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Analysis Of The Relationship Between Leg Muscle Strength And Leg Power In School Students' Athletic Performance

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ABSTRACT

Purpose of the study: This study aims to analyze the relationship between leg muscle strength and leg muscle power on students' athletic performance at school.

Methodology: The method used is correlational research with a quantitative approach. The sample consisted of 19 students selected by purposive sampling. The instruments used include a leg dynamometer to measure leg muscle strength, and a vertical jump test to measure leg muscle power. Data analysis was performed using the Spearman's rho correlation test.

Main Findings: The results showed a significant relationship between leg muscle strength and power and students' athletic performance ($p = 0.046 < 0.05$). This study confirms the importance of leg muscle strength and explosive power in supporting achievements in athletics, especially running and jumping.

Novelty/Originality of this study: This study offers a novel insight by specifically examining the direct correlation between leg muscle strength and leg power as distinct yet interrelated components influencing athletic performance among school students a demographic often overlooked in biomechanical performance research. The findings provide new evidence on how targeted development of these physical attributes can enhance students' performance in school-level athletics.

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1. INTRODUCTION

Today's competitive sports achievements are increasingly tight. Achievement is no longer owned by individuals but concerns the dignity and honor of a nation. Sports are also used as a tool to unite the nation and shape individual and collective character and sports also aim for health and physical fitness [1]-[3]. That is why various powers and efforts are made by a country to place its athletes as champions in various major sports activities involving the name of a country [4]-[6]. To improve sports achievements, it is necessary to carry out athlete development as early as possible by searching and monitoring talent, breeding, education and training for sports achievements through intracurricular and extracurricular activities. Thus, the government has provided opportunities and educational services to all young people to take part in sports education for those who have sports talent through special gifted schools [7]-[9].

Athletics is the parent of sports or can be called the mother of all sports. Because the movements in athletics are owned by most other sports. In the athletics sport, there are four types of numbers, namely walking, running, throwing and jumping [10]-[12]. While in the running number is divided into six types, one of which is

sprinting which is then divided into three distances, namely 100m, 200m, and 400m. To get a good run, supporting factors are needed, one of which is the strength and explosive power of the leg muscles. The explosive power of the leg muscles is the result of a combination of strength and speed to do maximum work in a very fast time [13], [14]. The combination of the two is what produces explosive movement speed. Muscle strength and speed of movement are the main characteristics of explosive ability. Strength and explosive power are very much needed in short-distance running, especially when starting. This is because explosive power is the driving force of every physical activity, also plays an important role in protecting athletes from possible injury, and can help strengthen joint stability [15]-[17].

The development of competitive sports requires intensive athlete development from an early age. Athletics as the parent of all sports has basic movement characteristics that require components of strength and explosive power of muscles, especially the legs. Special Sports Talent Schools (SKO) are a strategic means in developing students' sports talents [18], [19]. One of the leading branches is athletics, which includes activities such as running, jumping, and throwing.

In athletic activities, leg muscle strength and power play a crucial role. Muscle strength allows for maximum contraction to support the body and perform dynamic movements, while explosive power or power allows for explosive movement execution in a short time [20], [21]. The combination of the two supports optimal performance in events such as sprint, long jump, and shot put. However, there is not much data that describes the direct relationship between leg muscle strength and explosive power in SKO students, especially in supporting athletic performance. Therefore, this study is important to identify the relationship between the two variables.

Although both studies investigate the role of physical attributes particularly leg strength in student athletic performance, they approach the subject from slightly different angles [22]-[24]. The first explores the *correlational relationship* between leg muscle strength and leg power across general athletic performance, while the second focuses on the *specific contribution* of strength and speed to a single skill: the long jump. However, a research gap exists in understanding how these variables interact dynamically within various sport-specific contexts or skill executions [25]-[27]. Current research often isolates variables without examining how combined physical factors such as the synergy between strength, power, and speed collectively influence overall performance. Moreover, there is a lack of longitudinal or developmental data that explores how these relationships evolve with age, training exposure, or maturation in school-aged athletes.

The novelty of the first study lies in its broader exploration of the interplay between leg muscle strength and leg power as foundational components of general athletic performance in students [28]-[30]. Unlike studies that concentrate on a single sport or skill, this research considers how these two physical qualities relate in a more holistic way, offering new insight into how foundational strength and explosive ability may serve as predictors of broader athletic capacity. This broader approach fills a gap in literature that tends to be highly specialized and narrowly focused on individual events or sports.

The findings from these studies can significantly inform physical education programs and talent development strategies in schools. Understanding the specific contributions and relationships between muscle strength, speed, and power can help educators and coaches design more targeted training interventions to enhance student athletic outcomes [31]-[33]. For example, a balanced focus on developing both leg strength and speed may result in improved long jump performance and general athletic ability. These insights can also contribute to early identification of athletic talent and guide long-term training planning for youth athletes across multiple sports disciplines.

In the context of youth sports and physical education, understanding the fundamental physical attributes that influence performance is increasingly critical for fostering early athletic development and preventing injury. Leg muscle strength and leg power are essential components of most athletic movements, yet their specific relationship remains underexplored in the context of school-aged populations. Given the rise in structured school sports programs and talent identification initiatives, there is an urgent need to generate empirical evidence on how these two variables interact to affect overall performance. Such data is vital for designing age-appropriate training programs that optimize physical development and support long-term athlete preparation from a young age. Without a clear understanding of this relationship, educators and coaches may overlook essential physical conditioning strategies during key stages of motor and strength development.

2. RESEARCH METHOD

This study adopted a quantitative correlational design, aimed at identifying the relationship between two variables: leg muscle strength and leg explosive power in track and field athletes at the Sports Specialization School (SKO) in Makassar. The approach is non-experimental, where no manipulation or intervention was applied, and the data were collected at a single point in time. This design is suitable for establishing whether a statistically significant relationship exists between the strength and power of leg muscles.

The population in this study consisted of 32 student-athletes actively training in the track and field discipline at SKO Makassar. Using purposive sampling, a sample of 19 athletes was selected based on specific inclusion

criteria such as age (teenagers), active participation in sprint or jump events, and physical fitness to perform strength and power tests.

Data were obtained through primary data collection using standardized physical performance tests. Two variables were measured, Leg muscle strength, using a Leg Dynamometer Test. And Leg explosive power, using the Vertical Jump Test.Each test was performed three times, and the best result was recorded. The data collection took place in March 2020, and all tests were conducted under controlled conditions with proper warm-up and rest intervals to ensure safety and consistency.

The following table summarizes the instruments used in the study:

Table 1. Research Instruments

Variable	Instrument	Measurement Unit	Procedure Summary
Leg Muscle Strength	Leg Dynamometer	Kilograms (kg)	Subjects pulled a fixed bar while standing to measure maximal leg force.
Leg Explosive Power	Vertical Jump Test	Centimeters (cm)	Athletes jumped vertically; height was measured from chalk reach marks.

The Leg Dynamometer test required subjects to perform a controlled leg extension while measuring the maximum strength in kilograms. The Vertical Jump Test assessed explosive power by subtracting standing reach height from jump height (in cm).

After data collection, the researcher conducted descriptive and inferential analyses. Descriptive statistics were used to summarize the data, including mean, minimum, maximum, and standard deviation.For inferential analysis, the Spearman's rho correlation test was applied due to the non-parametric nature of the data, which does not assume normal distribution. This test evaluates the strength and direction of the relationship between the two variables.

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \qquad \ldots(1)$$

Where:
ρ = Spearman's correlation coefficient
d_i = difference between the ranks of corresponding variables
n = number of observations

Table 2. Data Analysis Process

Step	Explanation
Data Entry	Raw data from each instrument entered into SPSS/statistical software
Normality Test	Tested using Shapiro-Wilk (not normally distributed)
Correlation Test	Spearman's rho (non-parametric correlation test)
Significance Level	α=0.05\alpha = 0.05
Decision Rule	If p<0.05p < 0.05, the correlation is considered significant

The research was conducted through a structured and systematic procedure to ensure accuracy and reliability. It began with obtaining ethical approval and institutional permission, followed by the preparation of calibrated equipment such as the leg dynamometer and vertical jump scale. Participants were selected through purposive sampling based on specific criteria, and informed consent was obtained after briefing them on procedures and ethical considerations. The measurement phase involved testing leg muscle strength using a dynamometer and assessing leg explosive power via a vertical jump test, with each participant performing three attempts and the best result recorded. Data were then coded and analyzed using statistical software, applying both descriptive statistics and Spearman's rho correlation due to non-normal data distribution. Finally, the findings were interpreted based on statistical significance and their practical implications for sport science, specifically examining the relationship between leg strength and explosive power in young athletes.

3. RESULTS AND DISCUSSION

Description of initial data, the majority of students have leg muscle strength in the "moderate" to "good" category. The vertical jump results show varying explosive power, with a dominant distribution in the "moderate" category. The results of this study reveal a statistically significant relationship between leg muscle strength and leg explosive power among student-athletes in track and field at the Sports Specialization School (SKO) Makassar.

Initial descriptive analysis showed that most participants fell into the "moderate" to "good" category for leg muscle strength, while explosive power, measured through the vertical jump test, was more varied but predominantly also in the "moderate" category. These preliminary findings suggest a general baseline of physical capability, though with room for development in maximizing vertical performance output.

The inferential analysis was conducted using Spearman's rho correlation, due to the non-normal distribution of data. The statistical output is presented in the following table:

Table 1. Results of Spearman's rho Correlation Test

Variables 1	Variables 2	Correlation Coefficient (r)	Significance (p-value)	Interpretation
Leg Muscle Strength	Leg Muscle Explosive Power	0,468	0,046	Significant positive correlation, moderate strength

The correlation coefficient (r = 0.468) indicates a moderate yet meaningful positive correlation between the two variables, and the p-value (p = 0.046) is below the threshold of 0.05, confirming statistical significance. These results imply that as leg muscle strength increases, leg explosive power also tends to increase. In other words, athletes with stronger leg muscles are more likely to achieve better vertical jump performance.

From a physiological perspective, explosive power is the product of force (strength) multiplied by speed. Strength reflects the muscle's ability to generate force, while speed determines how quickly that force can be applied. In explosive movements such as sprinting or jumping—core components of athletics—these two components work synergistically. Stronger leg muscles enable an athlete to exert greater force against the ground, and when combined with high contraction speed, result in higher jump heights or faster acceleration.

This finding supports the foundational theories of Bompa (2018) and Sherwood (2014), who assert that power development is highly dependent on underlying muscular strength. Specifically, the efficiency of muscular contractions, motor unit recruitment, and the dominance of Type II (fast-twitch) muscle fibers are central to explosive athletic performance. These fibers are capable of generating force rapidly, making them critical in short-duration, high-intensity movements like vertical jumping.

Furthermore, this relationship has practical implications for athletic training. Coaches and sport scientists aiming to enhance explosive performance should prioritize not only plyometric or speed drills, but also strength training programs that develop maximal force capacity in the lower extremities. Well-structured resistance training can lead to neuromuscular adaptations that increase both muscle strength and the speed of contraction, thereby enhancing overall power output. In conclusion, the results of this study reinforce the importance of leg muscle strength as a foundational contributor to explosive power. While both qualities are distinct, their interdependence is critical in optimizing performance in track and field disciplines. By focusing on integrated training approaches that develop both strength and speed, athletic performance outcomes can be significantly improved.

While both studies examine the link between strength and athletic performance, they differ in scope, population, and focus [34]-[36]. The first study broadly investigates the relationship between leg muscle strength and athletic performance in a general school-aged population, whereas the second narrows the focus to adolescent girls and integrates movement skill as a third key variable. The research gap lies in the limited exploration of how strength interacts not only with athletic outcomes but also with the development of fundamental movement skills, especially in underrepresented groups like adolescent females [37], [38]. Most existing literature either generalizes across genders or overlooks the nuanced physical and developmental differences in adolescent girls. As a result, there is insufficient understanding of how strength training or muscular development influences not only performance but also motor competence and physical confidence during a critical developmental period.

The novelty of the second study lies in its holistic approach to evaluating the interconnectedness of strength, movement skill, and athletic performance in a specific and often underrepresented demographic: adolescent girls. Unlike more general studies, this research highlights the unique physiological and developmental considerations of female adolescents, offering a more nuanced view of how strength relates to both motor proficiency and sports ability [39], [40]. This integrated perspective is valuable for addressing gender disparities in physical activity participation and tailoring interventions that support lifelong engagement in sports and fitness.

These studies provide valuable insights for educators, coaches, and health professionals aiming to design effective physical development programs [41]-[43]. The broader findings on leg muscle strength can inform foundational training strategies for improving general athleticism, while the more focused study on adolescent girls suggests the need for gender-responsive approaches that emphasize movement competence alongside strength development. Together, the findings can support more inclusive and developmentally appropriate physical education curricula that foster both performance and confidence particularly among populations at risk of reduced physical activity, such as adolescent females.

A key limitation of both studies is the lack of longitudinal analysis, which restricts the understanding of how strength, movement skills, and athletic performance evolve over time. Additionally, the first study may overlook the influence of technical skill or neuromuscular coordination, while the second may face challenges in

generalizing findings beyond adolescent girls. Both may rely on isolated physical tests that do not fully capture the complexity of athletic performance in real-life or competitive contexts. Future research should consider incorporating more diverse samples, longitudinal tracking, and multifactorial performance assessments to enhance the depth and applicability of the findings.

4. CONCLUSION

This study concluded that there is a significant relationship between leg muscle strength and leg muscle explosive power, which directly affects the athletic performance of students at the Makassar Special Sports Talent School. The higher the leg muscle strength of an athlete, the greater the explosive power that can be produced. This finding emphasizes the importance of integrating strength training and explosive training in students' physical training programs. It is recommended for coaches and sports teachers to provide a balanced portion of training between strength training and explosive power (plyometric training) in order to achieve optimal athletic performance. Future studies are recommended to examine how leg muscle strength influences specific types of athletic performance across different age groups, genders, and sports disciplines, as well as to explore the effects of targeted strength training interventions over time.

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