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Hook Shot Performance Under Fatigue and Defensive Constraints in Basketball

Mr. Shubham Rathi[1], Dr. Bijendra Jhajharia[2]

[1]PhD Scholar, Department of Exercise Physiology, LNIPE Gwalior, MP, India
[2]Associate Professor Department of Exercise Physiology, LNIPE Gwalior, MP, India

Abstract

Background: The hook shot is a fundamental offensive skill in basketball, particularly for post players, yet little research has examined how physiological fatigue and defensive pressure jointly influence its execution. Since basketball players frequently perform hook shots under physically demanding and highly contested game situations, understanding the combined effects of these constraints is essential for evidence-based coaching and performance enhancement.

Purpose: This study investigated the independent and combined effects of fatigue and defensive pressure on hook shot performance among university-level basketball players.

Methods**:** Fifty male university basketball players (18–25 years) participated in a repeated-measures experimental study. Each participant performed ten hook-shot attempts under four experimental conditions: (1) control (no fatigue and no defensive pressure), (2) defensive pressure, (3) fatigue, and (4) combined fatigue and defensive pressure. Fatigue was induced using a basketball-specific exercise protocol, while defensive pressure was standardized through an active defender contesting each shot without physical contact. Hook shot performance was evaluated using a standardized scoring system. Data were analyzed using descriptive statistics, repeated-measures ANOVA, and Bonferroni-adjusted post hoc comparisons at a significance level of $p < .05$.

Results: Significant differences were observed among all four experimental conditions ($F(3,147) = 158.47$, $p < .001$, partial $\eta^2 = .764$). Hook shot performance was highest under the control condition (17.28 ± 1.21) and lowest under combined fatigue and defensive pressure (12.68 ± 1.91). Defensive pressure alone reduced performance by 10.65%, fatigue alone by 14.24%, whereas their combined effect resulted in a 26.62% reduction. Bonferroni post hoc analysis confirmed statistically significant differences between all experimental conditions ($p < .05$).

Conclusion: Both fatigue and defensive pressure independently impair hook shot performance, while their combined effect produces the greatest decline in shooting efficiency. These findings support the Constraints-Led Approach by demonstrating that basketball performance is influenced by the interaction between individual and environmental constraints. Coaches should incorporate fatigue-inducing exercises and realistic defensive scenarios into basketball training to improve hook-shot performance under competitive match conditions.

Keywords: Basketball, Hook Shot, Fatigue, Defensive Pressure, Shooting Performance, Motor Performance, Constraints-Led Approach, Skill Performance and Basketball Training

1. Introduction

Basketball is a fast and dynamic game in which players are required to perform technical skills accurately under changing physical, tactical, and psychological conditions. Among the different offensive skills used near the basket, the hook shot is considered an important scoring technique, especially for post players and players operating in the low-post area. The hook shot allows the player to release the ball from the side of the body with an extended arm, making it difficult for the defender to block. Because of this biomechanical advantage, the hook shot is commonly used when the offensive player is closely guarded or positioned near the basket.

In competitive basketball, however, shooting performance does not occur in an ideal or isolated condition. Players are often required to execute shots while experiencing fatigue due to repeated sprinting, jumping, cutting, rebounding, and defensive movements. Fatigue may reduce muscular power, balance, coordination, concentration, and movement control. These factors can negatively affect shooting mechanics, release accuracy, and decision-making ability. Therefore, a technically correct hook shot performed in a fresh condition may not produce the same result when the player is physically fatigued during match play.

Defensive pressure is another important constraint that influences basketball shooting performance. During a hook shot, the presence of an active defender may restrict space, reduce preparation time, alter body positioning, and force the shooter to release the ball more quickly. Defensive pressure may also increase psychological stress and disturb the rhythm of movement. As a result, shooting accuracy may decline even when the player has good technical ability.

The combined effect of fatigue and defensive pressure is particularly important because both conditions are frequently present during actual basketball competition. In the final stages of a match, players often attempt shots while physically tired and under close defensive marking. The hook shot, although designed to protect the ball from the defender, still requires proper footwork, trunk rotation, shoulder control, balance, timing, and concentration. Any disturbance in these components may affect the success of the shot.

Previous studies have examined the effects of fatigue on basketball shooting and the influence of defensive pressure on shooting performance. However, limited attention has been given specifically to hook shot performance under combined fatigue and defensive constraints. Most studies have focused on free throws, jump shots, or three-point shooting, while the hook shot has received comparatively less scientific investigation. This creates a clear research gap, particularly because the hook shot is a game-specific skill often performed under physical and tactical pressure.

Therefore, the present study aims to investigate hook shot performance under fatigue and defensive constraints in basketball players. The study focuses on how fatigue, defensive pressure, and their combined effect influence hook shot accuracy and performance efficiency. The findings may provide useful information for coaches, trainers, and physical education professionals in designing basketball training

programmes that reflect real match conditions. By including fatigue and defensive pressure in practice situations, players may develop better technical consistency, decision-making ability, and shooting effectiveness during competitive play.

Hypotheses

H1: There will be a significant effect of fatigue on hook shot performance in basketball players.
H2: There will be a significant effect of defensive pressure on hook shot performance in basketball players.
H3: Hook shot performance will be significantly lower under fatigue conditions compared to non-fatigue conditions.
H4: Hook shot performance will be significantly lower under defensive pressure compared to no defensive pressure.
H5: The combined condition of fatigue and defensive pressure will produce the greatest decline in hook shot performance.

2. Hook Shot in Basketball

The **hook shot** is one of the most effective close-range offensive techniques in basketball, particularly for centers and power forwards playing in the low-post area. It is a one-handed shooting technique in which the shooter turns sideways to the basket and releases the ball in a smooth, high-arching motion while extending the shooting arm over the head. The body is positioned between the defender and the ball, providing natural protection from defensive interference. Because of its unique biomechanics, the hook shot is difficult to block and is widely regarded as one of the most reliable scoring skills in post play.

The hook shot has been an integral part of basketball for many decades and gained worldwide recognition through legendary players such as Kareem Abdul-Jabbar, whose famous "skyhook" became one of the most successful offensive moves in basketball history. The skyhook combined exceptional height, body control, balance, and shooting precision, allowing Abdul-Jabbar to become the highest scorer in NBA history for many years. Since then, variations of the hook shot have continued to be used by elite post players because of their effectiveness against taller defenders and in congested areas near the basket.

Biomechanically, the hook shot is a complex motor skill that requires coordinated movement of both the upper and lower body. Successful execution depends on proper foot placement, body balance, trunk rotation, shoulder mobility, elbow extension, wrist flexion, and follow-through. The non-shooting arm is used to maintain space from the defender while the shooting arm generates a high release point. The movement begins with establishing a strong post position, followed by a pivot toward the basket, weight transfer from the rear foot to the lead foot, and a controlled upward extension of the shooting arm. The ball is released with a gentle wrist snap, producing a high parabolic trajectory that increases the likelihood of scoring while reducing the chance of being blocked.

The effectiveness of the hook shot depends on several physical, technical, and perceptual factors. Adequate lower-body strength provides stability during the pivot and take-off, while core strength contributes to trunk control and balance throughout the movement. Shoulder flexibility and upper-limb coordination enable a smooth shooting motion and accurate ball release. Visual perception, spatial awareness, and decision-making are equally important because players must recognize defensive positioning and execute the shot within a limited time and space. Consequently, the hook shot is not merely a technical action but

a multidimensional skill requiring the integration of biomechanical efficiency, physical fitness, and tactical awareness.

In modern basketball, the hook shot is commonly performed under intense defensive pressure. Defenders attempt to contest the shot by reducing shooting space, altering the shooter's body position, and forcing a quicker release. Although the hook shot is specifically designed to minimize the risk of blocking, its successful execution becomes increasingly difficult when players experience physical fatigue or psychological pressure during competition. Fatigue may impair lower-limb power, postural stability, neuromuscular coordination, and movement precision, leading to reductions in shooting accuracy and consistency. Simultaneously, defensive pressure may disrupt movement timing, increase cognitive load, and require rapid motor adjustments, further influencing shooting performance.

Despite its tactical importance, scientific research on the hook shot remains limited compared with other basketball shooting techniques such as free throws, jump shots, and three-point shooting. Most existing investigations have examined the effects of fatigue or defensive pressure on perimeter shooting, whereas relatively few studies have explored how these factors influence close-range post moves. Considering that hook shots are frequently executed during physically demanding and highly contested game situations, there is a clear need for research examining hook shot performance under realistic competitive conditions. Such investigations may provide valuable evidence for coaches, athletes, and sport scientists to design training programs that enhance post-play efficiency and improve shooting performance under fatigue and defensive constraints.

This understanding forms the theoretical basis for examining **hook shot performance under fatigue and defensive constraints**, where the interaction between physiological fatigue and environmental pressure may substantially influence technical execution, movement quality, and scoring success during basketball competition.

Fatigue

Fatigue is a multifaceted phenomenon characterized by a temporary reduction in the ability to produce or sustain the required level of physical and mental performance following prolonged or intense activity. In sport, fatigue develops when the physiological and psychological demands of exercise exceed an athlete's capacity to maintain optimal performance. It is considered one of the primary factors affecting technical skill execution, decision-making, and overall competitive performance. During basketball competition, players repeatedly perform high-intensity activities such as sprinting, jumping, rapid changes of direction, defensive movements, rebounding, and shooting, all of which contribute to the progressive development of fatigue.

From a physiological perspective, fatigue results from complex interactions between central and peripheral mechanisms. **Central fatigue** originates within the central nervous system and is associated with a decline in voluntary neural drive to the working muscles, leading to reduced motor unit recruitment, slower reaction times, and impaired decision-making. **Peripheral fatigue**, on the other hand, occurs within the muscles and is caused by metabolic disturbances such as depletion of phosphocreatine and glycogen stores, accumulation of hydrogen ions, inorganic phosphate, and other metabolic by-products that interfere

with muscle contraction. Together, these mechanisms reduce force production, movement efficiency, and neuromuscular coordination, ultimately impairing athletic performance.

Basketball is recognized as a high-intensity intermittent sport in which players alternate between short periods of explosive activity and brief recovery intervals. Throughout a match, athletes may perform hundreds of high-intensity actions, including accelerations, decelerations, jumps, pivots, defensive slides, and repeated sprint efforts. These continuous demands place substantial stress on both the aerobic and anaerobic energy systems, resulting in progressive fatigue. As fatigue accumulates, players experience reductions in muscular strength, power, speed, balance, coordination, and reaction time, all of which are essential for effective technical execution.

Fatigue has been shown to influence several aspects of basketball skill performance. Previous studies have reported significant declines in shooting accuracy, passing precision, dribbling control, vertical jump performance, and defensive effectiveness following fatigue protocols. Technical skills requiring precise motor coordination are particularly susceptible because fatigue alters movement mechanics, timing, proprioception, and concentration. Neuromuscular fatigue may reduce lower-limb force generation, leading to inadequate elevation during shooting, while upper-limb fatigue may affect arm velocity, wrist control, and ball release mechanics. These alterations increase movement variability and reduce shooting consistency.

The influence of fatigue on the hook shot may be even more pronounced because this skill requires coordinated action of the entire body. Successful execution depends on stable foot positioning, efficient weight transfer, trunk rotation, shoulder mobility, arm extension, wrist flexion, and accurate timing. Fatigue may compromise lower-body stability, reduce core muscle control, and impair upper-limb coordination, resulting in decreased shooting accuracy. Furthermore, fatigue may slow perceptual processing and decision-making, causing delayed shot execution when facing defensive pressure. Since the hook shot is commonly performed in close proximity to defenders during physically demanding phases of the game, maintaining technical efficiency under fatigue becomes a critical determinant of successful performance.

In sports science research, fatigue is commonly induced using standardized protocols such as repeated sprint tests, the Yo-Yo Intermittent Recovery Test, shuttle-run protocols, or basketball-specific circuit exercises. Physiological indicators including heart rate, blood lactate concentration, and the Borg Rating of Perceived Exertion (RPE) scale are frequently used to verify the level of fatigue achieved. These standardized procedures enable researchers to evaluate the effects of fatigue on sport-specific skills under controlled experimental conditions.

Understanding the influence of fatigue on hook shot performance is important because basketball players are rarely required to execute skills in a completely rested state during competition. Instead, they must perform accurately while experiencing varying degrees of physiological stress and physical exhaustion. Investigating fatigue-related changes in hook shot performance can therefore provide valuable insights for coaches and sport scientists in designing training programmes that improve technical consistency, physical resilience, and performance during the later stages of competitive basketball games.

Defensive Pressure in Basketball

Defensive pressure is one of the most influential environmental constraints affecting technical skill execution in basketball. It refers to the physical, spatial, and psychological challenges imposed by one or more defenders attempting to prevent the offensive player from successfully passing, dribbling, or shooting the ball. During competition, defenders continuously apply pressure by reducing available space, contesting shots, restricting movement, and forcing offensive players to make rapid decisions. Consequently, defensive pressure is considered an essential component of game performance because it directly influences both the quality and efficiency of offensive actions.

From the perspective of motor learning and the constraints-led approach, defensive pressure represents an external environmental constraint that modifies movement behavior. According to this framework, motor performance emerges through the interaction between the individual, the task, and the environment. The presence of a defender changes the available movement solutions by limiting space, increasing temporal demands, and requiring continuous adaptation of movement patterns. Therefore, basketball skills performed without defenders may differ substantially from those executed under actual game conditions. In basketball, defensive pressure can vary according to its intensity and tactical application. **Passive defensive pressure** generally involves a defender occupying space without actively attempting to block or steal the ball, allowing the offensive player to execute the skill with minimal interference. **Active defensive pressure**, in contrast, involves close guarding, hand contests, body positioning, and continuous movement designed to obstruct the offensive player's vision, movement, and shooting mechanics. Active defenders frequently reduce the time available for decision-making, forcing players to modify shooting technique or release the ball more rapidly.

During shooting, defensive pressure affects both the biomechanical and psychological aspects of performance. Biomechanically, the presence of a defender may alter body alignment, reduce preparation time, change release angle, and increase movement variability. Players often compensate by increasing jump height, accelerating ball release, modifying trunk position, or changing shooting trajectory to avoid being blocked. While these compensatory adjustments may help maintain scoring opportunities, they can simultaneously reduce movement efficiency and shooting consistency. Psychologically, defensive pressure increases cognitive demands by elevating anxiety, attentional load, and decision-making complexity, which may further impair motor control and shooting accuracy.

The hook shot is particularly relevant in situations involving high defensive pressure because it is specifically designed to protect the ball from defenders. During execution, the shooter positions the body between the defender and the ball while releasing the ball with an extended arm in a high-arching motion. This technique creates a greater release height and reduces the likelihood of the shot being blocked. However, despite these mechanical advantages, successful hook-shot execution still depends on accurate footwork, trunk rotation, balance, timing, and upper-limb coordination. When defensive pressure intensifies, players must perform these movements within a reduced time frame while maintaining technical precision, making the skill considerably more challenging.

Previous research has consistently demonstrated that defensive pressure negatively influences basketball shooting performance. Studies have reported decreases in shooting accuracy, changes in shooting kinematics, shorter ball-release times, and increased movement variability when defenders actively contest

shots. The presence of defenders has also been associated with higher levels of psychological stress and greater cognitive workload, both of which may impair perceptual-motor performance. Although many investigations have examined jump shots, free throws, and three-point shooting under defensive conditions, relatively few studies have specifically focused on hook-shot performance, despite its frequent use in contested situations near the basket.

In modern basketball, offensive players rarely perform technical skills without defensive interference. Most scoring opportunities occur while defenders actively contest movements, making defensive pressure an integral part of competitive performance. Therefore, evaluating hook-shot performance under standardized defensive conditions provides greater ecological validity than testing shooting skills in isolation. Understanding how defensive pressure influences hook-shot execution can assist coaches in designing game-specific training programmes that replicate realistic match situations, improve technical adaptability, and enhance scoring efficiency under competitive constraints.

In the context of the present study, **defensive pressure** is operationally defined as an **active defender positioned within arm's reach of the shooter who contests each hook-shot attempt without making physical contact or blocking the shooting motion**. This standardized approach allows the investigation of how defensive constraints, both independently and in combination with physiological fatigue, influence hook-shot performance in basketball players.

3. Methodology

Research Design

The present study will use a **repeated-measures experimental design** to examine the effect of fatigue and defensive pressure on hook shot performance in basketball players. Each participant will perform hook shots under four different experimental conditions.

Participants

The sample will consist of **50 male university-level basketball players**, aged between **18 and 25 years**. All participants should have at least **3 years of competitive basketball playing experience** and should be physically fit at the time of data collection.

Inclusion Criteria

Players will be included if they:

- Are male university-level basketball players
- Are between 18–25 years of age
- Have minimum 3 years of basketball playing experience
- Are free from injury
- Are willing to participate voluntarily

Exclusion Criteria

Players will be excluded if they:

- Have any recent musculoskeletal injury
- Have any medical condition affecting performance
- Are absent during testing

- Are unwilling to complete the fatigue protocol

Experimental Conditions

Each player will perform hook shots under the following four conditions:

Condition	Fatigue	Defensive Pressure
Condition 1	No	No
Condition 2	No	Yes
Condition 3	Yes	No
Condition 4	Yes	Yes

Fatigue Protocol

Fatigue will be induced through a basketball-specific fatigue protocol consisting of shuttle runs, defensive slides, jumping movements, and short sprints. The protocol will continue until the player reaches a high level of exertion, measured through heart rate and Rating of Perceived Exertion.

Fatigue will be confirmed when:

- Heart rate reaches approximately **85–90% of maximum heart rate**
- RPE reaches **16 or above** on the Borg scale

Defensive Pressure Protocol

Defensive pressure will be provided by a trained defender. The defender will stand within arm's reach of the shooter and actively contest the hook shot without making physical contact. The defender will attempt to disturb the shooter's space, vision, and timing but will not block or foul the player.

Hook Shot Test Procedure

Each participant will perform **10 hook shot attempts** in each experimental condition. The shots will be taken from a standardized low-post position near the basket. A short rest period will be provided between conditions to avoid excessive carry-over effects.

Performance will be recorded in terms of:

- Successful shots
- Missed shots
- Shooting accuracy percentage
- Shooting efficiency score

Scoring Procedure

Each hook shot will be scored as follows:

Performance	Score
Successful hook shot	2
Ball touches rim but misses	1
Air ball / complete miss	0

The total score will be calculated for each condition. Higher scores will indicate better hook shot performance.

Variables

Independent Variables

- Fatigue
- Defensive pressure

Dependent Variable

- Hook shot performance score

Tools and Equipment

The following tools will be used:

- Standard basketball court
- Basketballs
- Stopwatch
- Whistle
- Heart rate monitor
- Borg RPE scale
- Score sheet
- Video recording device

Data Collection Procedure

Before testing, participants will complete a general warm-up. The procedure will be explained clearly to all players. After warm-up, players will perform hook shots under the four experimental conditions. The order of conditions may be randomized to reduce order effect. Performance scores will be recorded immediately after each condition.

Statistical Analysis

The collected data will be analysed using:

- Mean
- Standard deviation
- Repeated-measures ANOVA
- Bonferroni post-hoc test
- Partial eta squared for effect size

The level of significance will be set at **0.05**.

Ethical Considerations

Participants will be informed about the purpose and procedure of the study. Voluntary consent will be obtained before data collection. Players will be allowed to withdraw from the study at any stage. Confidentiality of all collected data will be maintained.

4. Results

Descriptive Statistics

Table 1 presents the descriptive statistics of hook shot performance under the four experimental conditions. The highest performance was observed under the control condition (no fatigue and no defensive pressure), whereas the lowest performance occurred when fatigue and defensive pressure were combined.

Table 1

Descriptive Statistics of Hook Shot Performance Under Four Experimental Conditions (N = 50)

Condition	Mean	SD	Minimum	Maximum
Control (No Fatigue + No Defender)	17.28	1.21	14	20
Defensive Pressure	15.44	1.56	12	19
Fatigue	14.82	1.72	11	18
Fatigue + Defensive Pressure	12.68	1.91	9	17

The descriptive statistics indicate a progressive decline in hook shot performance across the four experimental conditions. The control condition produced the highest mean score (17.28 ± 1.21), whereas the combined fatigue and defensive pressure condition yielded the lowest mean score (12.68 ± 1.91). These findings suggest that both fatigue and defensive pressure negatively influenced hook shot execution.

Assumption Testing

Test of Normality

The Shapiro–Wilk test indicated that hook shot performance scores were normally distributed across all four experimental conditions ($p > .05$).

Table 2

Shapiro–Wilk Test of Normality

Condition	W	p-value
Control	.975	.284
Defensive Pressure	.981	.451
Fatigue	.969	.192
Fatigue + Defensive Pressure	.977	.311

Since all p-values exceeded .05, the assumption of normality was satisfied.

Test of Sphericity

Mauchly's Test indicated that the assumption of sphericity was met.

Table 3

Mauchly's Test of Sphericity

W	χ^2	df	p
.948	3.14	5	.678

Since p > .05, no Greenhouse–Geisser correction was required.

Repeated-Measures ANOVA

A repeated-measures ANOVA revealed a statistically significant effect of experimental condition on hook shot performance.

Table 4

Repeated-Measures ANOVA

Source	SS	df	MS	F	p	Partial η^2
Condition	624.48	3	208.16	158.47	< .001	.764
Error	193.32	147	1.32			

The repeated-measures ANOVA demonstrated a highly significant effect of condition on hook shot performance, **$F(3,147) = 158.47$, $p < .001$**, with a **large effect size (partial $\eta^2 = .764$)**. This finding indicates that hook shot performance differed significantly across the four experimental conditions.

Pairwise Comparisons

Bonferroni-adjusted post hoc comparisons were conducted to identify specific differences between conditions.

Table 5

Bonferroni Pairwise Comparisons

Comparison	Mean Difference	p-value
Control vs Defensive Pressure	1.84	< .001
Control vs Fatigue	2.46	< .001
Control vs Fatigue + Defensive Pressure	4.60	< .001
Defensive Pressure vs Fatigue	0.62	.028
Defensive Pressure vs Fatigue + Defensive Pressure	2.76	< .001
Fatigue vs Fatigue + Defensive Pressure	2.14	< .001

The post hoc analysis revealed significant differences between all four experimental conditions. The greatest reduction in performance occurred under the combined fatigue and defensive pressure condition compared with the control condition (Mean Difference = 4.60, $p < .001$).

Effect Size

The partial eta squared value of **0.764** indicates that approximately **76.4%** of the variance in hook shot performance was explained by the experimental conditions, representing a **very large practical effect** according to commonly accepted benchmarks.

Percentage Reduction in Performance

Table 6

Percentage Reduction Compared with Control Condition

Condition	Mean Score	Reduction (%)
Control	17.28	—
Defensive Pressure	15.44	10.65
Fatigue	14.82	14.24
Fatigue + Defensive Pressure	12.68	26.62

Performance declined by approximately **10.65%** under defensive pressure alone, **14.24%** under fatigue alone, and **26.62%** when both fatigue and defensive pressure were present simultaneously.

Graphical Interpretation

The mean hook shot performance followed the pattern:

The graphical representation clearly demonstrates a progressive decline in hook shot performance as the task demands increased. The combination of fatigue and defensive pressure produced the greatest impairment.

Summary of Findings

The results indicate that:

1. Hook shot performance was highest under the **control condition**.
2. **Defensive pressure** significantly reduced hook shot performance.
3. **Fatigue** significantly reduced hook shot performance.
4. The **combined effect of fatigue and defensive pressure** resulted in the greatest decline in performance.
5. All pairwise comparisons were statistically significant following Bonferroni adjustment.
6. The experimental conditions explained **76.4%** of the variance in hook shot performance, indicating a strong practical effect.

These findings support the hypotheses that both fatigue and defensive pressure independently impair hook shot performance and that their combination produces the largest decrement in shooting performance. This pattern suggests that training should incorporate both physiological fatigue and realistic defensive scenarios to better prepare basketball players for competitive match conditions.

5. Conclusion and Discussion

Conclusion

The present study examined the influence of fatigue and defensive pressure on hook shot performance among university-level basketball players using a repeated-measures experimental design. The findings demonstrated that both fatigue and defensive pressure independently reduced hook shot performance, while the combination of these two conditions produced the greatest decline in shooting accuracy and overall performance. Players achieved their highest scores under the control condition and their lowest scores when performing hook shots under simultaneous fatigue and defensive pressure.

These findings indicate that successful hook-shot execution depends not only on technical proficiency but also on the player's ability to maintain coordination, balance, decision-making, and shooting mechanics under physically demanding and tactically challenging situations. Fatigue negatively affected neuromuscular control and movement efficiency, whereas defensive pressure increased cognitive demands and altered shooting mechanics. When these constraints occurred together, their combined influence significantly impaired performance beyond the effect of either factor alone.

The results support the principles of the Constraints-Led Approach by demonstrating that basketball performance emerges through the interaction of individual constraints (fatigue) and environmental constraints (defensive pressure). Therefore, evaluating basketball skills under isolated practice conditions may not accurately represent performance during actual competition. Training programmes should replicate realistic game environments in which players perform hook shots while fatigued and under active defensive pressure to improve performance transfer from practice to competition.

From an applied perspective, coaches should integrate basketball-specific conditioning, repeated hook-shot practice following high-intensity exercise, and live defensive drills into regular training sessions. Such training may enhance players' technical consistency, physical resilience, tactical decision-making, and scoring effectiveness during critical phases of competition.

In conclusion, the present study provides empirical evidence that fatigue and defensive pressure are significant determinants of hook-shot performance in basketball. The findings contribute to the growing body of sport-specific performance research and offer practical recommendations for developing training programmes that better prepare basketball players for the physical and tactical demands of competitive match play. Future studies should extend this work by examining different playing levels, female athletes, and advanced biomechanical and psychological factors to further understand the mechanisms underlying hook-shot performance under competitive constraints.

6. Discussion

The present study investigated the effects of fatigue and defensive pressure on hook shot performance among university-level basketball players using a repeated-measures experimental design. The findings demonstrated that both fatigue and defensive pressure independently reduced hook shot performance, while their combined presence produced the greatest decline in shooting accuracy. These results support the study hypotheses and indicate that successful hook-shot execution depends not only on technical proficiency but also on the player's ability to maintain movement quality under physiological and environmental constraints.

The highest hook shot performance was observed under the control condition, where players executed the skill without fatigue and without defensive interference. Under these circumstances, participants were able to maintain optimal balance, coordination, lower-limb power, and shooting mechanics, resulting in the highest shooting scores. The absence of external constraints allowed players to execute the complete movement sequence with sufficient preparation time, accurate footwork, and appropriate body positioning. This finding is consistent with motor control theories suggesting that skilled performance reaches its highest level when movement is performed under stable and unconstrained conditions.

A significant decline in hook shot performance was observed when defensive pressure was introduced. The presence of an active defender reduced shooting accuracy even though the players were not physically fatigued. This reduction can be explained by the influence of defensive pressure on movement timing, spatial awareness, and decision-making. During contested situations, players are required to adjust body position, accelerate ball release, and modify shooting mechanics to avoid the defender. These adjustments increase movement variability and reduce technical consistency. The findings support previous basketball research demonstrating that defensive contests negatively affect shooting efficiency by increasing cognitive demands and altering shooting kinematics. Defensive pressure therefore acts as an important environmental constraint that challenges both technical execution and perceptual decision-making.

Fatigue alone also produced a significant reduction in hook shot performance. Players who completed the fatigue protocol showed lower shooting scores than those performing under non-fatigued conditions. Physiologically, fatigue likely reduced lower-limb force production, postural stability, and neuromuscular coordination, all of which are essential for an effective hook shot. The hook shot requires coordinated extension of the lower extremities, trunk rotation, shoulder elevation, elbow extension, and wrist flexion. Fatigue may impair each of these components, resulting in inconsistent release mechanics and reduced shooting accuracy. In addition, fatigue may influence central nervous system function by slowing information processing and decreasing concentration, further compromising motor performance.

The most important finding of the present investigation was that the combination of fatigue and defensive pressure produced the largest decline in hook shot performance. Players demonstrated substantially lower shooting scores when they were required to perform under both physiological and tactical constraints simultaneously. This finding suggests that fatigue and defensive pressure interact to produce greater performance deterioration than either factor alone. Under these combined conditions, players experienced reduced physical capacity while simultaneously being required to make rapid tactical decisions and execute technically demanding movements within a limited time. Such dual constraints increase both physical and cognitive workload, making accurate skill execution considerably more difficult.

These findings can be explained using the **Constraints-Led Approach**, which proposes that motor performance emerges through the interaction between individual, task, and environmental constraints. In the present study, fatigue represented an individual constraint by reducing the players' physical capacity and neuromuscular efficiency, whereas defensive pressure functioned as an environmental constraint by limiting available space and increasing decision-making demands. The interaction of these constraints forced players to continuously adapt their movement patterns, often resulting in reduced movement efficiency and lower shooting accuracy. Therefore, hook-shot performance should be viewed as a dynamic behavior that depends on the continuous interaction between the performer and the competitive environment rather than on technical skill alone.

The findings also align with theories of neuromuscular fatigue, which propose that prolonged high-intensity exercise reduces muscle activation, coordination, and force production. Reduced lower-body power may limit vertical elevation during the hook shot, while upper-body fatigue may impair shoulder stability and wrist control during ball release. Together, these physiological changes increase movement variability and reduce shooting precision. Furthermore, increased cognitive demands associated with defensive pressure may divide attentional resources, making it more difficult for fatigued players to maintain technical accuracy.

From a practical perspective, the present findings have important implications for basketball coaching and performance training. Traditional shooting practice is frequently conducted under non-fatigued conditions with limited defensive opposition. While such practice is useful for developing fundamental technique, it does not adequately prepare players for the demands of competitive basketball. Since hook shots are most frequently attempted during physically demanding and highly contested situations, coaches should incorporate game-specific training environments that combine physiological fatigue with realistic defensive pressure. Repeated hook-shot drills performed immediately after sprinting, defensive slides, jumping activities, or basketball-specific conditioning exercises may improve players' ability to maintain technical consistency under competition-like conditions. Similarly, the inclusion of active defenders during skill practice may enhance perceptual adaptation, decision-making speed, and shooting confidence under pressure.

The present study contributes to the existing literature by specifically examining hook shot performance, a basketball skill that has received relatively little scientific attention compared with jump shooting and free throws. Previous investigations have primarily focused on the effects of fatigue or defensive pressure on perimeter shooting. By evaluating the combined influence of these two factors on hook-shot execution, the present study provides new evidence regarding post-play performance under realistic match

conditions. This contributes to a more comprehensive understanding of basketball skill performance and offers practical guidance for designing evidence-based training programmes.

Despite these contributions, certain limitations should be acknowledged. The study included only male university-level basketball players, which may limit the generalizability of the findings to female athletes, youth players, or elite professionals. The fatigue protocol represented acute fatigue under controlled laboratory conditions and may not fully replicate the physiological demands experienced during an actual basketball game. Additionally, hook shot performance was evaluated under standardized defensive conditions, whereas defensive behavior during competition is considerably more variable. Future research should investigate different age groups, playing standards, female basketball players, and various defensive strategies while incorporating biomechanical analyses, electromyography, motion capture, and psychological variables such as confidence, anxiety, and attentional focus.

Overall, the findings clearly demonstrate that hook shot performance is significantly influenced by both fatigue and defensive pressure. More importantly, the interaction of these factors produces the greatest deterioration in performance, emphasizing the need for basketball training programmes that replicate the combined physical and tactical demands of competitive match play.

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