle performance among young swimmers (10–13 years)

on land led to the development of maximal speed and speed-strength and improved 25 m performance for the research sample. It is also supported by Petar Bubnjevic et al. (2020), who reported a statistically significant relationship between explosive power tests and speed in younger age groups, with a stronger correlation in intermediate categories, and that the level of correlation between motor-skill tests changes according to participants' age. This agrees with what Boutghan Al-Mahdi et al. (2024) stated: explosive power is a very important attribute in various sports specialties, especially sprint running (Boutghan Al-Mahdi et al., 2024, p. 21).

Based on the results obtained for the first sub-hypothesis, there is a statistically significant correlation between vertical jump test results and the 15 m freestyle race time among juniors (10–13 years), Based on the results of the second sub-hypothesis, there is a statistically significant correlation between vertical jump test results and the mean speed over 15 m freestyle among juniors (10–13 years). Accordingly, there is a statistically significant correlation between the explosive power of the lower limbs and 15 m freestyle performance among juniors (10–13 years), This result is consistent with the findings of the study by Saadi Khadhir and Majadi Meftah (2022), in which the researchers concluded that there is a positive correlational relationship between locomotor speed and the muscular power of the lower limb muscles (Saadi Khadir, Medjadi Meftah, 2022, p 850), This result is also consistent with the results Shiqi Thng et al. (2020), who indicated that dry-land lower-limb force-production characteristics contribute to explaining performance differences, and that squat jump force–time variables are among the most important determinants associated with start time up to 15 m in swimmers at national and international levels. It is also supported by Bosco et al. (1981), who indicated the use of vertical jump tests as a practical indicator of fast power/force characteristics of the lower limbs, this is in line with what was stated by Bardi Taha Elias et al. (2023), that the development of explosive strength had a positive impact on running speed performance (Berdi Taha Ilias et al, 2023, p 276).

4. Conclusion:

Through the present study, we were able to contribute, albeit modestly, to identifying some important aspects related to young swimmers aged 10–13 years. We also sought to examine the nature of the relationship between the explosive strength of the lower limbs and performance in the 15-m freestyle swimming event. After preparing a data collection tool represented by physical fitness tests and

administering them to a sample consisting of five (05) swimmers, and following the collection and statistical processing of the data, the following conclusions were reached:

- There is a correlational relationship between the explosive power of the lower limbs and 15 m freestyle performance among juniors (10–13 years).
- There is a correlational relationship between vertical jump test results and the 15 m freestyle race time among juniors (10–13 years).
- There is a correlational relationship between vertical jump test results and the mean speed over 15 m freestyle among juniors (10–13 years).

Within the limits of the procedures used and the results obtained, the researcher recommends the following:

- Emphasizing the development of lower-limb explosive power and its relationship to 15 m freestyle performance.
- Helping coaches select, identify, and predict talented swimmers in the future to achieve good results in short-distance sprint swimming events.
- The researcher also recommends conducting similar studies on other swimming strokes.
- Conducting studies that examine the relationships of other physical attributes not addressed in the current study among junior swimmers.
- Conducting studies aimed at evaluating certain physiological or morphological characteristics among junior swimmers.



The relationship between the explosive power of the lower limbs and 15 m freestyle performance among young swimmers (10–13 years)

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