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RELATIONSHIPS BETWEEN EXPLOSIVE POWER AND ISOMETRIC STRENGTH OF KEY UPPER AND LOWER LIMB MUSCLES IN YOUNG ADOLESCENTS

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ABSTRACT. *Introduction*: Developing lower limb strength can promote improved sports performance, as well as reduce the risk of injury in sports activities. *Objective*: The research aimed to discover the links between the explosive power and isometric strength of the lower and upper limbs of non-practicing teenagers. *Materials and methods*: The explosive power and isometric strength of the lower and upper limbs were tested on a group of 49 adolescents (21 girls, 28 boys) aged between 15 and 18 years, from the N-E region of Romania. The Squat Jump, Countermovement Jump and Abalokov's Jump protocols were applied to determine the explosive power of the lower limbs. The isometric strength of the upper limbs was tested using the pressure and traction protocols of a portable dynamometer, and to determine the strength of the leg adductors, the pressure test was applied, using the same dynamometer. *Results*: Statistically significant associations ($p<0.05$) were found between explosive power and isometric lower limb strength in the entire group, as well as between isometric arms strength and explosive lower limb power. Links were also found between isometric arms and legs strength. Regarding gender, legs adductors and arms strength determined by traction were correlated among girls. No significant correlations were found for boys' values. *Conclusions*: The study concluded that the strength of the lower limb muscles involved in vertical jump testing can influence its performance. This aspect was determined predominantly among the common group, so additional studies are needed to support the hypothesis in the case of each gender.

Keywords: explosive power; motric potential; teenagers; sport selection; muscle

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INTRODUCTION

Explosive strength is an essential functional determinant of performance in many sports and motor activities in childhood and adolescence, and is commonly assessed by vertical jumps (Countermovement Jump, Squat Jump), short sprints or medicine ball throws. In parallel, maximal isometric peak strength and characteristics of the strength-time curve (e.g. peak strength, rate of strength development) - measured with tests such as isometric mid-thigh pull (IMTP), knee extension isometrics or handgrip tests - are used as indicators of the neuromuscular system's ability to generate rapid strength. Recent studies show that the IMTP and other isometric tests are useful tools in profiling strength production and have correlations with dynamic performance measures, although the magnitude and consistency of these correlations may vary by population, methodology and analysis (Giles et al., 2022).

In adolescents, explosive strength development is strongly influenced by biological maturation, specifically the transition through the peak-height-velocity period stages causes large jumps in strength and power expression, which complicates the interpretation of direct correlations between isometric measurements and dynamic performance unless maturation and body mass are controlled for (Yapici et al., 2022).

Cross-sectional and association studies in young people have reported moderate correlations between absolute/relative values of isometric strength and dynamic performance, such as CMJ or sprint, but the significance of these correlations varies depending on normalization to body mass, method of measurement, and muscle specificity of the tests (e.g., upper limb tests do not substitute for lower limb strength/explosiveness tests). Therefore, concurrent investigation of key upper and lower limb muscles provides a more complete picture of the neuromuscular profile in adolescents (Stavridis et al., 2025).

Recent cross-sectional and meta-analytic reviews show that training programs consistently improve jumping and sprinting performance in adolescents (e.g. through plyometric and combined programs), but effects on absolute isometric strength may be less consistent, thus the relationships between isometric and explosive strength are not unidirectional and are dependent on dosage, exercise specificity and developmental stage (Chen et al., 2023, Ma et al., 2025). Also, changes in time-dependent isometric indicators are less predictable, emphasizing the importance of choosing the relevant variables according to the objective (increasing peak strength vs. increasing strength generation rate). The simultaneous investigation of isometric and dynamic indicators in the upper and lower limbs is needed to better understand which isometric variables correlate most strongly with explosive performance in adolescents (Maestroni et al., 2021).

In addition, there is evidence that simple tests, performed with portable equipment (e.g. handgrip), can partially reflect general musculoskeletal status and are correlated with indices of lower extremity strength among pediatric samples. However, these correlations are moderate and do not allow complete substitution of specific explosive strength tests. Some specialists advocate the usefulness of investigating both upper and lower limb isometric tests when assessing the strength-power profile of adolescents (Correia et al., 2024).

Based on these premises, we aim to investigate the relationships between explosive indicators and isometric measurements of the main muscle groups of the upper and lower limbs in young adolescents, taking into account the key variables chronological age and body mass. The aim is to identify isometric parameters strongly associated with dynamic performance, in order to provide practical recommendations for test selection in screening, monitoring and training programming among athletes.

MATERIAL AND METHODS

Sample

The group of 49 adolescents (*170.66±10.01 cm, 64.88±15.79 kg, 22.21±4.10 kg/m2, 20.09±8.67% body fat, 37.6±6.46% muscle mass, 1558.62±279.54 kcal*) tested included 21 girls (*161.84±6.87 cm, 53.85±8.92 kg, 20.53±2.78 kg/m2, 26±6.4% body fat, 31.39±2. 51% muscle mass, 1292.74±92.31 kcal*) and 28 boys (*176.64±6.88 cm, 72.36±15.10 kg, 23.4±4.51 kg/m2, 15.77±7.54% body fat, 42.14±4.26% muscle mass, 1752.92±195.96 kcal*), aged 15 to 18 years, from the N-E region of Romania (*Table 1*). This research was conducted in accordance with the Declaration of Helsinki.

Table 1. Subject demographics data

	Mean ± SD		
Variables	**Girls**	**Boys**	**Overall**
N	21	28	49
Age (years)	16.71±0.78	16.92±0.72	16.83±0.75
Heigh (cm)	161.84±6.87	176.64±6.88	170.66±10.01
Weight (kg)	53.85±8.92	72.36±15.10	64.88±15.79
BMI (kg/m^2)	20.53±2.78	23.4±4.51	22.21±4.10
Body fat (%)	26±6.4	15.77±7.54	20.09±8.67
Muscle mass (%)	31.39±2.51	42.14±4.26	37.6±6.46
BMR (kcal)	1292.74±92.31	1752.92±195.96	1558.62±279.54

Determining variables

Anthropometry

The height of the subjects was determined with a Bosh rangefinder placed on the end of a Handy 10625B LCD digital level, which was positioned on the head of the test subjects. The digital level helped to accurately calibrate the rangefinder, rendering the inclination in degrees (°). The subjects did not wear footwear.

The Omron analyzer reported body mass (kg), BMI (kg/m2), body fat (%), muscle mass (%) and basal metabolic rate (kcal). Subjects were barefoot.

Explosive power tests

The Squat Jump, Countermovement Jump and Abalokov's Jump protocols were applied to determine the explosive power of the lower limbs. The JustJump system was used (Coteață & Nistor, 2025). The Squat Jump was a vertical jump from an isometric position held for 3 seconds, with the hands always on the hips and the knees extended during the jump. The Countermovement test is similar, except that isometry is no longer maintained for 3 seconds. The Abalakov's Jump consisted of a vertical jump preceded by an arm swing. Their height in cm was determined.

Isometric strength lower limbs

The Axis FB5k dynamometer was used to assess the isometric strength of the adductor muscles of the lower limbs. Subjects were positioned on a chair with their feet parallel to the floor and knees bent at a 90° angle. The dynamometer was placed at the thighs, close to the knee joint, with two brackets for fixation. The teenagers pressed the dynamometer until the Axis system emitted a sound to register the value. The result was rendered in kgf (*Figure 1.a.*).

Isometric strength upper limbs

Upper limb strength was determined by two protocols, pressing and pulling. Using the same handgrip dynamometer, subjects performed the test with their arms bent at chest level until the dynamometer system beeped to record the result. They performed the pressure test first, then the tension test (*Figure 1.b.*).

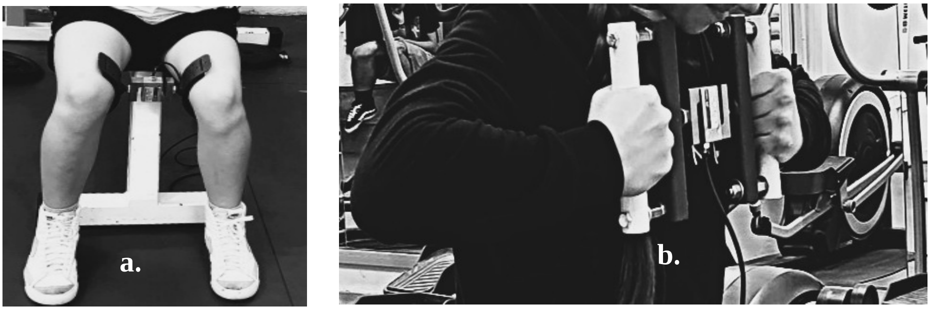

Fig. 1. Isometric test (a. lower limbs, b. upper limbs)

Statistical analysis

Pearson's correlation was used to calculate the r coefficient to analyze the relationship between explosive power and isometric strength of the lower and upper limb. Based on the values obtained for r, the level of correlation was interpreted as follows: 1 - perfect, above 0.75 - strong, between 0.50 and 0.75 - moderate, between 0.25 and 0.50 - acceptable, and below 0.25 - weak (Colton, 1974). The statistical significance threshold for the applied tests was set at $p < 0.05$.

RESULTS

The aim of our study is to determine the relationships between isometric lower and upper limb and explosive lower limb strength among adolescents in the region of Moldova, Romania. Our sample was divided by gender, in order to observe the correlation between the 3 variables for both genders, as well as for the whole group. *Table 2* presents the results obtained by the group in the strength tests.

Table 2. Results of variables by gender

Tests	N	Girls	N	Boys	N	Overall
		Mean ± SD		Mean ± SD		Mean ± SD
Squat Jump (cm)	21	27.66±3.76	28	37.63±6.38	49	33.36±7.32
Countermovement Jump (cm)	21	29.32±4.49	28	39.61±6.89	49	35.20±7.85
Abalakov's Jump (cm)	21	33.70±5.64	28	45.08±8.54	49	40.20±9.31
Isometric strength LL – Add. Pres. (kgf)	19	26.01±5.39	28	40.82±7.25	49	34.47±9.82
Isometric strength UL – Pres. (kgf)	19	22.84±4.89	28	43.27±10.61	47	35.01±13.35
Isometric strength UL – Trac. (kgf)	19	16.60±3.74	28	30±6.52	47	24.58±8.64

** LL – lower limbs, UL – upper limbs, kgf – kilograms strength, Pres. – pressure, Trac. - traction*

In the girls' sample, the explosive power of the lower limbs, as measured by the Squat Jump, correlated with that determined by the Countermovement protocol, the relationship being statistically significant ($r = 0.924$, $p<0.001$). The Squat Jump also correlated statistically significantly with Abalakov's Jump ($r = 0.921$, $p<0.001$). On the other hand, no statistically significant correlations were found between the explosive power rendered by Squat Jump and the isometric strength of the lower ($r = 0.351$, $p>0.05$) and upper limbs (pressures – $r = -0.057$, $p>0.05$, traction – $r = 0.148$, $p>0.05$) (*Table 3*).

Table 3. Pearson correlation (r) between explosive power (Squat Jump) and isometric strength (girls)

Parameter 1	Parameter 2	N	Pearson correlation coefficient (r)	p
Squat Jump	***Countermovement Jump***	21	0.924**	0.000
Squat Jump	***Abalakov's Jump***	21	0.921**	0.000
Squat Jump	***Isometric strength LL – Add. Pres.***	21	0.351	0.119
Squat Jump	***Isometric strength UL – Pres.***	19	-0.057	0.816
Squat Jump	***Isometric strength UL – Trac.***	19	0.148	0.545

*** Correlation is significant at the 0.01 level (2-tailed).*

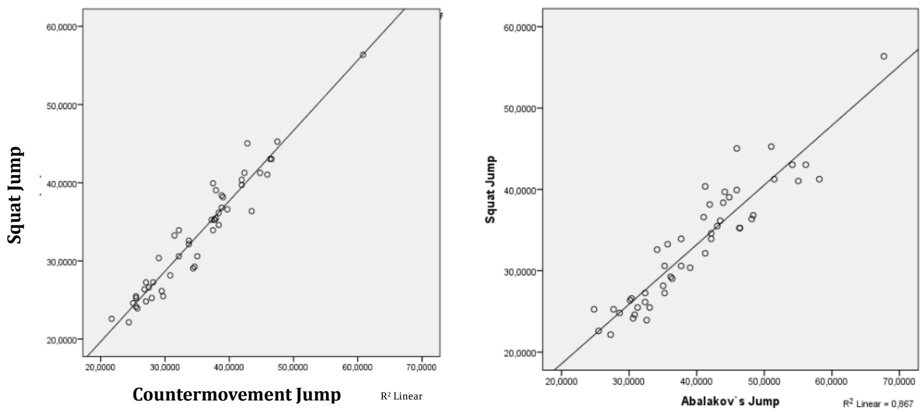

Fig. 2. Pearson correlation graph between different protocols of lower limbs explosive power (girls)

Based on the graph presented in *Figure 2.a.*, a strong positive correlation can be observed, indicating a directly proportional relationship between the two explosive power assessment protocols. Thus, the high performances obtained in the SJ test are associated with similar values in the CMJ test. The statistical analysis shows a significant relationship between the two parameters, demonstrating that participants who record a high jump height in the SJ test show corresponding trends in the values obtained in the CMJ test. The same situation is also shown in *Figure 2.b.* regarding the correlation between Squat Jump and Abalakov's Jump.

Considering the explosive power, determined by the Countermovement Jump protocol, a statistically significant relationship was observed with the explosive power as measured by Abalakov's Jump ($r = 0.861$, $p<0.001$). No correlation was found between CMJ and isometric strength ($p>0.05$).

Table 4. Pearson correlation (r) between explosive power (Countermovement Jump) and isometric strength (girls)

Parameter 1	Parameter 2	N	Pearson correlation coefficient (r)	p
Countermovement Jump	***Abalakov's Jump***	21	0.861**	0.000
Countermovement Jump	***Isometric strength LL – Add. Pres.***	21	0.293	0.197
Countermovement Jump	***Isometric strength UL – Pres.***	19	-0.140	0.569
Countermovement Jump	***Isometric strength UL – Trac.***	19	0.050	0.838

*** Correlation is significant at the 0.01 level (2-tailed).*

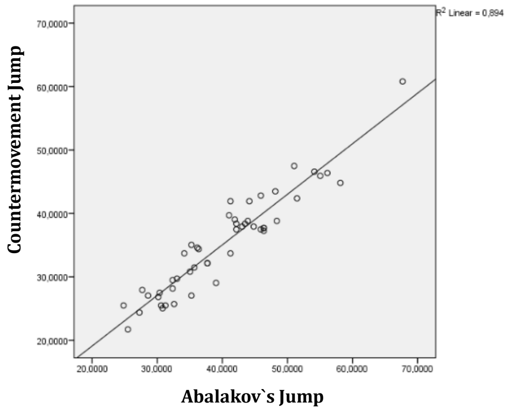

Fig. 3. Pearson correlation graph between Countermovement Jump and Abalakov's Jump (explosive power - girls)

Figure 3 shows a close association between the CMJ and Abalakov test values, confirming the consistency of the explosive power in both tests. The positive correlation identified indicates that high performance in the CMJ test is accompanied by similar results in the Abalakov test, suggesting the involvement of comparable neuromuscular mechanisms.

Similar to the connection between SJ, CMJ protocols and isometric lower and upper limb isometric strength, explosive power, as reproduced by Abalakov's Jump, did not correlate with the pressure and tensile strength tests ($p>0.05$) (*Table 5*).

Table 5. Pearson correlation (r) between explosive power (Abalakov's Jump) and isometric strength (girls)

Parameter 1	Parameter 2	N	Pearson correlation coefficient (r)	p
Abalakov's Jump	***Isometric strength LL – Add. Pres.***	21	0.405	0.069
Abalakov's Jump	***Isometric strength UL – Pres.***	19	0.085	0.729
Abalakov's Jump	***Isometric strength UL – Trac.***	19	0.312	0.194

Statistically significant correlations were found between lower limb isometric strength based on the pressure protocol and upper limb isometric strength determined by traction ($r = 0.487$, $p<0.05$). Also, upper limb isometric strength values rendered by pressure and traction were significantly correlated ($r = 0.601$, $p<0.05$) (*Table 6*).

Table 6. Pearson correlation (r) between different protocols of isometric strength for upper and lower limbs (girls)

Parameter 1	Parameter 2	N	Pearson correlation coefficient (r)	p
Isometric strength LL – Add. Pres.	***Isometric strength UL – Pres.***	19	0.231	0.341
Isometric strength LL – Add. Pres.	***Isometric strength UL – Trac.***	19	0.487*	0.035
Isometric strength UL – Pres.	***Isometric strength UL – Trac.***	19	0.601*	0.006

** Correlation is significant at the 0.05 level (2-tailed).*

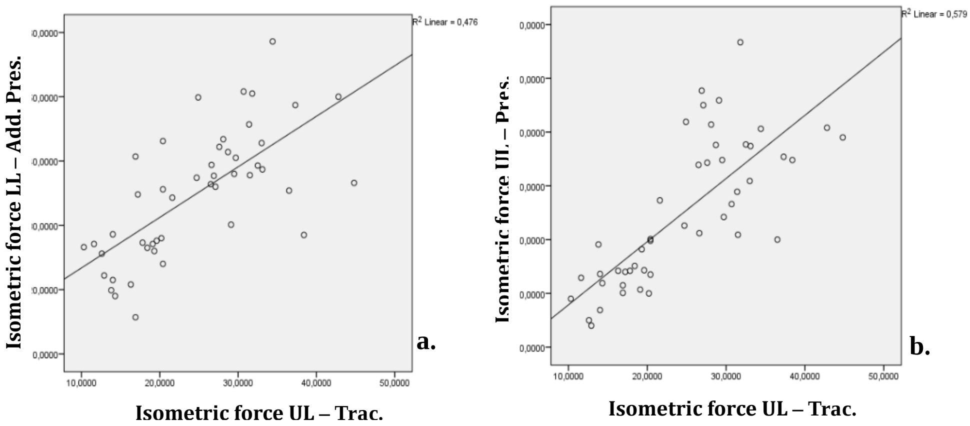

Fig. 4. Pearson correlation graph between different protocols of isometric strength for upper and lower limbs (girls**)**

Considering *Figure 4.a.*, an acceptable-moderate positive linear regression is observed based on the correlation between the isometric strength of the lower and upper limbs isometric strength by two different protocols, pressure and traction. Thus, the values from testing the isometric strength of the lower limb isometric strength by pressure will be in the same trend as those from testing the upper limb isometric strength by traction. Referring to *Figure 4.b.*, the same trajectory is observed between the pressure and tensile protocols of the upper limb isometric strength testing.

Table 7. Pearson correlation (r) between explosive power (Squat Jump) and isometric strength (boys)

Parameter 1	Parameter 2	N	Pearson correlation coefficient (r)	p
Squat Jump	***Countermovement Jump***		0.941**	0.000
Squat Jump	***Abalakov's Jump***		0.880**	0.000
Squat Jump	***Isometric strength LL – Add. Pres.***	28	0.034	0.119
Squat Jump	***Isometric strength UL – Pres.***		0.173	0.816
Squat Jump	***Isometric strength UL – Trac.***		0.249	0.545

*** Correlation is significant at the 0.01 level (2-tailed).*

Just as for girls, statistically significant correlations were found between the Countermovement (r = 0.941, p<0.001) and Abalakov's Jump (r = 0.880, p<0.001) protocols with the Squat Jump lower limb explosive power test. The same trend held for boys, the links between explosive power rendered by SJ and isometric strength were not significant (*Table 7*).

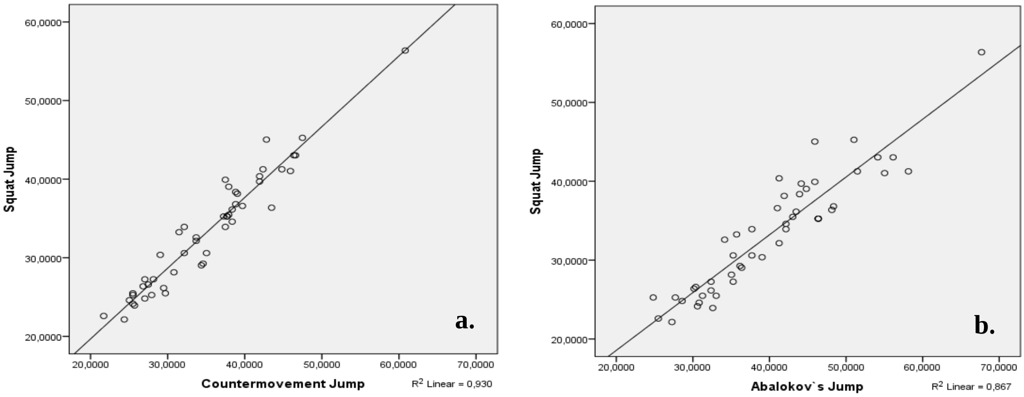

Fig. 5. Pearson correlation graph between different protocols of explosive power for lower limbs (boys)

Figure 5.a. predicts a strong positive correlation between the SJ and the CMJ, these two protocols having a directly proportional relationship in the evaluation of explosive power. The same trend can also be seen in *Figure 5.b.*, that the results obtained by the boys in the Squat Jump will follow the same trajectory as those recorded in the Abalakov's Jump, with the evolution of the explosive power performance being similar.

Table 8. Pearson correlation (r) between explosive power (Countermovement Jump) and isometric strength (boys)

Parameter 1	Parameter 2	N	Pearson correlation coefficient (r)	p
Countermovement Jump	***Abalakov's Jump***		0.927**	0.000
Countermovement Jump	***Isometric strength LL – Add. Pres.***		-0.050	0.800
Countermovement Jump	***Isometric strength UL – Pres.***	28	0.109	0.580
Countermovement Jump	***Isometric strength UL – Trac.***		0.208	0.287

*** Correlation is significant at the 0.01 level (2-tailed).*

The Countermovement Jump values were statistically significantly correlated with the explosive power measured by Abalakov's Jump (r = 0.927, p<0.001). In contrast, no correlation between CMJ and isometric strength (p>0.05) was found among the boys sample (*Table 8*).

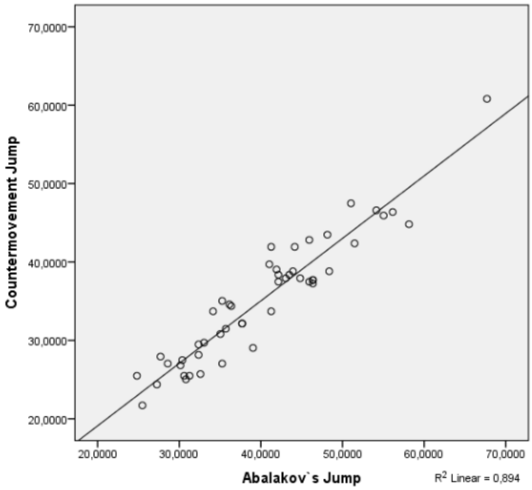

Fig. 6. Pearson correlation graph between Countermovement Jump and Abalakov's Jump (explosive power - boys)

Figure 6 shows the strong association between CMJ and Abalakov lower limb explosive power tests. This positive correlation indicates that performance on the two protocols will have similar trends.

The results in *Table 9* demonstrate the same situation found in the girls' sample, the explosive power as measured by Abalakov's Jump did not correlate with the isometric strength as determined by the 3 protocols (p>0.50).

Table 9. Pearson correlation (r) between explosive power (Abalakov's Jump) and isometric strength (boys)

Parameter 1	Parameter 2	N	Pearson correlation coefficient (r)	p
Abalakov's Jump	***Isometric strength LL – Add. Pres.***		-0.155	0.431
Abalakov's Jump	***Isometric strength UL – Pres.***	28	-0.054	0.786
Abalakov's Jump	***Isometric strength UL – Trac.***		0.070	0.722

As in the case of girls, the results obtained by adolescent boys when testing isometric upper limb isometric strength by the two protocols, pressure and traction, show a statistically significant correlation (r = 0.396, p<0.050) (*Table 10*).

Table 10. Pearson correlation (r) between different protocols of isometric strength for upper and lower limbs (boys)

Parameter 1	Parameter 2	N	Pearson correlation coefficient (r)	p
Isometric strength LL – Add. Pres.	***Isometric strength UL – Pres.***	28	0.266	0.172
Isometric strength LL – Add. Pres.	***Isometric strength UL – Trac.***		0.215	0.272
Isometric strength UL – Pres.	***Isometric strength UL – Trac.***		0.396*	0.037

** Correlation is significant at the 0.05 level (2-tailed).*

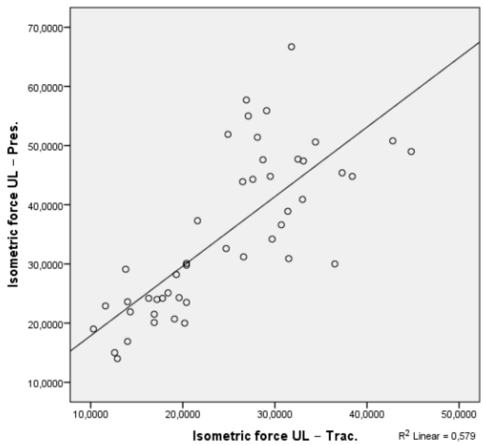

Fig. 7. Pearson correlation graph between isometric strength protocols for upper limbs (boys)

Figure 7 indicates an acceptably-moderate positive regression trajectory for the pressure and tensile protocols of the upper limb isometric strength test. Thus, if high values are recorded for the pressure test, the same situation will follow for the upper limb isometric strength test by traction.

For the whole sample, explosive power testing by Squat Jump correlated statistically significantly with the CMJ (r = 0.964, p<0.001) and Abalakov (r = 0.931, p<0. 001), which determine the same variable, as well as with the isometric strength tests of the lower limb (r = 0.567, p<0.001) and upper limb, both pressure (r = 0.594, p<0.001) and pull (r = 0.642, p<0.001) (*Table 11*).

Table 11. Pearson correlation (r) between explosive power (Squat Jump) and isometric strength (overall)

Parameter 1	Parameter 2	N	Pearson correlation coefficient (r)	p
Squat Jump	***Countermovement Jump***	49	0.964**	
Squat Jump	***Abalakov's Jump***	49	0.931**	
Squat Jump	***Isometric strength LL – Add. Pres.***	47	0.567**	0.000
Squat Jump	***Isometric strength UL – Pres.***	47	0.594**	
Squat Jump	***Isometric strength UL – Trac.***	47	0.642**	

*** Correlation is significant at the 0.01 level (2-tailed).*

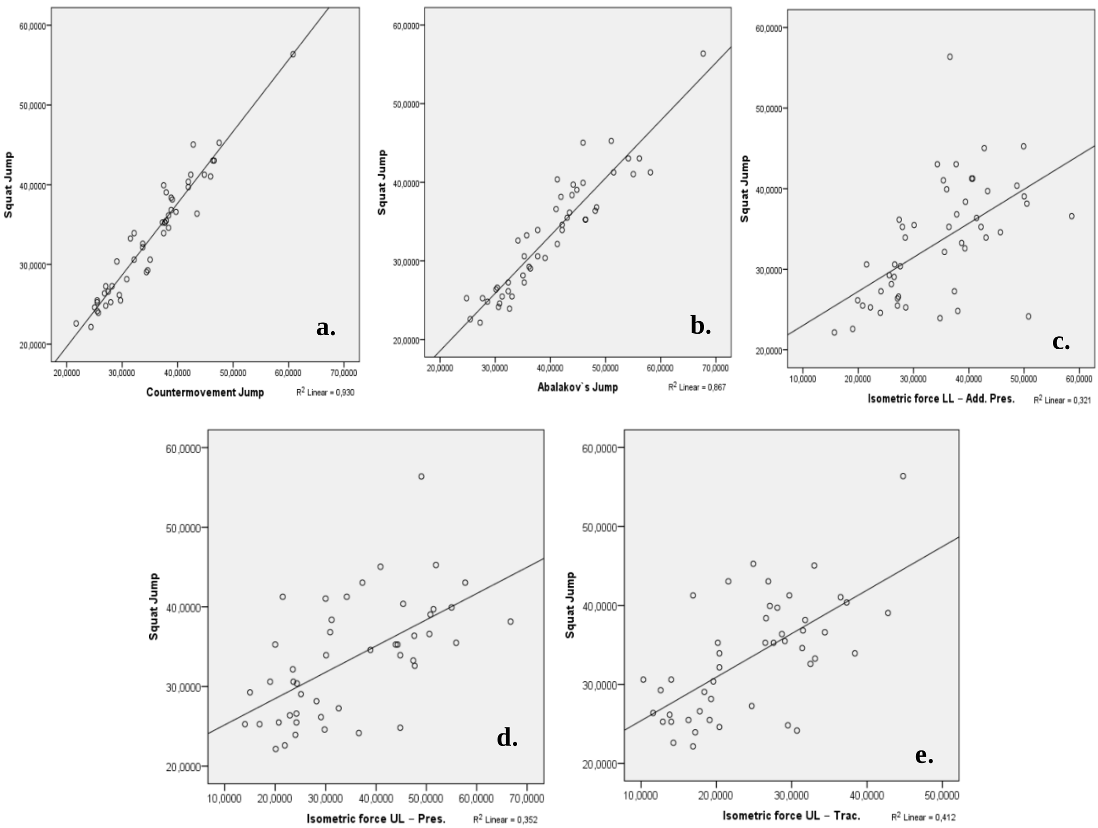

Fig. 8. Pearson correlation graph between explosive power (Squat Jump) and isometric strength (overall)

Figure 8 shows 2 strong positive correlations between the explosive power rendered by Squat Jump, Countermovement Jump (*Figure 8.a.*) and Abalakov's Jump (*Figure 8.b.*), with a directly proportional relationship between these three protocols. Thus, the high performances obtained in the SJ test are associated with similar values in the CMJ and Abalakov test. There are also three moderately strong positive relationships between explosive power (SJ test) and isometric strength of the lower limbs determined by pressure (*Figure 8.c.*) and isometric strength of the upper limbs determined by the pressure (*Figure 8.d.*) and traction (*Figure 8.e.*) protocols. Subjects who perform significantly on the SJ test will have the same trajectory among the values obtained on the three isometric tests.

According to the results in *Table 12*, CMJ was statistically significantly correlated with Abalakov ($r = 0.945$, $p<0.001$), as well as with isometric strength of the lower limb ($r = 0.514$, $p<0.001$) and upper limb (pressure: $r = 0.540$, $p<0.001$, traction: $r = 0.598$, $p<0.001$).

Table 12. Pearson correlation (r) between explosive power (Countermovement Jump) and isometric strength (overall)

Parameter 1	Parameter 2	N	Pearson correlation coefficient (r)	p
Countermovement Jump	***Abalakov's Jump***	49	0.945**	0.000
Countermovement Jump	***Isometric strength LL – Add. Pres.***	47	0.514**	
Countermovement Jump	***Isometric strength UL – Pres.***	47	0.540**	
Countermovement Jump	***Isometric strength UL – Trac.***	47	0.598**	

*** Correlation is significant at the 0.01 level (2-tailed).*

Just as in the case of the SJ protocol, according to *Figure 9*, a strong positive correlation is observed between the explosive power and Abalakov's Jump (*Figure 9.a.*), the ratio between the 2 being directly proportional. Between the explosive and isometric strength of the lower (pressure - *Figure 9.b.*) and upper limbs (pressure - *Figure 9.c.* and traction - *Figure 9.d.*), as rendered by the 3 protocols, there are three positive links with moderate intensity, thus those who perform significantly in the CMJ test will have the same trajectory among the values obtained in the isometric strength tests.

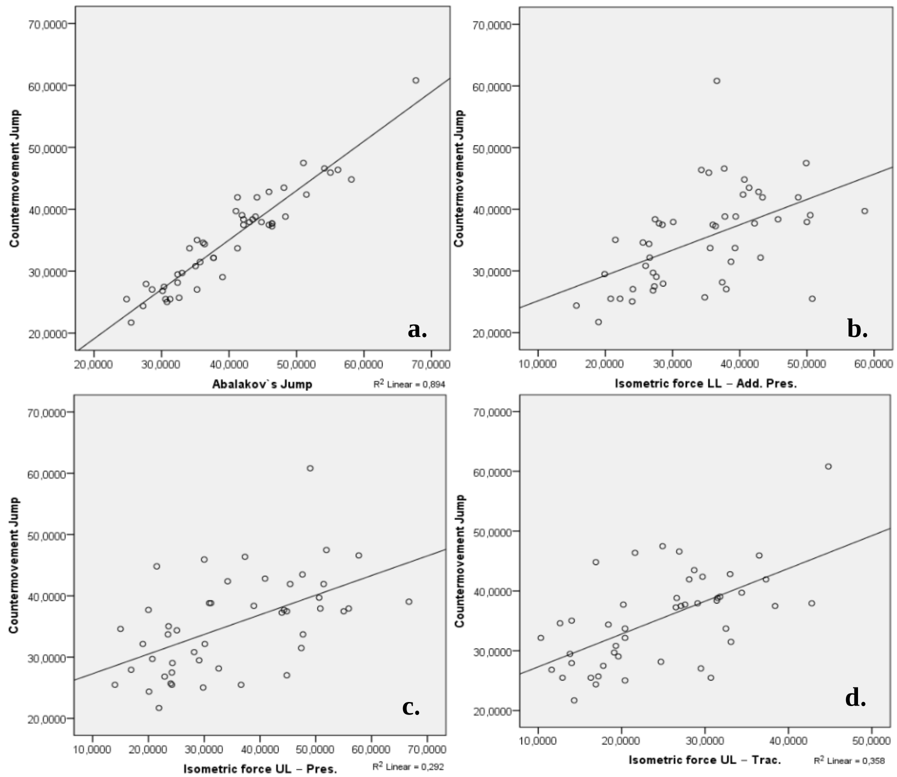

Fig. 9. Pearson correlation graph between explosive power (Countermovement Jump) and isometric strength (overall)

Table 13 indicates statistically significant correlations between Abalakov's Jump and isometric strength of the lower limb, determined by pressure (r = 0.457, p<0.001), and upper limb, determined by pull (r = 0.457, p<0.001), for both protocols: pressure - r = 0.461, p<0.001, pull - r = 0.541, p<0.001).

Table 13. Pearson correlation (r) between explosive power (Abalakov's Jump) and isometric strength (overall)

Parameter 1	**Parameter 2**	**N**	**Pearson correlation coefficient (r)**	**p**
Abalakov's Jump	***Isometric strength LL – Add. Pres.***		0.457**	
Abalakov's Jump	***Isometric strength UL – Pres.***	47	0.461**	0.000
Abalakov's Jump	***Isometric strength UL – Trac.***		0.541**	

*** Correlation is significant at the 0.01 level (2-tailed).*

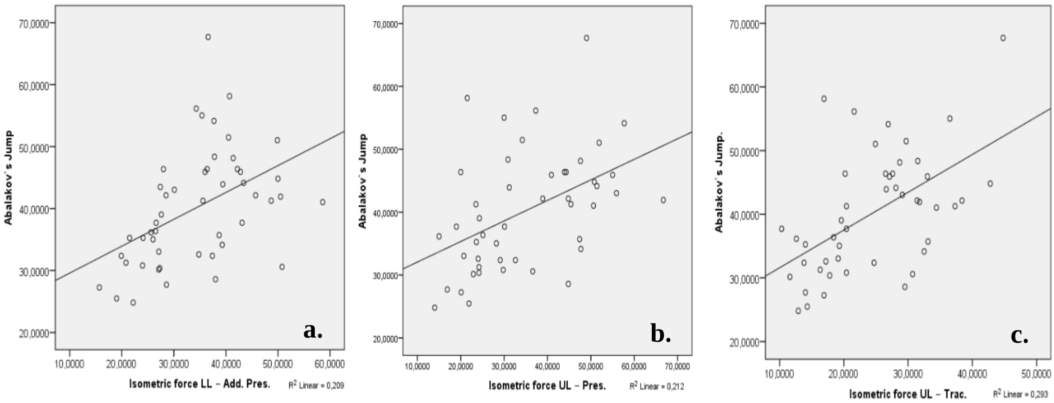

Fig. 10. Pearson correlation graph between explosive power (Abalakov's Jump) and isometric strength (overall)

The explosive power (Abalakov's Jump) shows moderate relationships with the isometric strength, as determined by pressure, of the lower (*Figure 10.a.*) and upper (*Figure 10.b.*) limbs. In contrast, there is a strong positive correlation between the arm-elbow jump protocol and the isometric strength of the upper extremity as determined by pull (*Figure 10.c.*).

The explosive power testing protocols formed statistically significant relationships with each other. The lower train strength correlated with the upper train strength, as rendered by pushing the handles (r = 0.657, p<0.001) and pulling the handles (r = 0.690, p<0.001). Connections were also observed between the two methods of testing isometric hand strength (r = 0.761, p<0.001) (*Table 14*).

Table 14. Pearson correlation (r) between different protocols of isometric strength for upper and lower limbs (overall)

Parameter 1	**Parameter 2**	**N**	**Pearson correlation coefficient (r)**	**p**
Isometric strength LL – Add. Pres.	***Isometric strength UL – Pres.***		0.675**	
Isometric strength LL – Add. Pres.	***Isometric strength UL – Trac.***	47	0.690**	0.000
Isometric strength UL – Pres.	***Isometric strength UL – Trac.***		0.761**	

*** Correlation is significant at the 0.01 level (2-tailed).*

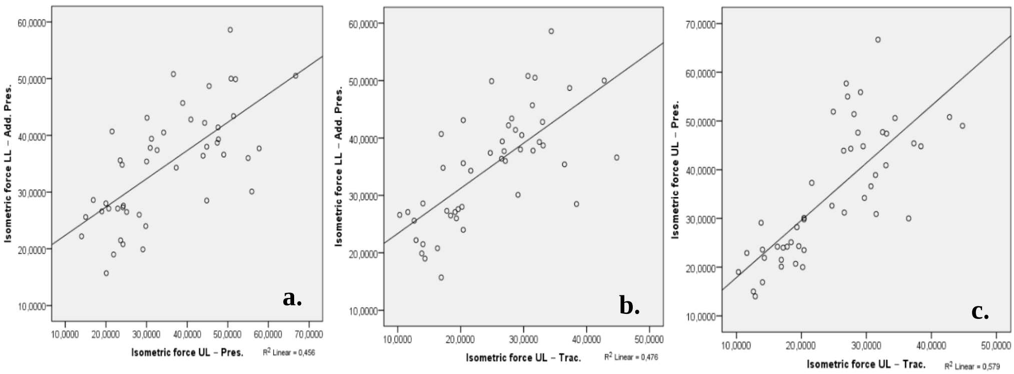

Fig. 11. Pearson correlation graph between isometric strength protocols for upper and lower limbs (overall)

According to the graphs in *Figure 11*, moderate positive correlations were found between the isometric lower-train isometric strength with the isometric arm strength tests by pressure (*Figure 11.a.*) and tension (*Figure 11.b.*). A strong positive correlation was observed between the two protocols for measuring isometric upper-train isometric strength (*Figure 11.c.*).

DISCUSSIONS

Our research has determined links between explosive (SJ, CMJ, Abalakov) and isometric strength of the upper (pressure and traction measurements) and lower limbs. Among girls, isometric strength correlations were found between lower and upper extremity isometric strength as well as between the two methods of measuring hand isometric strength. In adolescent boys, however, only a statistically significant correlation was observed between the two upper limb isometric strength testing procedures.

This association supports data in the literature showing a strong link between the ability to generate maximal or near maximal isometric strength with the ability to produce explosive power in dynamic movements, particularly when isometric tests are biomechanically positioned similarly to dynamic movement (Pasfield et al., 2024, Grzyb et al., 2025; Akoğlu et al., 2025; Shiba, 2023). Similarly, Fahey et al. (2025) found in adolescent female soccer players moderate-to-strong correlations between relative isometric strength (IMTP) and CMJ/Rebound-Jump performance. França et al. (2023) revealed that upper limb strength (handgrip) is one of the fundamental predictors of vertical jumps.

Similar to the age range of our study, Rago et al. (2024) found moderately-strong correlations (r = 0.61-0.78) between isometric strength measured by Isometric Mid-Thigh Pull (IMTP) and Countermovement Jump Height (CMJ) among young athletes (13-17 years). Naim et al. (2024) tested a group of professional football players and found correlations between handgrip strength and isometric lower limb isometric strength (r = 0.52) and CMJ jump. The same conclusion was determined by Ferrero-Hernández et al. (2023), who analyzed adolescents in Europe. Relative to gender, Patti et al. (2022) showed an association between upper limb strength (handgrip) and strength at CMJ, with values of r = 0.60 among boys and r = 0.48 among girls.

Some authors have concluded that strength, speed and agility correlate in adolescents. These studies observing adolescent development contribute to our understanding of how the body behaves physically during a period of biological change (Trofin et al., 2023).

Possible mechanisms that explain these correlations include neuromuscular factors (motor activation and coordination), muscle-tendon properties (stiffness/elasticity) and strength transfer between segments (e.g. role of the arms in Abalakov jump performance). Data from the literature concluded that isometric variables (peak strength, rate of strength development), obtained from standardized tests (IMTP or specific isometric tests), can contribute to a better understanding of the variation in jumping performance, especially when biological maturation and body composition are taken into account (Rago et al., 2024, Dobbs et al., 2020). Hughes et al. (2022) concluded that the strength-time analysis of SJ and CMJ protocols shows that isometric parameters (RFD and peak strength) determine more than 50% of the jump variability.

Another variable on which the correlations of the present study may depend is the process of biological maturation. Some studies indicate that, in adolescence, the pattern of muscle mass development and its distribution may influence both isometric strength and jumping performance (explosive power), and these processes are shaped by variations in biological maturation. França et al. (2023) recommending gender-relative data interpretation. The studies by Curovi et al. (2024) and Correia et al. (2024) support the hypothesis that there is a relationship between upper-train strength and vertical jump performance.

CONCLUSION

The results of the study showed significant correlations between lower extremity explosive power, as measured by Squat, Countermovement and Abalakov jumps, and isometric lower and upper extremity strength. These links confirm the literature evidence that explosive performance is closely related to the neuromuscular ability to rapidly develop maximal strength, regardless of the body segment involved (Grzyb et al., 2025; Rago et al., 2024; Akoğlu et al., 2025).

The correlations identified in the fetor group, between isometric adductor and upper extremity tensile isometric strength, may suggest the existence of a global strength profile, which may be influenced by factors such as biological maturity and intersegmental coordination. Some specialists support the hypothesis that the balanced development of upper and lower muscle chains favors dynamic performance and reduces the risk of functional imbalances (Curović et al., 2024; Correia et al., 2024; Correia et al., 2024; Quintana-Cepedal et al., 2024).

The present study concluded that the strength of the lower limb muscles, particularly those involved in vertical jump execution, significantly influences jump performance. This association was most evident across the total sample, suggesting that isometric lower-limb strength contributes meaningfully to explosive performance capacity. However, since these relationships were predominantly observed in the combined group rather than consistently across genders, further studies with larger and more balanced samples are required to confirm and clarify gender-specific patterns.

AUTHOR CONTRIBUTIONS

Coteață Maria-Andreea and Ungurean Bogdan-Constantin contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript. All authors have read and agreed to the published version of the manuscript.

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