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Relationship Between Leg Power and Long Jump Performance among Male College Students

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Abstract

Long jump performance depends on the effective interaction of approach velocity, explosive lower-limb power, take-off mechanics, flight control, and landing technique. Among these factors, leg power is particularly important because the take-off phase requires the athlete to generate substantial force within a very short ground-contact period while preserving as much horizontal velocity as possible. This review examines the relationship between leg power and long jump performance, with particular relevance to male college students. Existing biomechanical and sports-performance literature indicates that greater lower-limb power can contribute to improved take-off ability, vertical impulse, and jumping performance. However, successful long jumping is not determined by leg power alone. Approach-run velocity, take-off velocity and angle, coordination, technical proficiency, and the ability to control the body during flight and landing also influence the final jump distance. Consequently, athletes with similar levels of leg power may achieve different performances due to differences in technique and in the effective utilization of force during take-off. For male college students, the combined development of explosive leg power and event-specific technique may therefore provide a more appropriate approach to improving long jump performance than emphasizing strength or power in isolation.

Keywords: Leg power, long jump, explosive strength, take-off, male college students, athletic performance.

1. Introduction

The long jump is a track-and-field event in which performance results from the coordinated execution of the approach run, take-off, flight, and landing. Although the final outcome is measured as horizontal distance, successful performance requires an athlete to generate high approach velocity and effectively convert part of this velocity into vertical motion during a brief take-off period [1], [2]. The event, therefore, represents a complex interaction between physical capability and technical efficiency.

Among the physical characteristics involved in jumping, lower-limb power is particularly relevant. Leg power represents the ability of the lower extremities to generate force rapidly and is influenced by both muscular force and contraction velocity. During long-jump take-off, the athlete must produce a large impulse within a short period while minimizing the loss of horizontal velocity. Consequently, the ability to generate explosive force can influence the conditions at take-off and ultimately the distance achieved [2], [3].

However, long jump performance cannot be explained by leg power alone. Research on elite long jumpers has demonstrated the importance of approach velocity, take-off velocity, vertical velocity generation, take-off angle, and technical execution [1], [4]. An athlete may possess considerable explosive power but fail to achieve an optimal jump if that power is not effectively coordinated with the approach run and take-off technique.

This relationship is particularly relevant to male college students, among whom differences in training experience, muscular development, coordination, and technical proficiency may produce considerable variation in jumping performance. Understanding the contribution of leg power can therefore assist in fitness assessment and the development of appropriate training programs while recognizing the importance of technical factors.

The present review examines the relationship between leg power and long jump performance, with emphasis on the mechanical role of lower-limb power during take-off and its interaction with approach velocity and jumping technique. It also considers the practical relevance of these relationships for male college students.

2. Understanding Leg Power in Long Jump

Leg power refers to the ability of the lower-limb muscles to produce force rapidly. Unlike maximal strength, which primarily reflects the amount of force that can be generated, muscular power depends on the interaction between force and movement velocity. This ability is particularly

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important in explosive athletic activities where force must be produced within a limited period of time [3], [5].

In the long jump, the importance of leg power becomes most evident during take-off. After developing horizontal velocity during the approach run, the athlete has only a brief ground-contact period to generate the impulse required to redirect the body's centre of mass upward while continuing forward movement. The take-off leg must therefore tolerate high loading and produce force rapidly [2], [6].

Explosive lower-limb capability may help the athlete generate greater vertical impulse and achieve favorable take-off conditions. However, effective performance does not simply require maximum upward force. Excessive conversion of horizontal velocity into vertical motion can reduce forward velocity and negatively affect jump distance. The athlete must therefore use leg power in a technically efficient manner that produces sufficient vertical velocity while preserving horizontal momentum [1], [4].

Leg power can be assessed using field and laboratory methods, including the standing broad jump, vertical jump, countermovement jump, squat jump, and force-platform measurements. These tests provide distinct indicators of explosive lower-limb performance and should not be treated as identical measures of long-jump ability.

For male college students, leg-power assessment can provide useful information about explosive physical capacity. Nevertheless, its interpretation should be combined with technical evaluation because successful long jumping depends on how effectively an athlete applies available muscular power during the approach and take-off phases.

3. Performance Structure of the Long Jump

Long jump performance develops through four interconnected phases: the approach run, take-off, flight, and landing. Although each phase has a distinct function, the distance achieved depends on its effective coordination. Errors in one phase may affect the mechanical conditions of subsequent phases and ultimately reduce performance.

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3.1 Approach Run

The primary purpose of the approach run is to develop sufficient horizontal velocity while positioning the athlete accurately for take-off. Approach velocity is considered an important determinant of long jump performance because greater horizontal velocity provides greater potential for horizontal displacement [1], [4].

However, speed must remain controllable. During the final strides, the athlete prepares for take-off without producing excessive braking or disturbing running rhythm. Therefore, an effective approach combines high velocity with accuracy and technical control.

3.2 Take-off

Take-off is the critical transition between the approach run and flight. During this brief phase, the take-off leg applies force against the ground to generate vertical impulse while attempting to preserve horizontal velocity [2], [6].

Leg power is particularly important during this phase because force must be generated rapidly within a short contact period. Effective take-off does not require converting all horizontal motion into vertical motion; instead, the athlete must achieve an appropriate balance between horizontal and vertical velocity. Excessive loss of horizontal velocity can negatively affect the final jump distance.

3.3 Flight

Once the athlete leaves the ground, the trajectory of the centre of mass is largely determined by the velocity and projection conditions established at take-off. Movements performed during flight cannot substantially increase the trajectory of the centre of mass, but they assist in controlling body rotation and preparing an effective landing.

Techniques such as the sail, hang, and hitch-kick are used to manage body position during flight. Their effectiveness depends considerably on the athlete's technical proficiency and the conditions produced during take-off.

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3.4 Landing

The landing represents the final opportunity to preserve the horizontal distance generated during the preceding phases. Athletes attempt to extend the legs forward while positioning the trunk appropriately to avoid falling backward after ground contact.

Poor landing technique can reduce the measured jump distance even when approach and take-off performance are effective. Therefore, the final long-jump result reflects not only explosive leg power but also the athlete's ability to integrate approach velocity, take-off mechanics, flight control, and landing technique.

4. How Leg Power Influences Long Jump Performance

The relationship between leg power and long jump performance is primarily expressed during the take-off phase. After developing horizontal velocity during the approach, the athlete must generate substantial force within a short period of ground contact. Greater explosive capability of the lower limbs can assist in producing the impulse required to redirect the centre of mass and establish effective conditions for flight [2], [6].

4.1 Explosive Force during Take-off

The take-off leg experiences considerable loading as it contacts the board at high approach velocity. The athlete must rapidly generate force to resist this loading and produce an effective upward and forward movement. Greater lower-limb power may therefore allow the jumper to generate the required force more rapidly and use the short take-off period efficiently.

4.2 Take-off Velocity and Impulse

Jump distance is strongly influenced by the velocity of the centre of mass at take-off. The athlete enters take-off with substantial horizontal velocity and generates vertical impulse through interaction with the ground. Leg power contributes to this process by supporting rapid force production during the limited contact period.

However, achieving greater vertical velocity is not always advantageous if it results in an excessive reduction in horizontal velocity. Effective long jumping requires an appropriate compromise between generating vertical impulse and preserving approach velocity [1], [4].

4.3 Interaction between Horizontal and Vertical Velocity

Horizontal and vertical velocities jointly determine the initial conditions of flight. Horizontal velocity directly contributes to forward displacement, whereas vertical velocity determines the flight time required to cover horizontal distance. The take-off technique must therefore use available leg power in a direction that produces an effective combination of both components.

This explains why two athletes with similar levels of leg power may achieve different jump distances. The athlete who applies force more effectively during take-off and retains greater horizontal velocity may produce superior performance.

4.4 Relationship between Jumping Ability and Performance

Field tests such as the standing broad jump and vertical jump are commonly used to estimate explosive lower-limb capability. Better performance in such tests may indicate greater potential for forceful take-off. Nevertheless, these tests do not replicate the full mechanical demands of the long jump, particularly the need to take off after a high-speed approach.

Therefore, leg power should be considered an important contributor to long jump performance rather than an independent predictor of success. Its influence depends on how effectively muscular power is integrated with approach velocity, take-off mechanics, coordination, and technical skill.

5. Evidence from Previous Research

Previous research has consistently shown that long jump performance depends on the interaction between approach velocity and the mechanical characteristics of take-off. Studies of competitive long jumpers indicate that successful athletes can approach the board at high velocity and generate sufficient vertical impulse during a relatively short take-off period while minimizing the loss of horizontal velocity [1], [2].

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Hay et al. [1] examined the relationship between approach velocity and long jump performance and demonstrated that approach speed is an important determinant of jump distance. However, differences in performance could not be explained by approach velocity alone, emphasizing the importance of take-off mechanics and the athlete's ability to use the velocity developed during the approach.

Lees et al. [2] investigated the biomechanics of the take-off phase and highlighted the importance of lower-limb force production, body configuration, and the generation of vertical velocity. Their findings indicate that take-off is not simply an upward jump but a rapid mechanical action in which horizontal momentum must be effectively managed.

Research on jumping performance has also demonstrated that explosive lower-limb capabilities are related to the ability to generate force rapidly [5], [7]. Vertical jump, countermovement jump, and standing broad jump tests are therefore frequently used as practical indicators of lower-body explosive performance. Nevertheless, these tests differ mechanically from a competitive long jump because they do not fully reproduce a high-speed approach followed by unilateral take-off.

Table 1. Selected Evidence Relevant to Leg Power and Long Jump Performance

Research Focus	**Variables Examined**	**Major Finding**	**Relevance to Long Jump**
Approach-run studies [1]	Approach velocity and jump distance	Higher controlled approach velocity is associated with better performance	Establishes the horizontal velocity available before take-off
Take-off biomechanics [2]	Horizontal and vertical velocity, take-off mechanics	Effective take-off requires generation of vertical velocity while limiting horizontal velocity loss	Demonstrates the mechanical importance of the take-off leg

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Lower-limb power research [5]	Force, velocity and mechanical power	Explosive performance depends on rapid force production	Supports the role of leg power during short-duration take-off
Jump-performance studies [7]	Vertical/broad jump and explosive capability	Jump tests provide practical indicators of lower-limb explosive performance	Useful for assessing physical capacity, but not a complete measure of long-jump ability

Taken together, previous research supports a meaningful relationship between explosive lower-limb capability and long jump performance. However, the evidence also demonstrates that leg power operates within a broader biomechanical system. Approach velocity, take-off mechanics, coordination, and technical proficiency determine how effectively available muscular power is converted into horizontal jump distance.

6. Interpretation of the Leg Power–Performance Relationship

The available evidence suggests that leg power provides an important physical foundation for long jump performance, but its contribution should be interpreted in the context of the event's complete movement pattern. Greater lower-limb power may increase an athlete's capacity to generate force rapidly during take-off, yet the final jump distance depends on how effectively this capacity is used following the approach run.

One important consideration is the interaction between leg power and approach velocity. A faster approach can increase the potential for horizontal displacement, but it also increases the mechanical demands placed on the take-off leg. The athlete must tolerate the forces associated with high-speed ground contact and rapidly generate an appropriate vertical impulse without losing excessive horizontal velocity. Therefore, greater leg power may be particularly valuable when it can be expressed under high-speed take-off conditions [1], [2].

Technical proficiency can further modify this relationship. Two athletes with similar explosive leg power may produce different jump distances because of differences in foot placement, body position, take-off timing, and the direction of force application. Consequently, physical power

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reflects the athlete's capacity to perform explosive work, whereas technique influences how effectively that capacity translates into performance.

The method used to assess leg power also requires consideration. Standing broad jump, vertical jump, and countermovement jump tests provide useful information about explosive lower-limb capability, but each involves different movement characteristics. None completely reproduces the unilateral take-off performed after a high-speed approach in the long jump. A strong relationship between a field power test and long jump distance should therefore not be interpreted as evidence that both tasks are mechanically identical.

Overall, long jump performance is best understood as the outcome of an interaction between physical capacity and technical efficiency. Leg power increases the potential for an effective take-off, while approach velocity, coordination, and biomechanical technique determine how successfully this potential is converted into jump distance.

7. Application to Male College Students

The relationship between leg power and long jump performance has practical relevance for male college students participating in athletics and physical education programs. At the college level, students may differ considerably in training experience, muscular strength, coordination, body composition, and technical proficiency. Consequently, assessment and training should consider both physical capacity and long-jump technique.

Leg power can be evaluated through practical field tests such as the standing broad jump, vertical jump, and countermovement jump. These assessments can help identify differences in explosive lower-limb capability and provide useful information for planning physical conditioning. However, field-test performance should be interpreted alongside actual long-jump performance, as general jumping ability does not fully capture the mechanical demands of a running long jump.

Training programs for male college students should include exercises that develop rapid force production. Plyometric activities, jumping exercises, sprinting, and appropriately supervised resistance training can contribute to the development of lower-limb strength and power [5], [8]. Training progression should reflect the student's previous experience and physical preparedness.

Technical practice should accompany physical conditioning. Students need to develop a controlled approach, run, accurate board contact, effective take-off mechanics, and appropriate landing technique. Improving leg power without adequate technical preparation may not produce a corresponding improvement in jump distance.

For coaches and physical education teachers, combining leg-power assessment with event-specific performance evaluation provides a more meaningful approach than relying on either measure alone. This can assist in identifying whether an individual student's limitation is primarily related to explosive physical capacity, approach-run consistency, take-off technique, or another component of long-jump performance.

8. Limitations in Existing Evidence

Although previous research provides a biomechanical basis for the relationship between lower-limb power and long jump performance, several limitations warrant consideration. A major issue is the variation in methods used to assess leg power. Studies have employed vertical jump, countermovement jump, standing broad jump, force-platform measurements, and other explosive-performance tests. Since these tests involve different movement patterns, their results cannot always be directly compared.

Another limitation is the relatively limited evidence specifically involving male college students. Much of the established biomechanical literature has examined trained, competitive, or elite long jumpers. Findings obtained from highly trained athletes may not completely represent college students, who can differ substantially in training history, technical proficiency, strength, and experience.

The assessment of long jump performance also presents methodological challenges. Jump distance is influenced not only by leg power but also by approach velocity, accuracy at the take-off board, take-off mechanics, flight technique, and landing efficiency. Therefore, the observed relationship between a leg-power test and jump distance does not establish leg power as the sole cause of improved performance.

A further limitation concerns the predominance of cross-sectional and correlational approaches in studies examining relationships between physical characteristics and athletic performance.

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Correlation can demonstrate an association between variables, but cannot by itself establish causation. An athlete with greater leg power may jump farther, but other characteristics, such as training status and technical ability, may contribute to both variables.

These limitations indicate that findings concerning leg power should be interpreted within the broader biomechanical and technical requirements of the long jump. More population-specific and methodologically consistent research is required before precise conclusions can be drawn for male college students.

9. Future Research Perspective

Future research should examine the relationship between leg power and long jump performance, specifically among male college students, as this population may differ from trained and elite long jumpers in physical development, training experience, and technical proficiency.

Studies should use clearly defined and standardized methods for assessing lower-limb power. Comparing measures such as the standing broad jump, countermovement jump, and vertical jump with actual long jump distance may help determine which field test has the greatest practical relevance for college-level athletes. Where facilities are available, force-platform measurements could provide additional information about force, impulse, and power production.

Future investigations should also consider approach velocity and take-off mechanics when examining the leg power–performance relationship. Evaluating leg power alone may provide an incomplete explanation, as the athlete must demonstrate explosive capability while approaching the take-off board at speed. Combining physical tests with video-based biomechanical analysis could therefore provide a more complete assessment.

Longitudinal and training-intervention studies would also be valuable. Such research could determine whether improvements in lower-limb power are accompanied by meaningful improvements in long jump distance and whether these changes depend on simultaneous technical training.

Finally, larger samples representing different levels of college athletes would improve the generalizability of findings. Future research integrating physical capacity, biomechanical technique, and actual performance may provide a clearer understanding of how leg power contributes to long jump success among male college students.

10. Conclusion

The present review indicates that leg power is an important physical component associated with long jump performance. The ability of the lower limbs to generate force rapidly is particularly relevant during take-off, when the athlete must produce sufficient vertical impulse within a short ground-contact period while retaining as much horizontal velocity as possible.

However, long jump distance cannot be explained by leg power alone. Approach velocity, take-off mechanics, coordination, flight control, and landing technique collectively influence performance. Therefore, athletes with similar levels of explosive leg power may achieve different jump distances depending on how effectively they apply this physical capacity during the take-off phase.

For male college students, assessment of leg power through appropriate field tests can provide useful information regarding explosive lower-limb capacity. Nevertheless, such assessments should be combined with an evaluation of actual long jump performance and technical execution. Training programmes should similarly integrate lower-limb power development with approach-run and take-off practice rather than emphasizing physical conditioning in isolation.

Overall, the relationship between leg power and long jump performance should be viewed as an interaction between explosive physical capacity and technical efficiency. Further research specifically involving male college students is required to clarify the strength of this relationship and determine which measures of leg power are most relevant to long jump performance.

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