THE EFFECTIVENESS OF A STRENGTH TRAINING PROGRAM IN IMPROVING SPRINT AND JUMP PERFORMANCE IN MALE STUDENT FOOTBALL TEAMS

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Abstract The purpose of this study was to enhance the training process for university students by using effective methods and means designed to improve lower-limb strength. Thirty-two university students (male), aged 18–20 years, from two different universities voluntarily participated in the study. Participants were divided into two groups: an experimental group (N = 16) and a control group (N = 16). The research took place during the academic year, training typically consisted of two sessions per week, each lasting 90 minutes on the football field. In order to achieve the proposed goal and verify the hypothesis, we introduced a lower limb strength training program—incorporating the independent variables—into the experimental group's preparation, allocating 15–20 minutes per lesson. Meanwhile, the control group continued with their usual training program. This intervention formed part of the student's in-season conditioning program. The results indicate that in the post-intervention phase, the experimental group achieved significantly better outcomes than the control group across several key performance indicators. This progress can be attributed to the effective methods and means employed, the proper implementation of their structure, consistent training, and well-organized sessions. The findings of this study confirm the efficacy of a structured lower-limb strength training program in enhancing sprint and jump performance among male university football players. The observed improvements underscore the pivotal role of strength-based interventions in developing essential physical attributes necessary for football-specific actions, including sprinting, jumping, and rapid directional changes.

Keywords: *football, jump, sprint, strength training, student*

Introduction

Football is universally recognized as the most popular sport across the globe, engaging millions of players of various ages and competitive levels, including those at the university sports level (Stølen et al., 2005). Sports performance in modern football is influenced by a complex network of factors, including technical execution, tactical decision-making, psychological preparedness, and physiological capabilities. It is the synergy among these components that defines the holistic nature of the sport, and the high physical and cognitive demands placed on players throughout a match.

The physiological profile of football is characterized by intermittent patterns of activity that alternate between low-intensity efforts and high-to-maximal intensity actions such as sprinting, tackling, jumping, turning, and sudden accelerations or decelerations (Bangsbo, 1994). Although high-intensity actions account for a limited portion of the overall distance covered during a match, they are crucial due to their frequent association with decisive phases of play, such as scoring opportunities or key defensive interventions (Reilly, et. al., 2000; Bush et. al., 2015).

While all these components contribute to performance, physical capacity—particularly explosive strength and power—has emerged as a decisive factor in match outcomes (Reilly et. al., 2000). These motor components have been identified as key physical factors underlying athletic success. Sprinting and vertical jumping are being directly associated with both offensive and defensive succes during the game (Stølen et al., 2005; Faude et al., 2012). They frequently occur during game-defining moments such as goal scoring, defensive recoveries, or transitions (Reilly et. al., 2000; Bush et al., 2015).

Research by Faude, Koch, and Meyer (2012) highlights that sprinting and jumping are not only frequent during game play but also strongly associated with successful offensive and defensive actions. Contemporary studies indicate that players in elite European leagues typically cover between 9 and 14 kilometers per match, including approximately 900 meters at high-speed running (>19.8 km/h) and around 300 meters at sprint speed (>25.2 km/h). Additionally, over 700 directional changes may occur during a game, with substantial variation based on positional role (Asimakidis et al., 2024). In this context, the development and optimization of neuromuscular function through strength training programs have become a central focus of athletic preparation, including within the university environment. At the university level, physical training must integrate modern and efficient methods adapted to the students' training status and their biological and functional characteristics.

The goal is to improve physical performance without compromising health or structural integrity (Kraemer & Ratamess, 2004). Some studies highlight the significant benefits of strength training programs incorporating exercises such as squats, Romanian deadlifts, and Nordic hamstring curls, demonstrating positive effects on maximal strength, sprinting speed, and jumping ability (Suchomel et al., 2016; Mendiguchia et al., 2013). Other studies demonstrate that conventional exercises such as half-squatting weight-bearing, half-squatting jumping weight-bearing, and leapfrog provide a stimulus to the lower limb muscles to encourage the development of the strength of the lower limb muscles.

Exercises such as the countermovement jump and squat jump are commonly used to assess these muscles (Comfort et al., 2014; Suchomel et al., 2016; de Hoyo et al., 2016). Plyometric training, a form of high-velocity strength training, has been widely researched in young athletes (Zubac et al., 2019). Its benefits include: improved neural drive to agonist muscles, enhanced muscle activation patterns, structural and size-related adaptations in muscles, and improved efficiency in single muscle fiber kinetics (Markovic & Mikulic, 2010). Moreover, relative strength (adjusted to body weight) has shown a strong correlation with acceleration and jumping ability, especially in young and moderately experienced players (Wisloff et al., 2004; Loturco et al., 2015).

Well-structured training programs have demonstrated significant improvements in key performance indicators including sprint times, change-of-direction speed, and jump height (Suchomel et. al., 2016; Mendiguchia et. al., 2013). These adaptations are particularly relevant in elite and semi-professional environments, where performance margins are increasingly narrow and competition is intense.

Performance evaluation in the university sports context requires validated methods that are applicable under real field conditions. It is well known that the development of basic football skills assessment is progressing in parallel with the increasing level of expertise and competencies in the fundamental aspects of the sport (Akbar et al., 2024; Liza et al., 2024; Paixao et al., 2021).

Despite increasing interest in performance optimization at the university level, current literature offers limited insights into the effectiveness of strength training protocols specifically designed for male university football teams.

Assessment is broadly acknowledged as a crucial element of education, as inaccurate evaluation can obstruct the attainment of learning goals. Assessments need to be adapted to align with the unique needs and characteristics of the target population (Nusri et al., 2024).

In this context, the present study aims to investigate the effectiveness of a targeted lower-limb strength training program on sprint and jump performance in male university football teams.

Research objective and tasks

The purpose of this study was to enhance the training process for university students by using effective methods and means designed to improve lower-limb strength. To achieve this aim, we set out to accomplish the following tasks:

• Undertake a thorough review of the scientific literature to identify appropriate methods and strategies for optimizing lower-limb strength in the field of football;

• Outline the research stages and develop the hypothesis;
• Select subject groups and assign them to experimental and control conditions;
• Choosing and applying tests to assess the of sprint and jump performance;
• Designing and implementing methods and means of intervention in accordance with the students' physical and biomotor development, aiming to optimize strength;
• Empirically validating the designed training program and assessing the effectiveness of the applied methodology through data collection, processing, and analysis;
• Draw conclusions based on the research findings.

Research hypothesis

We hypothesize that the implementation of a structured lower-limb strength training program may lead to significant improvements in sprint and jump performance among male university-level football players.

Materials and methods

The research used a comparative approach and a quantitative analysis.

The methods used in this research included: the bibliographic study method, direct and indirect observation (observation of students during training sessions through and the analysis of planning documents), pedagogical experiment of ascertaining type method, the mathematical and statistical method.

Participants

Thirty-two university students (male), aged 18–20 years, from two different universities from Bucharest, Romania (the National University of Science and Technology Politehnica of Bucharest and Ecological University of Bucharest) voluntarily participated in the study. The students were informed in advance about the training plans and assessment methods.

Criteria for inclusion and exclusion

Participants were selected based on specific criteria: being enrolled as students, having at least 10 years of football experience, being between 18 and 22 years old and demonstrating willingness to participate in the study by providing informed consent. Individuals who did not meet these criteria or had injuries were excluded from the intervention.

Ethics

At the begining of the study, all investigated subjects were clinically healthy, and had no injuries that could have negatively impacted their health during the study. The study was conducted according to the Declaration of Helsinki. All players were required to sign an informed consent in which the entire evaluative and experimental process was detailed.

Research organization

Participants were divided into two groups: an experimental group (N = 16) and a control group (N = 16). The experimental part of the study was conducted at the National University of Science and Technology Politehnica of Bucharest.

The research took place during the 2023–2024 academic year, from November 2023 to April 2024, as part of the regular training schedule.

Stages of the study

Stage I took place on November 6–7, 2023, and included the pre - testing of the two groups: experimental and control. The pre-testing aimed to assess the initial level of lower limb strength, sprint and jump performance. The analysis and interpretation of the obtained results provided important information, which were landmarks in the development of strength training program.

Stage II occurred from November 8, 2023, to April 22, 2024, and involved introducing the independent variable—specific methods and techniques aimed at developing lower-limb strength—into the experimental group's training process.

Stage III took place on April 23–24, 2024, and comprised the post - testing of both groups. This phase completed the experimental part of the study.

Instruments

The tests conducted during the initial and final evaluations were as follows:

- Test 1: 10 m agility shuttle (2x10 m);
- Test 2: 30 m sprint;
- Test 3: Plyometric Jump (PJ);
- Test 4: Counter Movement Jump (CMJ).

For Tests 1 and 2, performance was assessed by timing the completion of both the 10 m agility shuttle (2x10 m) and the 30 m sprint.

Lower limb strength was assessed using Plyometric Jump (PJ) and Counter Movement Jump (CMJ) tests administered with the Myotest Pro device. Before testing, a specific 10-minute warm-up was performed, consisting of 5 minutes of jump exercises followed by 5 minutes of stretching exercises.

The PJ test measures the contractile properties and intermuscular coordination of the lower limb muscles, providing information about jump quality and its impact on performance. Participants were instructed to perform five repetitions, aiming to reach maximum jump height while minimizing ground contact time. The device recorded the three best jumps, and the average of those three was stored in its memory.

For the CMJ test, participants executed a maximal vertical jump from a standing position, hands placed on their hips, by first flexing the lower limbs and then immediately extending them. After returning to a standing position, participants received a brief rest period of a few seconds between each of the five jumps. The mean jump height (in centimeters) from these attempts was used for further analysis.

In all tests, participants were advised to jump as high as possible.

Data analysis

Data analysis was conducted using IBN SPSS Statistic 20 and Excel Microsoft 365 following these steps:

- statistical analysis was performed to calculate the arithmetic mean (AM), standard deviation (SD), coefficient of variability (CV) for both the control and experimental groups;
- CMJ, PJ and sprinttest results from the initial and final assessments were compared between the control and experimental groups using the independent t-test. According to Fisher's table, critical t-test value for n = 16, critical t-value = 2.042. The significance level was set at $p < 0.05$.

Data presentation was both tabular and graphical.

Design of the study

After designing a training program that incorporates operational structures aimed at improving jump and sprint performance, the pre-testing was carried out. The training program spanned six months and utilized methods specifically tailored to enhance physical performance. When planning and dosing these methods, the students' pre-test jump and sprint performance levels were carefully considered.

Both groups completed twice-weekly training sessions during the study intervention. In order to achieve the proposed goal and verify the hypothesis, we introduced a lower limb strength training program—incorporating the independent variables—into the experimental group's preparation, allocating 15–20 minutes per lesson. Meanwhile, the control group continued with their usual training program.

This intervention was part of the student's in-season conditioning program.

Training intervention

Training was conducted over six months during the academic year to achieve the study's objectives. It typically included two sessions per week, each lasting 90 minutes and taking place on the football field. Twice a week, the applied training program included 15–20 minutes of plyometric and conventional exercises. The planning of the training sessions involved several fundamental steps, including the establishment of operational objectives and the selection of appropriate methods and means (operational structures). The operational objectives were to develop the lower-limb strenght.

Thematic learning units were developed that included plyometric exercises such as quick leaps, jumps, and box jumps as well as conventional exercises such as half-squats, weight-bearing exercises ,back squats, half-squat jumps with weights, leapfrog drills.

The means used had a level of complexity appropriate to the students' training level and age, allowing for execution at maximum speed and efficiency with minimal effort. These have been optimized and standardized, with rest intervals and duration designed to ensure the proper recovery of key physiological indicators. The volume load of sessions was manipulated through the repetitions and sets.

Below is an example of the program implemented during weeks 1–2 (Table 1) and weeks 5–6 (Table 2) of the study

Table 1 *Conventional Strength Training Program during weeks 1-2*

Conventional Means	Sets	Reps	Intensity	Rest
Back squats (barbell)	4	6-8	50-60%	90 s
Walking lunges (DB)	3	60 s	50-60%	60 s
Standing calf raises	3	45 s	50-60%	45 s
Wall sit	2	30-60 s	50-60%	60 s

Table 2 *Plyometric training program during weeks 5-6*

Plyometric Means	**Sets**	**Reps**	**Intensity**	**Rest**
Single-leg hops (alternating legs)	3	10	40-50%	90 s
Explosive step-ups (on a step or box)	3	8 each leg	40-50%	90 s
Skater jumps (side-to-side movement)	3	12	40-50%	60 s
Drop jumps (from a low box)	3	6-8	40-50%	60 s

Results

To highlight the effectiveness of the methods and means used in preparing the experimental group and to validate the working hypothesis, the independent t-test was applied.

Following the experiment, the results obtained by the experimental and control groups in the initial and final testing phases were interpreted and comparatively analyzed. The data were recorded in datasheets and subsequently processed using statistical and mathematical methods.The results from both the initial and final tests are detailed in Tables 3 and 4.

Table 3 *Results obtained by the experimental group (EG) vs. control group (CG) in the jump and sprint performance - initial test*

	STATISTICAL AND MATHEMATICAL INDICATORS						
initial	M/±SD		Mean def	CV		independent	
test	*EG*	*CG*	*EG-CG*	*EG*	*CG*	t-test	p
CMJ							
Height	31.69 cm/±1.29	31.45 cm/± 1.26	0.24cm	4.07	4.00	0.535	>0.05
Power	28.03w/kg /± 1.03	27.70w/kg /±1.27	0.33w/kg	3.67	4.58	0.806	>0.05
Force	18.42N/kg /±0.95	18.40N/kg /±0.95	0.02N/kg	5.15	5.16	0.037	>0.05
Velocity	178.18cm/s/±7.62	178.25cm/s/±7.11	-0.07cm/s	4.27	3.98	-0.024	>0.05
PJ							
Height	23.51cm/±1.06	23.16/±1.16	0.35 cm	4.50	5.00	0.890	>0.05

Contact	279.93ms/±1.94	279.48ms/±2.17	0.44/ms	0.69	0.77	0.612	>0.05
Reactivity	1.60/±0.22	1.60/±0.03	0.00	13.75	1.87	0.066	>0.05
Stifness	9.30 N/m/±0.02	9.30 N/m/±0.02	0.00N/m	0.21	0.21	-0.793	>0.05
10 m agility shuttle (2x10m)							
	4.91 s/±0.12	4.96 s/± 0.12	0.05 s	2.44	2.46	1.154	>0.05
30 m sprint							
	4.67 s/± 0.08	4.80 s/±0.06	- 0.05 s	1.71	1.27	-1.88	>0.05

Table 4 *Results obtained by the experimental group (EG) vs. control group (CG) in jump and sprint performance – final test*

	STATISTICAL AND MATHEMATICAL INDICATORS						
final test	M/±SD		Mean def	CV		independent t-test	p
	EG	*CG*	*EG-CG*	*EG*	*CG*		
CMJ							
Height	33.43 cm/±1.09	32.06 cm/± 1.20	1.37cm	3.26	3.68	3.364	<0.05
Power	29.46w/kg /± 0.82	28.31w/kg /±1.16	1.15w/kg	2.78	4.09	3.224	<0.05
Force	20.09N/kg /±0.84	19.03N/kg /±0.90	1.06N/kg	4.18	4.72	3.440	<0.05
Velocity	189.12cm/s/±6.27	182.18cm/s/±7.92	6.94cm/s	3.31	4.34	3.75	<0.05
PJ							
Height	25.10cm/±0.99	24.14/±1.24	0.95 cm	3.94	5.13	2.400	<0.05
Contact	286.79ms/±3.26	282.55ms/±3.79	4.23/ms	1.13	1.34	3.380	<0.05
Reactivity	1.80/±0.10	1.68/±0.04	0.12	5.55	2.38	4.440	<0.05
Stiffness	9.78 N/m/±0.14	9.37 N/m/±0.03	0.41N/m	1.43	0.32	11.230	<0.05
10 m agility shuttle (2x10m)							
	4.75 s/±0.09	4.86 s /± 0.12	-0.21s	1.89	2.41	-5.7	<0.05
30 m sprint							
	4.55 s/± 0.07	4.72 s /±0.08	-0.27 s	1.53	1.65	-10.08	<0.05

Analyzing the data presented in Table 3 the following aspects can be observed:

- at the initial **Counter Movement Jump (CMJ)** assessment the mean (± SD) lower limb strength values for the male football players in the experimental group were as follows: jump height 31.69 ± 1.29 cm, power 28.03 ± 1.03 W/kg, force 18.42 ± 0.95 N/kg and velocity 178.18 ± 7.62 cm/s. Within these results the control group demonstrated a jump height of 31.45 ± 1.26 cm, power of 27.70 ± 1.27 W/kg, force of 18.40 ± 0.95 N/kg and velocity of 178.25 ± 7.11 cm/s. These results are illustrated graphically in Figure 1:

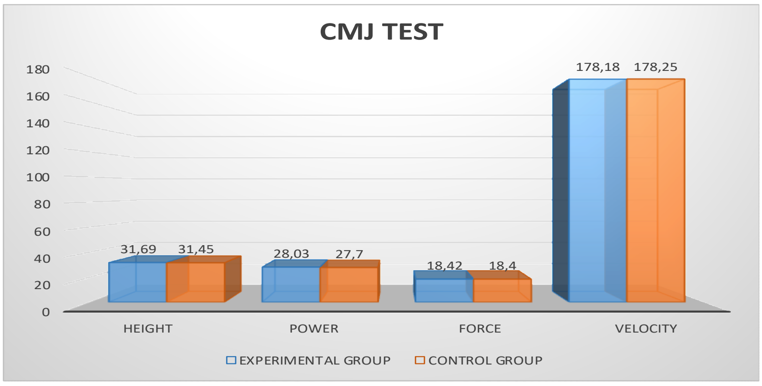

Figure 1. Dynamics of the average results obtained by the two groups in the initial testing – CMJ

- regarding **Plyometric Jump (PJ)** results were as follows: a jump height of 23.51 ± 1.06 cm, a contact time of 279.93 ± 1.94 ms, a reactivity of 1.60 ± 0.22 and a stiffness of 9.30 ± 0.02 N/m. The control group recorded a jump height of 23.16 ± 1.26 cm, a contact time of 279.48 ± 1.94 ms, a reactivity of 1.60 ± 0.03 and a stiffness of 9.30 ± 0.02 N/m (Figure 2);

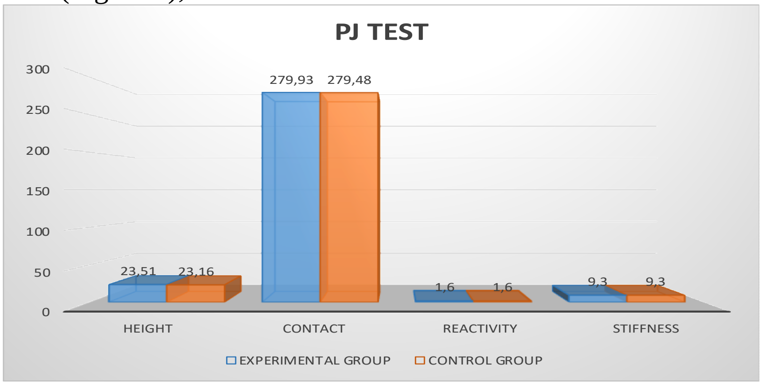

Figure 2. Dynamics of the average results obtained by the two groups in the initial testing - P

- the mean **10 m agility shuttle (2x10m)** (Figure 3) was 4.91 ± 0.12 s for the experimental group and 4.96 ± 0.12 s for the control group. Regarding the **30 m sprint test** (Figure 3) the overall mean was 4.67 ± 0.08 s for the experimental group and 4.80 ± 0.06 s for the control group.

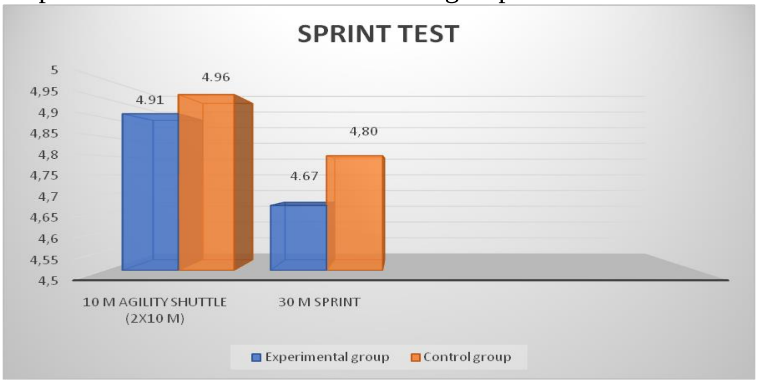

Figure 3. Dynamics of the average results obtained by the two groups in the initial testing – sprint performance

A Student's t-test was applied to determine if there were significant differences between the mean values of the two groups during the initial test. The results indicated that there were no statistically significant differences at the $p < 0.05$ level between the experimental and control groups' initial mean values. Comparing the average results obtained in the initial phase of the research between the two groups shows similar values in the jump and sprint performance of the subjects under investigation (Table 3).

According to the results presented in table 4 we notice that in the final testing the subjects from the experimental group progressed compared to those from the control group. At the final **Counter Movement Jump (CMJ)** assessment the mean (± SD) lower limb strength values for the male football players in the experimental group were as follows: jump height 33.43 ±1.09 cm, power 29.46 ± 0.82 W/kg, force 20.09 ±0.84 N/kg and velocity 189.12 ± 6.27 cm/s. Within these results the control group demonstrated a jump height of 32.06 ± 1.20 cm, power of 28.31 ± 1.16 W/kg, force of 19.03 ± 0.90 N/kg and velocity of 182.18 ± 7.92 cm/s. These results are summarized in Table 4 and illustrated graphically in Figure 4.

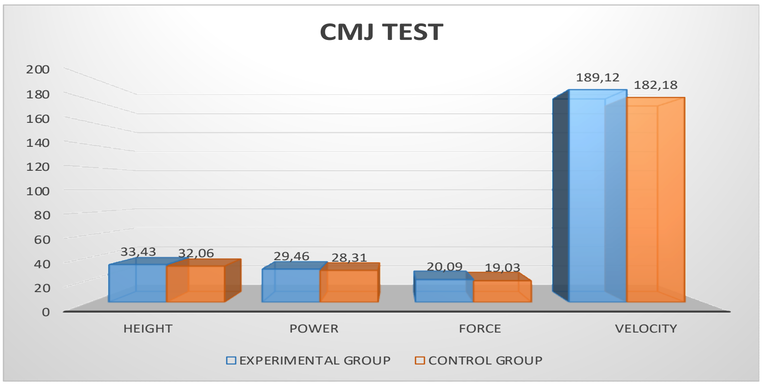

Figure 4. Dynamics of the average results obtained by the two groups in the final testing - CMJ

As shown in Table 4 the experimental group's final **Plyometric Jump (PJ)** results were as follows: a jump height of 25.10 ± 0.99 cm, a contact time of 286.79± 3.26 ms, a reactivity of 1.80± 0.10 and a stiffness of 9.78 ± 0.14 N/m. The control group recorded a jump height of 24.14 ± 1.24 cm, a contact time of 282.55± 3.79 ms, a reactivity of 1.68 ± 0.04 and a stiffness of 9.37 ± 0.03 N/m (figure 5). These results are illustrated graphically in Figure 5.

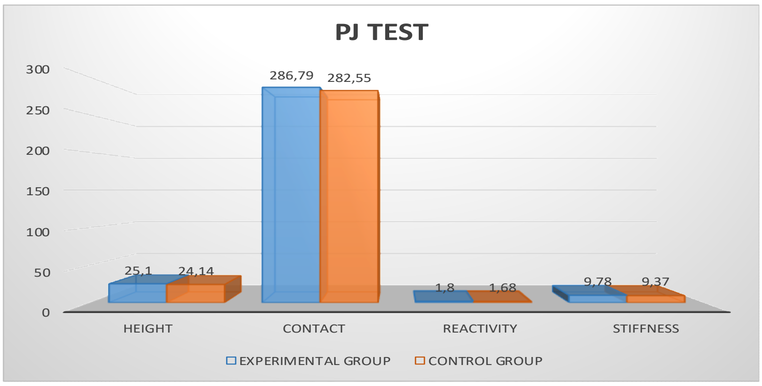

Figure 5. Dynamics of the average results obtained by the two groups in the final testing - PJ

The mean **10 m agility shuttle (2x10m)** (Figure 6) was 4.75 ± 0.09 s for the experimental group and 4.86 ± 0.12 s for the control group. The value of the calculated Student's t-test is -5.70, therefore 2.042 > -5.70 (at the level of $p < 0.05$), so there are statistically significant differences between the averages of the two groups in the final test.

Regarding the **30 m sprint test** (Figure 6) the overall mean was 4.55 ± 0.07 s for the experimental group and 4.72 ± 0.08 s for the control group. The value of the calculated Student's t-test is -10.80 therefore 2.042 > -10.80 (at the level of $p < 0.05$), so there are statistically significant differences between the averages of the two groups in the final test.

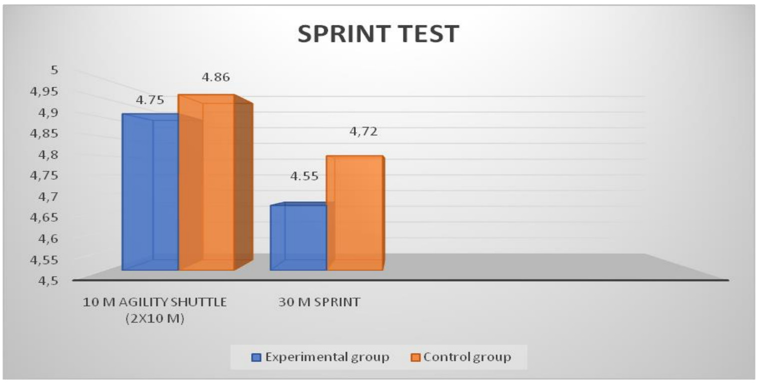

Figure 6. Dynamics of the average results obtained by the two groups in the final testing – sprint performance

The comparison of the average results obtained at the end of the experimental research by the two groups highlights the significance of the differences made in preparation in favour of the experiment group.

Discussion

The present study examined the effects of a structured lower-limb strength training program on sprint and jump performance in male university-level football players. The results indicate that in the post-intervention phase the experimental group achieved significantly better outcomes than the control group across several key performance indicators. This progress can be attributed to the effective methods and means employed the proper implementation of their structure consistent training and well-organized sessions. The structured implementation of multi-joint compound exercises such as squats, plyometric drills and conventional exercises has been consistently associated with neuromuscular adaptations conducive to enhanced sprinting and jumping capacity (Mendiguchia et al., 2013; de Hoyo et al., 2016).

In particular the Counter Movement Jump (CMJ) and Plyometric Jump (PJ) tests revealed statistically significant improvements in jump height, peak power, force output and take-off velocity suggesting enhanced neuromuscular coordination and muscle-tendon unit efficiency. Furthermore improvements in sprint performance evidenced by decreased times in the 10 m agility shuttle (2x10 m) and 30 m sprint tests underscore gains in acceleration explosive strength and reactive capacity—qualities directly linked to match-deciding actions in competitive football (Faude et al., 2012; Wisloff et al., 2004).

These findings align with prior research emphasizing the critical role of lower-body strength in sports performance (Comfort et al. 2014; Suchomel et al., 2016). Moraes et al. (2024) emphasize that fundamental skills are essential in football as players cannot perform their tactical roles without mastering them.

It is also noteworthy that no statistically significant differences were observed between the experimental and control groups during the pre-intervention testing phase. This baseline homogeneity reinforces the attribution of observed post-intervention performance gains to the training protocol itself. rather than to confounding variables.

However the study is not without limitations. The sample size although adequate for preliminary validation restricts the generalizability of findings. Moreover, factors such as nutritional intake, sleep quality, academic stress, and individual recovery strategies were not controlled, yet they might have influenced training responsiveness. Future research should consider these variables and explore long-term adaptations as well as transferability to other sports or levels of competition.

Conclusions

The findings of this study confirm the research hypothesis supporting the effectiveness of a structured lower-limb strength training program in significantly enhancing sprint and jump performance among male university football players. It can be concluded that the research hypothesis was confirmed. The observed performance improvements highlight the critical role of strength-based interventions in the development of key physical attributes required for football-specific actions such as sprinting, jumping and rapid direction changes.

Statistically significant improvements were recorded in the experimental group in both CMJ and PJ assessments indicating increased lower-limb explosive strength.

Sprint test results also demonstrated meaningful improvements post-intervention confirming the program's efficacy in enhancing short-distance acceleration.

The absence of significant differences at baseline and the use of a control group provide methodological robustness to the conclusions drawn.

In light of these findings it is recommended that university football training programs systematically incorporate targeted strength development modules focused on the lower limbs. Such programs should be tailored to the biological and functional characteristics of student-athletes and integrated within the competitive season framework to optimize performance outcomes without increasing injury risk.

Additional investigations with larger cohorts and longitudinal follow-up are warranted to validate the durability of these adaptations and to refine training methodologies for broader application across athletic populations.

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