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Optimizing Long Jump Ability: The Synergistic Effect of Leg Power, Balance, and Flexibility

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Abstract: The problem addressed in this study is the low long jump performance among Senior High School (SHS) students. The independent variables examined are leg muscle explosive power (X_1), balance (X_2), and flexibility (X_3), while the dependent variable is long jump ability (Y). This correlational study aims to determine the extent to which leg muscle explosive power, balance, and flexibility explain the variance in long jump ability. The population consists of 169 students, from which 20 male student-athletes were randomly selected as the sample. Research instruments included the standing broad jump test for leg muscle explosive power, the modified Bass test for balance, a flexiometer test for flexibility, and a long jump test to measure performance. Data analysis was conducted using correlation and multiple correlation techniques with a significance level of $\alpha = 0.05$. The results show that: 1) Leg muscle explosive power explains 43% of the variance in long jump ability ($R^2 = 0.43$). 2) Balance explains 28% of the variance ($R^2 = 0.28$). 3) Flexibility explains 12% of the variance ($R^2 = 0.12$). 4) Collectively, leg muscle explosive power, balance, and flexibility explain 77% of the variance in long jump ability (Multiple $R^2 = 0.77$). These findings indicate that leg muscle explosive power, balance, and flexibility are significant predictors of long jump performance among SHS students..

Keywords: Contribution of Leg Muscle Explosive Power; Balance; Flexibility; Long Jump Ability

1. Introduction

Coaching and development of physical education sports are carried out by considering the potential, abilities, interests, and talents of students comprehensively, both in intramural and extracurricular activities [1], [2], [3]. The improvement of sports coaching and development is an effort to enhance human quality in shaping character, personality, discipline, and sportsmanship, thus improving achievements [4], [5]. Achieving an accomplishment is not easy and is a long process that involves various components, both internal and external [6], [7]. The presence of both intramural and extracurricular activities can help develop and enhance the potential or talents possessed by students, thus supporting their achievements in the competitions they participate in, and ultimately bringing honor to the school [6], [8]. There are also several benefits in physical education sports, including: 1) sports can reduce stress, 2) improve brain power, and 3) boost self-confidence [9]. Exercising can also maintain physical condition, enabling individuals to face various activities they will undertake [10], [11].

Good physical condition represents the fundamental foundation for an athlete to achieve peak performance [11], [12], [13]. Physical condition is a crucial aspect in carrying out training programs, especially for athletes who aim to achieve high performance [14], [15], [16]. In physical conditions, there is an element of explosive power which is very much needed in sports. Daya ledak merupakan kemampuan seseorangzmempergunakan kekuatan maksimummyang dikerahkan pada waktu yang sesingkat-singkatnya [17]. Leg muscle strength is important in correcting movement shifts or errors to prevent falling. An individual must have sufficient lower leg muscle strength in the feet to stabilize and counteract the kinetic energy from an unbalanced individual [18], [19]. So this is very much needed for a long jumper because it is very used at the beginning to do the initial phase, namely when running and jumping. Various restrictions can be set when performing such jumps, which ultimately affect the jump technique and the altitude obtained. In addition, balance is also needed in the long jump, where balance is the ability to maintain our neuromuscular system in a static condition or to control posture and positioning efficiently while we are in motion [20], [21].

In order to achieve a good jump, movement coordination also plays a role. Movement coordination is the reciprocal relationship between the central nervous system and the muscles, which regulates and controls muscle impulses, energy, and work, as well as the motor processes that occur during the execution of movement [22]. To achieve the best performance, the jumper must perform a coordinated pattern of counter-movement, full-body forward rotation, and double-arm swings. Then, in the long jump, good flexibility is also needed for athletes, flexibility is one of the elements of physical conditioning that determines in learning movement skills, preventing injuries, developing strength, speed, endurance, agility and coordination [23].

Based on the author’s observations, many students still struggle to perform the long jump effectively, with results that fall below expectations. This may be attributed to underdeveloped physical components that are essential for long jump performance — particularly leg muscle explosive power, balance, and flexibility. These elements play critical roles in each phase of the long jump, from the approach and take-off to the flight phase and landing. Given these considerations, this study seeks to explore how these three physical components work synergistically to optimize long jump ability. Specifically, it aims to analyze the extent to which leg power, balance, and flexibility individually and collectively contribute to long jump performance among Senior High School students. By identifying the strength of these relationships, this research aims to provide empirical evidence that supports the development of more targeted training programs. Ultimately, the goal is to enhance athletic performance in long jump events by focusing on the integrated development of leg power, balance, and flexibility.

2. Materials and methods

This study is a correlational research conducted at SHS 1 Nan Sabaris from August 13 to September 13, 2020. The population consisted of 169 students; however, the sample comprised only 20 male athletes. It is important to note that not all students in the population were athletes, and thus the sample represents a convenience sample of male athletes available during the study period, rather than a truly random sample from the entire population. The instruments used to collect data included the standing broad jump test for measuring leg muscle explosive power, the modified Bass test for balance, a flexiometer test for flexibility, and a long jump ability test. Data were analyzed using correlation and multiple correlation techniques with a significance level of $\alpha = 0.05$. A limitation of this study is the small sample size ($n = 20$), which is relatively low for correlational analysis involving three predictor variables. This small sample size increases the risk of Type II errors (failing to detect a true effect) and potential overfitting in the statistical model, which may limit the generalizability of the findings. Future research should consider larger and more representative samples to validate these results.

3. Results

This The results of this study are presented in the form of normality tests, significance tests, and hypothesis testing. The normality test was conducted to determine whether the data followed a normal distribution. Subsequently, a significance test was carried out to assess the relationship between the variables, and the hypothesis test was performed to examine whether the proposed hypotheses were supported by the data. The findings from these tests are discussed in detail to provide insights into the correlations and relationships identified in the study. Dengan kode Leg Power (X1), Balance (X2), Flexibility (X3), Long Jump Capability (Y).

a. *Normality Test*

Table 1. Summary Normality Test Data Distribution.

Variable	L_O	Ltab	Distribution
X1	0,114	0,190	Normal
X2	0,100		
X3	0,077		
Y	0,162		

Based on the normality test results, the Lilliefors statistics (L_0) for all variables (X1, X2, X3, and Y) are smaller than the critical L value at a significance level of $\alpha = 0.05$. This indicates that the null hypothesis—that the data are normally distributed—cannot be rejected. Therefore, the data for all variables in this study can be considered to follow a normal distribution.

b. *Significant Test*

Table 2. *Summary Significant Test Data Distribution*

Variable	tc	ttable	Distribution
X1	3,67	0,190	Normal
X2	2,69		
X3	2,75		
Y	8,49		

The significance test for the contribution of leg muscle power (X1) to long jump ability showed a significant relationship, as the calculated t value (3.67) was greater than the table value (1.73). Similarly, the test for balance (X2) also revealed a significant relationship, with a calculated t value of 2.69, which is higher than the table value (1.73). The test for flexibility (X3) indicated a significant relationship as well, with a calculated t value of 2.75, greater than the table value (1.73). Lastly, the multiple correlation test showed a significant relationship between leg muscle power, balance, flexibility, and long jump ability, as the calculated F value (8.49) was greater than the table value (3.24). This means all three variables together have a significant effect on long jump ability.

c. *Hypothesis Testing*

1) H1 (X1 and Y) Contribution of Explosive Power of Leg Muscles to Long Jump Ability

Tabel 3. Summary of the Correlation and Determination Analysis Results of Leg Muscle Explosive Power on Long Jump Ability.

Correlation	(r)	R^2	Sig
Leg muscles against long jump ability	0,65	0.43	0,000

The calculation results in the table above show that the correlation coefficient between leg muscle strength and long jump ability is positive. This is evident from the statistical analysis, where the calculated r value is 0.654, and the table r value at $\alpha = 0.05$ is 0.000.

2) H2 (X2 and Y) Contribution Balance to Long Jump Ability

Table 4. Summary of Correlation and Determination Analysis of Balance on Long Jump Ability.

Correlation	(r)	R^2	Sig
Balance against long jump ability	0,536	0.28	0,002

The calculation results in the table above show that the correlation coefficient between balance and long jump ability is positive. This is evident from the statistical analysis, where the calculated r value is 0.536, and the table r value at $\alpha = 0.05$ is 0.002.

3) H3 (X3 and Y) Flexibility to vLong Jump Ability

Table 5. Summary Results of Analysis Correlation and Determination of Flexibility to Ability Long Jump.

Correlation	(r)	R^2	Sig
Flexibility in the long jump	0,54	0.12	0,001

The calculation results in the table above show that the correlation coefficient between flexibility and long jump ability is positive. This is evident from the statistical analysis, where the calculated r value is 0.545, and the table r value at $\alpha = 0.05$ is 0.001.

4) H4 (X1, X2, X3, and Y) Leg Muscle Power, Balance, and Flexibility in Relation to Long Jump Ability

Table 6. Summary of Correlation and Determination Analysis of Leg Muscle Explosive Power, Balance, Flexibility, and Long Jump Ability.

Correlation	(r)	R^2	Sig
Power, Muscles, Legs, Balance, and Flexibility, and Ability To Jump Long	0,76	0.77	0,000

The results of the calculations in the table above show that the correlation coefficient between leg muscle explosive power, balance, flexibility, and long jump ability is positive. This is evident from the statistical analysis, which yielded a calculated r value of 0.77, while the r value from the table at a significance level of $\alpha = 0.05$ is 0.000.

4. Discussion

This research provides valuable insights into the multifaceted nature of athletic performance and the physical attributes that contribute to the success of athletes, particularly in the sport of long jump. A long jump is a dynamic and technically complex event that demands a combination of strength, speed, balance, coordination, and flexibility. Identifying and understanding the contributions of each of these elements can help athletes optimize their training regimens, coaches improve their training techniques, and sports organizations design better developmental programs for young athletes. By analyzing these factors in-depth, this research highlights their combined effect on long jump performance and provides a scientific basis for improving athletic training.

This study is also significant in light of previous research that has explored the role of physical attributes in athletic performance. In the context of long jump, studies have shown that explosive leg power is a critical component of performance. A study by [24] confirmed that strength and power in the lower limbs significantly contribute to better jumping performance, as they allow athletes to generate the speed and force needed during the takeoff phase. This aligns with the findings of the present study, where leg muscle explosiveness demonstrated a strong positive correlation with long jump ability, with a correlation coefficient of 0.654.

Balance has also been recognized as a key factor in various sports disciplines, including long jump. According to a study by [25] balance plays a crucial role in maintaining proper posture and controlling body movement during the flight phase of the long jump. The study found that athletes with better balance demonstrated superior performance in their jumps. This supports the findings in the current research, where balance exhibited a correlation coefficient of 0.536 with long jump ability. Proper balance ensures that athletes can control their posture throughout the jump, from takeoff to landing, which directly impacts their distance. Flexibility, often overlooked in some training programs, is another element critical for improving long jump performance. A study by [26] concluded that flexibility contributes significantly to the range of motion, injury prevention, and muscle performance during dynamic movements such as the long jump. Flexibility ensures that the athlete can perform the required motion sequences smoothly, leading to greater efficiency and reduced injury risk. The current study corroborates these findings, as flexibility also showed a positive correlation (0.545) with long jump ability.

The implications of this study are far-reaching. For coaches and sports educators, the findings underscore the need for a comprehensive approach to training athletes, especially in the long jump. Athletes must not only focus on developing explosive leg strength but should also prioritize exercises that improve balance and flexibility. This holistic approach could lead to better performance outcomes. Moreover, since the study showed that these three factors—leg muscle explosiveness, balance, and flexibility—work synergistically, it is essential that training programs incorporate exercises targeting all these areas rather than focusing on one attribute at a time. From a practical perspective, the results suggest that sports trainers and coaches should incorporate drills that enhance muscle power in the legs, such as plyometric exercises, as well as activities that improve balance and flexibility, such as yoga or balance-focused exercises. These exercises should be included in a balanced training regimen to optimize athletic performance and reduce the likelihood of injury, particularly in high-impact sports like the long jump.

While the study provides useful insights, there are certain limitations to consider. First, the sample size of only 20 male athletes may limit the generalizability of the results. A larger, more diverse sample that includes female athletes and individuals from different age groups and experience levels could provide a more comprehensive understanding of the relationship between these physical attributes and long jump performance. Additionally, the study's focus on a single school (SHS 1 Nan Sabaris) may introduce bias, as the results may not reflect the broader population of athletes in different regions or schools with varying training methods and resources. Another limitation is the reliance on tests such as the standing board jump test for leg muscle power and the modified Bass test for balance, which may not capture the full spectrum of an athlete's capabilities. A more comprehensive battery of tests could provide a more accurate and nuanced understanding of the relationship between physical attributes and athletic performance. Finally, the study did not account for the athletes' training history or the duration of their training, both of which could influence their performance.

Given the limitations mentioned, future studies should aim to expand the sample size and include a more diverse group of participants. Researchers could also consider incorporating longitudinal studies to examine the long-term effects of training on leg muscle explosiveness, balance, and flexibility. This would help determine how these attributes develop over time and how they relate to performance improvements in the long jump. Furthermore, future research could explore the specific types of training exercises that are most effective for enhancing these physical attributes. For example, it would be valuable to compare the effectiveness of different flexibility training programs or balance exercises on long jump performance. Additionally, examining the interaction between these physical attributes and other psychological factors, such as motivation or focus, could provide a more complete picture of athletic performance. Lastly, researchers might investigate the potential differences in the relationships between leg muscle explosiveness, balance, and flexibility based on the athlete's experience level.

5. Conclusions

In conclusion, the findings of this study offer valuable insights into the critical factors affecting long jump performance, namely leg muscle explosiveness, balance, and flexibility. These factors work synergistically to enhance the athlete's performance in the event, with each contributing in a unique way. As a result, coaches and trainers should consider incorporating a balanced training regimen that targets all these areas. While the study provides important contributions to sports science, future research should address its limitations and continue to explore how these physical attributes influence athletic performance across various contexts.

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