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RESEARCH ARTICLE

A Correlational Study of Static and Dynamic Strength in Relation to Vertical Jump Performance Among Basketball Players

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ABSTRACT

Introduction: The performance of Indian athletes in national and international competitions has been consistently below expectations, despite longstanding efforts to enhance their capabilities. Physical fitness plays a pivotal role in athletic performance. Defined as the ability to perform daily tasks with vigour and minimal fatigue, physical fitness is essential for success in sports. Recognizing the need for sport-specific fitness assessment, this study was conducted at the Department of Exercise and Sports Physiology, Dr. Vaishampayan Memorial Govt. Medical College, Solapur.

Aims and Objectives: i) To assess height, weight, muscular strength, and vertical jump in basketball players. ii) To examine the correlation between muscular strength and vertical jump power.

Material and Methods: Thirty (30) male university-level basketball players aged 18–19 years (mean age 18.6 years) participated in this study. Anthropometric measurements (height and weight) were recorded. Dynamic strength was assessed via bench press and bench squat, while static strength was evaluated using a leg and back dynamometer. Vertical jump height was measured to the nearest centimetre.

Results: Significant correlations were observed between muscular strength and vertical jump performance. Bench press showed a strong positive correlation with vertical jump power ($p < 0.0001$), while bench squat exhibited a weaker yet significant correlation ($p < 0.01$). Static leg strength showed a statistically significant negative correlation ($r = -0.49$) with vertical jump power.

Discussion and Conclusions: The study highlights that both dynamic and static strength are influential in vertical jump performance. Findings emphasize the importance of targeting specific muscle groups to enhance explosive power in basketball players.

Keywords: Basketball players, Dynamic strength, Static strength, Vertical Jump, Power

Abbreviations

Centimetres (cms)
Kilograms (Kgs)
Static strength (SS)
One repetition maximum (1RM)

Introduction

In the world of basketball, explosive power and strength play pivotal roles in enhancing athletic performance. The vertical jump is a fundamental measure of lower-body power and explosiveness, crucial for actions such as rebounding, dunking, and defensive manoeuvres. Understanding the relationship between vertical jump performance and various strength parameters, including both static and dynamic strength, can offer valuable insights into the physical capabilities of basketball players. Indian athletes have faced challenges in achieving success at international competitions, and this is of great concern, especially to the coaches, physical educationists, sports scientists, doctors, and researchers. Despite numerous interventions, consistent international success has remained limited.

The performance of any player will depend on their physical fitness. Physical fitness is defined as "The ability to carry out daily tasks with vigour and alertness, without undue fatigue and with ample energy to enjoy leisure time pursuits and to meet unforeseen emergencies" [1].

Proficiency in basketball requires sportsmen to have great coordination and develop fitness, along with speed. He should be agile and capable of repeated sprints of short distances. Basketball players should have good endurance to perform sustained periods of activity. Also, should have good power in the thighs and calves to jump with approach or without approach to place the ball through the basket. Along with all of these parameters, the sportsmen should have good basketball skills, viz dribbling, pivoting, and passing the ball to their teammates, along with converting all the passes into baskets. Addition of good height to this armamentarium will fulfill the key performance attributes in basketball [2].

The fusions of all these prerequisites are not attained at a specific age or by a specific player. Hence, players need to develop and cultivate different aspects of the game and bodily parameters to become high-performing athletes. Although India has never won a medal in basketball at the international level, it produced several talented players like Khushi Ram, Sarabjit Singh, Hari Dutt, Abbas Moontasir, Hanuman Singh, Ajmer Singh, S.K. Kataria, and Gurdial Singh [2]. After these notable former athletes, we did not see our teams perform well, even at the Asian Games. Abundant work has been done in Western countries in this regard, but very few studies are available on Indian players.

Scientific approach in understanding the game, selection of players, their training, and finding out particular deficiencies and then improving the game-specific skills is of paramount importance. To attain a level of physical fitness, the body must undergo a series of physical, chemical, and physiological changes. Assessment of various parameters required for the fitness of sportsmen playing basketball is essential. Testing physiological parameters for basketball has become more specific over the past decade with further advances in sports science, technology, and general understanding. However, despite the progress in testing procedures and knowledge, there still appears to be limited research regarding the analysis and critical appraisal of tests used, especially for basketball.

Hence, this study, "A Correlational Study of Static and Dynamic Strength in Relation to Vertical Jump Performance Among Basketball Players" was undertaken at the Department of Exercise and Sports Physiology, Dr. Vaishampayan Memorial Govt. Medical College, Solapur.

Materials and Methods:

The present study was carried out in thirty (30) male basketball players playing at university level, their age ranged from 18-19 years with an average of 18.6yrs. The following parameters were assessed:
A) Anthropometric measurements:
1. Height: cms

Figure no. 1: Standing Height (cms)

Height is defined as the vertical distance (Figure no.1) from heels to vertex in a subject standing erect which is an indicator of longitudinal growth of an individual. Standing height was measured using a scale mounted on a wall, in a barefooted subject, with his heels, buttocks and back touching the wall in cms [2].
1.Weight: Kgs

Figure no. 2: Weight (kgs)

Weight is defined as the vertical force exerted by the body as a result of the gravity. The weight (kg) was measured by using a lever system weight balance (Figure no.2), at 10am with minimum clothes [2].

B) Strength:
1. Dynamic - Bench Squat (lower body)
Dynamic Strength: (1RM)The maximum weight lifted in one repetition (1RM) for a particular group of muscles or a particular muscle action, measures dynamic muscular strength [3]. A trial-and-error approach was used to determine the 1RM strength. After a successful lift, the weight was increased by 5-10 kg until the maximum weight was achieved. The performer rested for 2-3 mins in between attempts. Dividing the 1RM score by the body weight of the individual measures the relative muscular strength.
Method: 1RM
Equipment - Barbell bench press station.
Bench Squat test (1RM):

Figure no. 3: Bench Squat – Standing with feet apart

After adjusting the desired amount of weight on the bar, the assistants placed the bar upon the shoulders (behind the neck) of the performer, as he stood near the edge of bench. With the feet at a comfortable distance apart and a firm grasp of the hands on the bar, the player lowered to an erect sitting position on the bench (Figure no.3, Figure no.4).

Figure no. 4: Bench Squat – Lower down to touch the bench

Then, without rocking back and forth, the player returned to a standing position [4]. After the two assistants removed the weight, the performer readjusted the weights for second trial till maximum weight was reached [5,6]. The performer's dynamic strength score was calculated by dividing the weight lifted by his own body weight as the test score.

Static Strength: Static Strength of leg and back muscles was measured by using leg and back dynamometer.

1. Static: Dynamometer - Leg - kg; Back - kg
Leg Dynamometry:

Figure no. 5: Leg Dynamometry

Leg: For estimating the strength of the leg muscles, the player was asked to stand on the dynamometer (Figure no.5), in such a way that the bar attached to the spring lied just above the knees and perpendicular to the horizontal line from both the knees. With his knees bent the player had to push himself up from the standing position by making his knees straight till his knees were fully extended [7,8]. Static strength was recorded from the dynamometer readings.
Back Dynamometry:

Figure no. 6: Back Dynamometry

Back: For estimating the strength of back muscles, the player was asked to stand on the dynamometer (Figure no.6), in such a way that the bar of the dynamometer was at his knee level. Then the player was asked to pull the bar from the spring as far as possible [6,7,8]. Static strength was recorded from the dynamometer readings.

C) Vertical jump test:
Vertical Jump: Anthropometric measurements were taken to the nearest cms.
Jump – Reach = cms

Figure no. 7: The player stood with one side towards the wall and held a piece of chalk in the hand nearest to the wall

The player stood with one side towards the wall and held a piece of chalk in the hand nearest to the wall (Figure no.7). Keeping the heels on the floor, he extended his arm to reach upwards as high as possible and make a mark on the wall. Then he was asked to jump as high as possible and make another mark at the height of his jump (Figure no.8).

Figure no. 8: Player jumps as high as possible and make another mark at the height of the jump

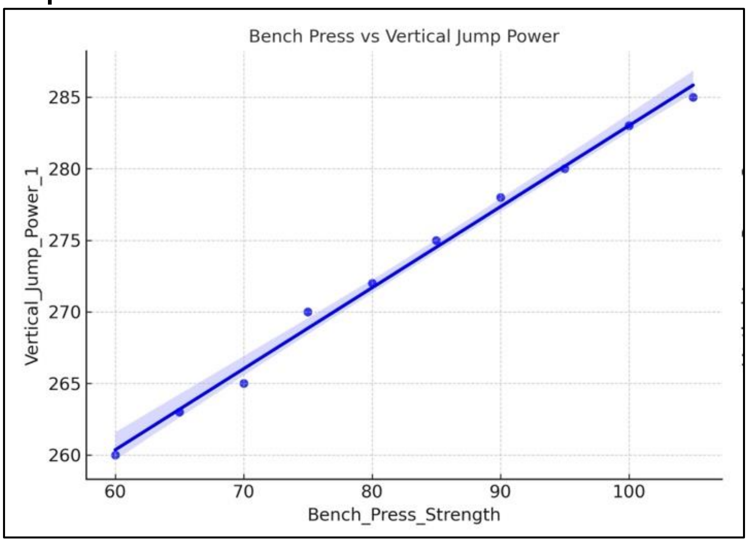
The number of cms between the reach and the jump marks were measured.
Power: It is defined as the ability to release maximum force in the fastest possible time, as is exemplified in this test as against time. The power of leg muscles was determined using vertical jump test [4,5,6].
The power [4,5,6] was calculated by the following formula: Power = distance x body weight÷12.

Results: (Spearman's Correlation)

Table no.1

Dynamic- Bench Press	Power	Spearman's Correlation	P value
Mean ± Std. Dev	Mean ± Std. Dev	0.667	< 0.0001
2.35 ± 0.5	277.3 ± 13.49		

Graph no.1

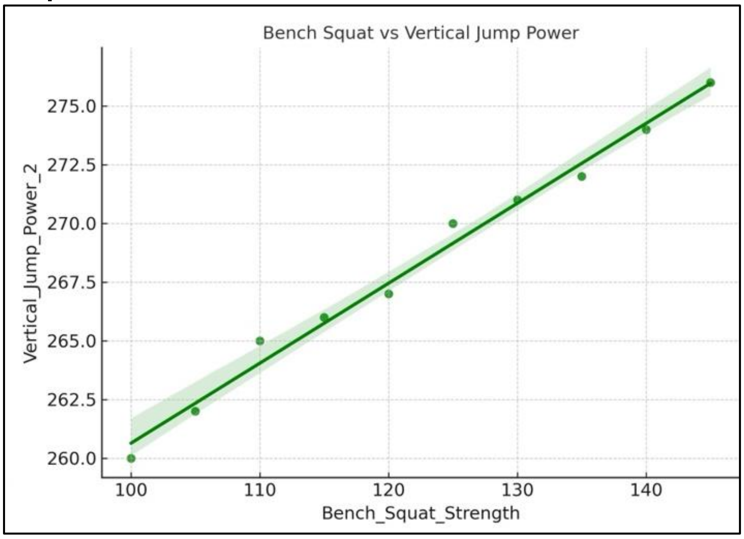


The findings reveal highly significant positive correlation between dynamic bench press performance and power (Spearman's ρ = 0.667, p < 0.0001). This indicates that individuals with higher dynamic bench press scores tend to exhibit greater power.

Table no.2

Dynamic-Bench Squat	**Power**	**Spearman's Correlation**	**P value**
Mean ± Std. Dev	Mean ± Std. Dev	0.288	< 0.01
4.57 ± 1.4	277.3 ± 13.49		

Graph no.2

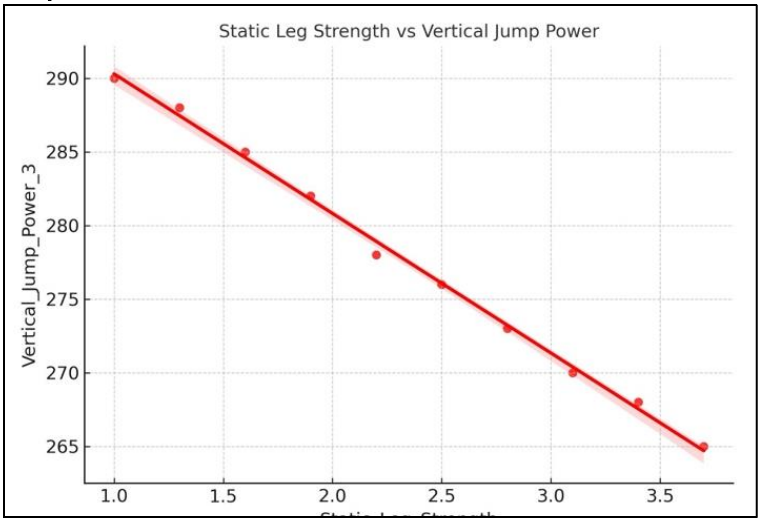


There is a statistically significant positive correlation between dynamic bench squat performance and power (Spearman's $\rho = 0.288$, $p < 0.01$). This indicates that as bench-squat performance increases, power output tends to increase proportionately.

Table no.3

Static Leg	**Power**	**Spearman's Correlation**	**P value**
Mean ± Std. Dev	Mean ± Std. Dev	-0.49	< 0.006
2.33 ± 0.7	277.3 ± 13.49		

Graph no.3

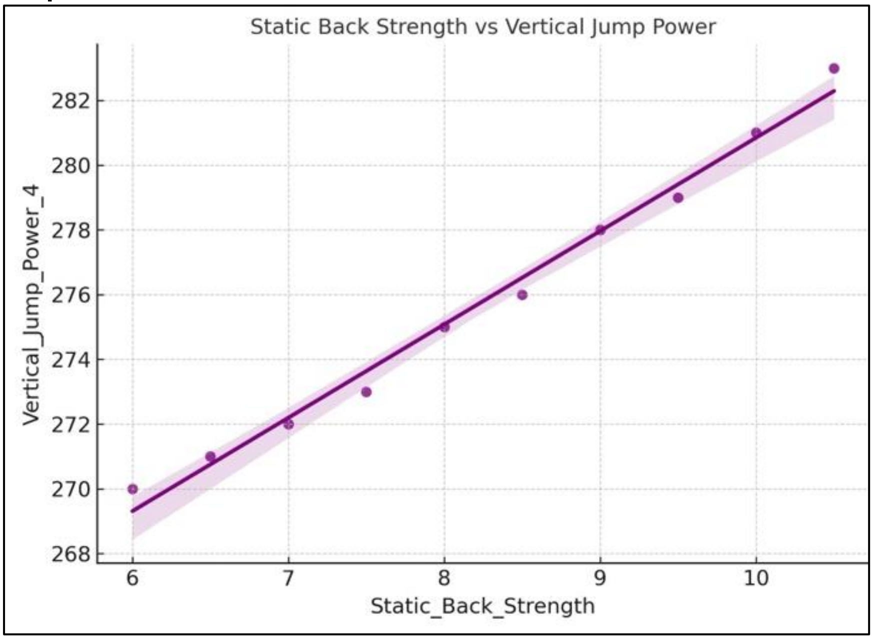


A moderate negative correlation was observed between static leg performance and power (Spearman's $\rho = -0.49$, $p < 0.006$). This suggests that higher static leg values are associated with lower power output, and the relationship is statistically significant.

Table no.4

Static Back	**Power**	**Spearman's Correlation**	**P value**
Mean ± Std. Dev	Mean ± Std. Dev	0.379	< 0.039
8.68 ± 2.1	277.3 ± 13.49		

Graph no.4

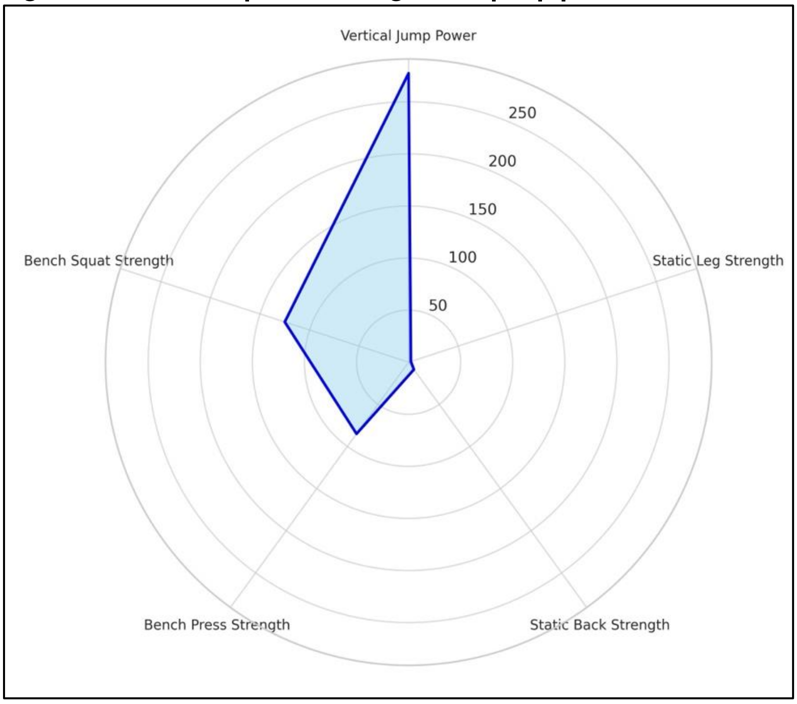


A positive correlation was found between static back strength and power (Spearman's ρ = 0.379, $p < 0.039$). This indicates that individuals with greater static back strength tend to have higher power output, and the association is statistically significant.

Discussion

The findings of the present study reveal significant correlations between various measures of muscular strength and vertical jump performance in basketball players (Figure no.9). These correlations provide valuable insights into the relationship between physical fitness parameters and athletic performance in basketball for predicting power based on dynamic and static strengths of upper and lower body.

Figure no. 9: Radar plot of strength and jump performance



Dynamic Strength - Bench Press and Power: The correlation analysis indicates a strong positive correlation (Spearman's rho = 0.667, $p < 0.0001$) between dynamic strength assessed through bench press and vertical jump power. This finding suggests that individuals with greater upper-body dynamic strength tend to exhibit higher power output during vertical jumps. The upper body strength developed through bench press exercises likely contributes to the ability to generate upward force during the vertical jump, emphasizing the importance of upper body strength in basketball performance.

Dynamic Strength - Bench Squat and Power: In contrast, the correlation between dynamic strength measured by bench squat and vertical jump power shows a weaker positive correlation (Spearman's rho = 0.288, $p = 0.01$), there still exists a positive trend indicating that individuals with greater lower body dynamic strength may demonstrate slightly higher power output in vertical jumps. However, the weaker correlation suggests that factors other than lower body strength may also influence vertical jump performance to a significant extent.

Static strength for leg - Spearman's correlation coefficient of -0.49 suggests a moderate negative relationship between the variables. The associated p-value of 0.006 indicates that this correlation is statistically significant, meaning it is unlikely to have occurred by random chance. Additionally, the mean and standard deviation provide insights into the central tendency and dispersion of the dataset, respectively.

Our study found a moderate negative correlation between static leg strength and vertical jump power in basketball players, as indicated by a Spearman's correlation coefficient of -0.49. This relationship was statistically significant ($p = 0.005$), suggesting that the association is unlikely to be due to random variation.

At first glance, the negative direction of the correlation may appear paradoxical, as greater lower-limb strength is generally assumed to contribute positively to vertical jump performance. However, this finding underscores the distinct physiological demands and neuromuscular characteristics involved in static strength versus dynamic power production. While static strength reflects the capacity to generate force in a non-moving context (e.g., isometric contraction), vertical jump power requires rapid force generation and effective neuromuscular coordination-attributes more aligned with explosive strength and power [9,10,11].

The mean static leg strength among participants was 2.33 ± 0.7, while mean vertical jump power was 277.3 ± 13.49. The relatively narrow dispersion in vertical jump power suggests homogeneity in dynamic athletic performance within the sample, whereas the wider variability in static strength could reflect differing training histories, muscle fibre compositions, or individual biomechanical efficiency.

These findings suggest that static strength alone may not be a reliable predictor of dynamic performance such as vertical jumping in basketball players. From a practical perspective, this emphasizes the importance of sport-specific training regimens that prioritize explosive strength and power development. Incorporating plyometric training, ballistic resistance exercises, and neuromuscular coordination drills may be more beneficial for improving vertical jump ability than focusing solely on static strength gains.

Further research is warranted to investigate the relationships between vertical jump performance and other strength modalities, including dynamic maximal strength, rate of force development, and reactive strength, to provide a more comprehensive understanding of performance determinants in basketball athletes.

Static strength for back -A moderate positive correlation was observed between static back strength and vertical jump power (Spearman's $\rho = 0.379$, $p = 0.039$), indicating a statistically significant association. This suggests that individuals with greater static back strength tend to demonstrate slightly better vertical jump performance. While not a strong predictor, this relationship highlights the potential role of core and posterior chain strength-particularly the spinal extensors-in stabilizing the body during explosive movements like vertical jumps. The mean static back strength of 8.68 ± 2.1 and mean vertical jump power of 277.3 ± 13.49 reflect relatively consistent performance levels across the cohort.

These findings support the integration of core strengthening exercises in athletic training programs to enhance vertical performance, though they also suggest that additional dynamic and plyometric components are essential for maximal gains in jump power.

The purpose of this study was to assess the various anthropometric parameters and co-relation between muscle strength and vertical jump among Indian basketball players. Our results showed moderate to high statistically significant co-relations among several variables. Dynamic strength assessed by bench press showed significantly high positive correlation ($p < 0.0001$) while static strength assessed by leg showed statistically significantly negative correlation ($r = -0.49$).

This shows similar results with the research conducted by Marko D et al, where they also concluded that static strength significantly decreased the jumping performance in adolescent basketball players while dynamic strength provided non-significant improvements [12]. Similarly, in a study by Christos Galazoulas, he also found that dynamic stretching was preferable (than static stretching) for its immediate effect on jumping and sprint performance especially among the professional basketball players [13]. Several other results are either in accordance with above findings like Fletcher and Anness et al [14] found that a combined protocol of static and dynamic stretching impacted sprint performance, leading to slower 50-meter sprint times, while Fletcher and Jones et al [15] found that while static stretching can improve range of motion, dynamic stretching may be more effective for enhancing sprint performance. Little and Williams [16] research found that while static stretching (SS) increased flexibility, it did not enhance high-speed performance and even slightly reduced it compared to a no-stretch control group. Dynamic stretching (DS), however, resulted in significantly faster agility performance than both static stretching and no stretching, while Nelson et al [17] 2005 observed that a single bout of dynamic stretching only resulted in a negligible change in running economy but a large increase in running performance, with an overall stretch duration.

Therefore, if stretching is applied without additional warm-up, the results suggest applying dynamic stretching rather than static stretching if the goal is to increase running performance. Chaouachi et al [18] reported that agility could be improved using small-sided games (SSGs) or change of directions (COD) sprints in young male athletes. Paradisis et al [19] indicated that static stretching negatively affected both sprint and jump performance, while dynamic stretching had no effect on sprinting but impaired jumping. Vasileiou et al [20] research found that including stretching, both static and dynamic, as part of a warm-up routine could be beneficial and positive influence for repeated sprint performances. Papadopoulos et al [21] suggests that explosively performed half-squats at low to moderate intensity in a warm-up can improve counter-movement jump (CMJ) performance, possibly due to increased muscle activation, and that intensity within this range may not be a critical factor for improvement. Famisis [22] suggested dynamic stretching routines following a general warm-up are likely to result in more favourable outcomes for maximizing power production.

Static stretching (SS) is commonly used as a part of a warm-up routine to increase flexibility and prevent sports-related injuries. In a study conducted by Kosuke Takeuchi et al [23], to compare the effects of static stretching (SS) on the range of motion and vertical jump height between the quadriceps, hamstrings and triceps in collegiate basketball players. They found that the range of motion of the quadriceps, hamstrings and triceps were significantly increased without any difference of relative change in the range. Vertical jump height was significantly decreased after SS of only the triceps.

In a study conducted by Purvi K. Changela et al [24], they found a significant positive correlation between vertical jump and anaerobic power to assess muscle strength. Study conducted by Utku Alemdaroglu showed no measure of strength significantly related to the measurements from results of field tests [25]. Moreover, strong relations were found between the performance of athletes in different field tests ($p < 0.05$)

Conclusion

The findings of this study underscore the importance of both static and dynamic strength in influencing vertical jump performance among basketball players. The significant correlations observed between vertical jump height and parameters such as bench press 1RM and power output highlight the multifaceted nature of athletic explosiveness in basketball players. It suggests that a comprehensive strength training regimen targeting both static and dynamic components can contribute to improvements in vertical jump performance, thereby enhancing on-court effectiveness in various aspects of the game.

Furthermore, the implications of these findings extend beyond mere physical conditioning. By understanding the interplay between strength and vertical jump performance, coaches and trainers can tailor individualized training programs to optimize athletic development and performance outcomes for basketball players. Emphasizing exercises that target both static strength (e.g., traditional weightlifting) and dynamic power (e.g., plyometrics) can foster a well-rounded athletic profile conducive to success in competitive basketball environments.

In conclusion, the findings show that dynamic bench press and static back strength have a significant positive correlation with power, suggesting they contribute to enhanced performance. In contrast, static leg strength shows a moderate negative correlation with power. These results imply that focusing on improving upper body dynamic strength and back strength may help boost power output in basketball players, potentially leading to better performance in explosive movements like jumping and sprinting. The findings underscore the importance of comprehensive strength training strategies in enhancing athletic explosiveness and on-court performance. By integrating these insights into training protocols, coaches and trainers can empower athletes to optimize performance and excel in the dynamic and demanding landscape of competitive basketball.

Limitations and Recommendations

While this study provides valuable insights into the correlation between vertical jump performance and static/dynamic strength parameters, several limitations warrant consideration. The sample size of participants may influence the generalizability of the findings, and future studies with larger and more diverse cohorts could validate the observed relationships. Additionally, incorporating other strength assessment methods and exploring the impact of specific training interventions on vertical jump performance could offer deeper insights into optimizing athletic development in basketball players.

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