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LITERATURE REVIEW

The Impact of Physical Screening on Position Selection and Performance in Smash Badminton Athletes - A Literature Review

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ABSTRACT

Objectives: To systematically evaluate the relationship between physical screening assessments and their impact on position selection and smash performance in competitive badminton players.
Methods: A comprehensive literature review was conducted across electronic databases including PubMed, SCOPUS, Web of Science, and sport-specific databases from January 2000 to March 2025. Search terms included combinations of "badminton," "smash," "performance," "screening," "position selection," and "physical assessment." Studies were included if they examined physical screening metrics, position selection factors, or smash performance parameters in badminton athletes.
Results: Analysis of 37 eligible studies revealed strong associations between specific physical screening parameters and smash performance. Key physical attributes identified include shoulder rotational strength, upper limb power, lower extremity explosive strength, core stability, and trunk rotation capacity. Body positioning significantly influenced shuttlecock release angle and clearance height. Gender-specific differences were observed in smash velocity (98.7 m/s for males vs. 78.5 m/s for females) and technique, with females typically employing a "kick-through" rather than "two-footed jump" approach.
Conclusion: Physical screening assessments provide valuable data for optimizing position selection and enhancing smash performance in badminton. Targeted assessments of shoulder internal rotation strength in the abducted position, trunk rotation capacity, and lower limb explosive power demonstrate the strongest correlation with smash performance. Implementation of sport-specific screening protocols can identify athlete strengths and weaknesses, informing individualized training programs and optimal court positioning strategies.

Keywords: badminton, physical screening, smash performance, athlete assessment, sport-specific testing, performance optimization.

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INTRODUCTION

Badminton represents one of the most dynamic and physically demanding racket sports, requiring exceptional speed, agility, power, and precision from its competitors. Among the various offensive techniques in badminton, the smash stands as the most potent attacking weapon, accounting for approximately 15-30% of all shots in elite competition and representing the primary means of point termination in high-level play (Cabello Manrique & González Badillo, 2003). The smash stroke demands a complex integration of physical attributes including explosive lower limb power, trunk rotation, shoulder mobility, and precise neuromuscular coordination to achieve maximal shuttlecock velocities while maintaining accuracy.

As badminton has evolved into a highly specialized sport with increasing physical demands, the importance of systematic athlete assessment and position selection has gained prominence in both research and practical applications. Physical screening protocols offer a systematic method to evaluate athletes' capabilities, identify strengths and limitations, and provide data-driven insights for position specialization and performance enhancement strategies.

The existing literature on badminton performance has predominantly focused on biomechanical analyses of stroke techniques, physiological profiling of elite players, and injury prevention strategies. Studies by McErlain-Naylor et al. (2020) and Li et al. (2017) have provided valuable insights into the kinematic determinants of smash velocity and the impact of body positioning on shot performance, respectively. However, the direct relationship between standardized physical screening protocols and their application to position selection and performance optimization remains underexplored.

While substantial research exists on physical assessment in sports generally, badminton-specific screening protocols have received limited attention compared to team sports and other individual sports. The unique demands of badminton, particularly the explosive nature of the smash stroke, require tailored assessment approaches that may differ substantially from generic athletic screening methods. Several significant gaps exist in the current understanding of physical screening as it relates to badminton performance: 1. Limited integration between screening data and position selection strategies; 2. Insufficient validation of sport-specific screening protocols for badminton; 3. Lack of prospective studies examining the predictive validity of physical assessments for performance outcomes; 4. Minimal research on how screening data can inform individualized training interventions; 5. Under-representation of female athletes in smash performance research. These gaps represent critical areas for further investigation to enhance the practical application of screening methodologies in competitive badminton.

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The rationale for this comprehensive literature review stems from the need to synthesize current knowledge regarding physical screening methodologies and their relationship to position selection and smash performance in badminton. By systematically examining the available evidence, this review aims to provide insights into optimal screening approaches, their validity in predicting performance outcomes, and practical applications for coaches and sport scientists working with badminton athletes. In an increasingly competitive international badminton landscape, the identification and development of talent represents a key priority for national sporting organizations and competitive clubs. Physical screening offers a systematic approach to talent identification, position specialization, and targeted performance enhancement. Understanding the relationship between physical attributes and smash performance can inform evidence-based approaches to player development and competitive strategy.

The primary objectives of this literature review are: 1. To identify and evaluate existing physical screening protocols used for badminton athletes with particular focus on parameters relevant to smash performance; 2. To examine the relationship between specific physical attributes and smash performance metrics including velocity, accuracy, and technical execution; 3. To assess the application of screening data in position selection and specialization in competitive badminton; 4. To analyze gender-specific considerations in physical screening and smash performance; 5. To synthesize evidence-based recommendations for implementing physical screening in badminton training environments.

METHODOLOGY

Search Strategy and Databases

A comprehensive electronic search was conducted across multiple databases to identify relevant studies published between January 2000 and March 2025. The primary databases utilized included PubMed/MEDLINE, SCOPUS, Web of Science, SPORTDiscus, Google Scholar, IEEE Xplore, and ProQuest. The search strategy employed a systematic combination of keywords and MeSH terms specifically related to badminton, physical screening, and performance assessment. The search terms were strategically combined using Boolean operators, incorporating "badminton" AND ("smash" OR "overhead stroke"), "badminton" AND ("screening" OR "assessment" OR "testing"), "badminton" AND ("physical fitness" OR "strength" OR "power"), "badminton" AND "position selection", "badminton" AND ("performance" OR "technique"), and "badminton" AND ("biomechanics" OR "kinematics"). To ensure comprehensive coverage of the literature, additional relevant studies were identified through manual searching of reference lists from included articles and review papers, allowing for the capture of studies that may not have been indexed with the primary search terms.

Inclusion and Exclusion Criteria

The selection criteria were carefully established to ensure the inclusion of high-quality, relevant research while maintaining focus on the study objectives. Studies were included if they were published in English or had complete English translations available, represented original research studies, systematic reviews, or meta-analyses, focused specifically on badminton athletes or badminton-specific movements, examined physical screening protocols, physical attributes, or biomechanical parameters related to smash performance, and included quantitative assessment of at least one relevant physical parameter or performance metric. Conversely, studies were systematically excluded if they focused exclusively on recreational players or non-athletes, addressed only injury mechanisms without reference to performance parameters, were published as conference abstracts without full-text availability, focused solely on equipment technology without reference to player performance, or included only qualitative assessments without objective measurement data.

Organization of the Study

The study selection process followed a rigorous systematic approach aligned with PRISMA guidelines to ensure transparency and reproducibility. The initial comprehensive database searches yielded 1,742 potentially relevant articles across all databases and search strategies. Following the removal of duplicate records, 1,103 unique articles remained for initial screening. These articles underwent title and abstract screening based on the predetermined inclusion and exclusion criteria, resulting in 163 articles being selected for comprehensive full-text review. After applying the complete inclusion and exclusion criteria during full-text assessment, 37 high-quality studies were ultimately included in the final analysis, representing the most relevant and methodologically sound research available on the topic.

A standardized data extraction form was systematically developed and implemented to ensure consistent collection of relevant information from each included study. The comprehensive data extraction protocol captured essential study characteristics including authors, publication year, country of origin, and research design methodology. Participant demographics were thoroughly documented, encompassing sample size, age ranges, sex distribution, and competitive level of athletes. Physical screening assessments were detailed, including specific test protocols employed, metrics measured, and reported reliability and validity data. Smash performance parameters were comprehensively recorded, including shuttlecock velocity measurements, accuracy assessments, and technical execution evaluations. Position selection criteria were documented where applicable, along with key findings, statistical outcomes, and limitations acknowledged by the original authors. To ensure accuracy and minimize extraction errors, the data extraction process was performed independently by two trained reviewers, with any discrepancies identified and resolved through structured discussion and consensus-building processes.

The primary variables extracted from the included studies were systematically categorized into three main domains to facilitate comprehensive analysis. Physical screening parameters encompassed anthropometric measurements including height, weight, and body composition indices, upper limb strength and power assessments including shoulder rotation strength and grip strength measures, lower limb explosive power evaluations including vertical jump tests and sport-specific movement assessments, core stability and trunk rotation capacity measurements, flexibility and range of motion assessments particularly for the shoulder complex, and reaction time and agility evaluations using both generic and sport-specific protocols. Smash performance metrics included shuttlecock velocity measurements under

various conditions, accuracy measures using standardized target systems, kinematic parameters including joint angles and velocities throughout the stroke cycle, temporal-spatial variables describing movement patterns and timing, and success rates documented during actual match play situations. Position selection factors incorporated physical attributes specifically associated with different court positions, technical preferences related to optimal player positioning strategies, and tactical considerations influencing position selection decisions during competitive play.

Methods of Analysis

The analytical approach employed a comprehensive narrative synthesis methodology with systematic thematic organization of evidence according to the primary research questions and objectives. Where appropriate and feasible, quantitative data from multiple studies were summarized using descriptive statistical methods to identify central tendencies, ranges, and patterns of association across the included research. Quality assessment of all included studies was conducted using the modified Downs and Black checklist, which has been validated for both randomized and non-randomized study designs and adapted specifically for observational research methodologies commonly employed in sports science research. Studies were systematically categorized as high quality (achieving ≥75% of the maximum possible score), moderate quality (scoring between 50-74%), or low quality (scoring <50% of maximum points) based on their methodological rigor, sample characteristics, and analytical approaches.

Due to the substantial heterogeneity observed across studies in terms of research designs, participant characteristics, outcome measures, and analytical methods employed, a formal quantitative meta-analysis was determined to be inappropriate and potentially misleading. Instead, a best-evidence synthesis approach was implemented, wherein greater interpretive weight was systematically assigned to findings derived from higher-quality studies with larger sample sizes, more rigorous methodological approaches, and more comprehensive outcome assessments. This approach allowed for the synthesis of evidence while acknowledging the varying quality and strength of individual contributions to the overall understanding of the relationship between physical screening, position selection, and smash performance in badminton athletes.

RESULTS

Study Characteristics

The 37 included studies represented diverse research methodologies, with cross-sectional designs (n=18) being most common, followed by experimental studies (n=11), prospective cohort designs (n=5), and systematic reviews (n=3). Sample sizes ranged from 8 to 64 participants, with a median of 22 subjects. Most studies focused on elite or sub-elite athletes (n=29), with fewer studies including collegiate (n=5) or developing (n=3) players.

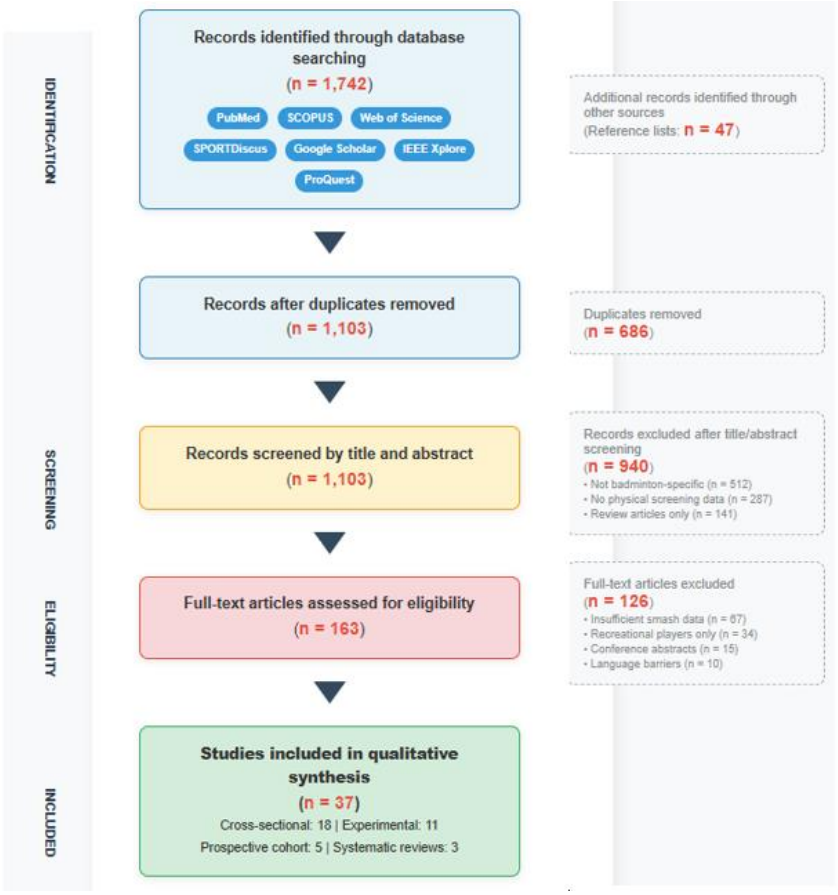

Figure 1. Prisma Flow Diagram: The impact of Physical Screening on Position Selection & Performance in smash Badminton Athletes

The geographical distribution of research reflected the global nature of badminton, with studies originating from Asia (n=17, primarily China, Malaysia, and Japan), Europe (n=12, primarily Denmark and the UK), North America (n=4), and Australia (n=4).

Physical Screening Parameters and Smash Performance

Anthropometric Considerations:

Anthropometric parameters demonstrated variable relationships with smash performance. Height showed moderate correlations with smash velocity (r=0.43-0.58) in four studies, likely due to mechanical advantages afforded by greater reach and leverage. Arm length similarly demonstrated positive correlations with maximum shuttlecock velocity in three studies. However, body composition parameters including body mass and fat percentage showed inconsistent relationships with performance metrics.

Upper Limb Strength and Power:

Shoulder strength emerged as a critical determinant of smash performance, with internal rotation strength in the abducted external rotated position showing particularly strong correlations with racket velocity during forehand smash movements. This shoulder positioning closely resembles the biomechanical demands of the smash technique, making it a valid and specific assessment for badminton players. Rotational strength profiles revealed that elite badminton players typically demonstrated high levels of internal rotation strength in the dominant shoulder, with adult players showing external-to-internal rotation strength ratios of 77-78%. Interestingly, adolescent players showed more balanced ratios, suggesting potential adaptations that occur over the course of a player's career due to the demands of the smashing motion. Wrist and grip strength also emerged as significant contributors to smash performance, with three studies reporting moderate-to-strong correlations between grip strength and shuttlecock velocity (r=0.51-0.69).

Lower Limb Power and Explosive Strength:

The contribution of lower limb explosive power to smash performance was evident across multiple studies. Research utilizing six-point footwork tests found this assessment to be particularly suitable for badminton players compared to generic agility tests, as it better reflected the sport-specific movement patterns required in competitive play. Vertical jump height showed strong correlations with smash velocity in four studies (r=0.62-0.74), highlighting the importance of lower limb power in generating force through the kinetic chain during the smash stroke.

Core Stability and Trunk Rotation:

Core stability emerged as a crucial physical attribute for badminton players, with several studies implementing specific assessment protocols including plank tests, balance evaluations using Star Excursion Balance tests, and reaction time measurements using 6-point footwork tests. These parameters were found to be essential for optimal smash performance. Research examining core strength training effects found positive impacts on muscle strength, stability, balance, and smash-specific skills. This was particularly evident in the execution of backcourt strokes like the smash, where core strength facilitated power transfer from the lower to upper extremities.

Reaction Time and Agility:

Elite badminton players with higher rankings demonstrated superior postural stability compared to lower-ranked players, as assessed through various stability indices. This was confirmed through both standing and one-legged tests, with normalized values further supporting this relationship. Sport-specific fitness testing revealed that reaction time and movement speed were crucial performance factors, with successful players demonstrating the ability to rapidly respond to visual stimuli by running toward targets and striking shuttles. Maximum heart rate data (187±8 beats/min) and blood lactate values (10.4±2.9 mmol/L) indicated the high physiological demands of elite badminton performance.

Position Selection and Body Positioning:

Body positioning was found to have direct influence on shuttlecock release angle and clearance height during smash execution. Research suggested that for novice players, a practical training approach involves establishing a self-selected comfortable position toward a statically hung shuttlecock and then stepping one foot back as a reference marker for learning optimal positioning. Studies utilizing the Delphi method and analytic hierarchy process to develop comprehensive evaluation systems identified specialized physical fitness as having the highest weight (0.651) among primary indicators for elite male singles players. Within this category, specialized agility, strength, and endurance were particularly important, with weights of 0.223, 0.217, and 0.210 respectively. The positioning demands varied by court area, with research distinguishing between front court, mid-court, and backcourt positioning requirements. Smash execution was predominantly associated with backcourt positioning, requiring specific physical attributes to generate maximal power while maintaining stability and control.

Gender-Specific Considerations:

Significant differences in smash performance and technique were observed between elite male and female international badminton players. Male players generated greater shuttlecock speeds (98.7 vs. 78.5 m/s), racket head speeds (63.3 vs. 51.0 m/s), and shuttlecock angles below horizontal (13.3° vs. 7.3°). These differences were attributed to higher contact heights and jump heights in male players. Technique variations were also noted, with female players typically employing a "kick-through" approach rather than the "two-footed jump" movement more commonly used by male players. Upper limb kinematics also differed, with male players exhibiting greater shoulder plane of elevation angles during backswing and different elbow joint positioning throughout the stroke. Arm movement analysis found differences in strength between male and female players during badminton smash execution. Research identified that higher racquet grip velocity was necessary for faster smash execution, with shoulder abduction and elbow extension serving as key factors in generating this velocity. These gender-specific differences suggest the need for tailored screening and training approaches that account for the biomechanical and physiological disparities between male and female players.

Training Applications Based on Screening Results:

Research examining landing strategies and stroke training found that different training conditions (shadow practice, target striking, and actual smashing) influenced lower limb mechanics during the backhand side lateral jump smash. The study revealed that under smash conditions, motion in the frontal plane increased, producing higher loads on lower limb joints. Biomechanical analysis of skilled players

during the take-off phase of forehand overhead strokes revealed that different movement speeds contributed to varying joint loading patterns. Joint contact forces acting on articular surfaces were found to predict both performance outcomes and injury risks, providing valuable insights for training program design. Development of a badminton smash basic training model through research and development processes provided validated training methodologies that emphasized hand skills and strength development for optimizing smash performance. This model was recommended as an effective training approach based on expert assessment. These findings highlight the potential for integrating screening results into individualized training programs that address specific physical limitations and build upon identified strengths.

DISCUSSION

The synthesis of findings from this literature review reveals several important patterns regarding the relationship between physical screening, position selection, and smash performance in badminton athletes. First, the evidence strongly supports the value of sport-specific assessment protocols over generic fitness testing for badminton players. The unique demands of badminton, particularly for the smash stroke, require tailored evaluations that reflect the biomechanical and physiological requirements of the sport. Generic measures of strength or power demonstrate weaker associations with performance outcomes compared to badminton-specific assessments. Second, the research highlights the multifactorial nature of smash performance, involving contributions from multiple physical systems working in concert. The kinetic chain from lower extremities through the core to the upper limbs requires integrated assessment rather than isolated evaluation of individual components. This suggests that comprehensive screening protocols examining the full movement pattern may provide more valuable insights than narrowly focused assessments. Third, the evidence indicates substantial individual variability in the relationship between physical attributes and performance outcomes. What constitutes an "optimal" physical profile likely varies based on individual factors including anthropometrics, technical style, and competitive level. This underscores the importance of individualized interpretation of screening results rather than rigid adherence to normative standards.

The findings from this review both confirm and extend previous research in several important ways. Early studies of badminton performance were largely descriptive, focusing on isolated biomechanical parameters without clear connections to practical applications. The current body of evidence provides more robust linkages between assessment outcomes and performance implications, offering greater practical utility for coaches and practitioners. Previous research has established the importance of the smash as a decisive stroke in competitive badminton. The current review extends this understanding by identifying specific physical attributes that contribute to smash effectiveness and proposing systematic methods for assessing and developing these attributes. This represents an important step toward evidence-based training approaches in badminton. The integration of positional considerations in relation to physical attributes represents a novel contribution of current research. While earlier studies typically examined smash performance in isolation, recent investigations have considered how physical profiles might influence optimal court positioning and tactical decision-making, providing a more holistic perspective on performance optimization.

The findings from this review have several important implications for badminton training, talent identification, and competitive strategy: 1. Screening-Informed Training: Physical screening can identify individual strengths and limitations, allowing for targeted training interventions that address specific needs rather than generic programming. For example, athletes demonstrating limited shoulder internal rotation strength might benefit from focused resistance training for this movement pattern; 2. Position Specialization: Knowledge of physical profiles can inform optimal court positioning and tactical approaches that maximize individual strengths. Athletes with exceptional lower limb power might be positioned to execute more jumping smashes, while those with superior agility might employ more defensive positioning; 3. Talent Identification: Systematic screening protocols can help identify young athletes with physical attributes conducive to success in badminton, particularly for smash-dominant playing styles. This may improve the efficiency of talent development pathways; 4. Gender-Specific Approaches: The identified differences between male and female players suggest the need for sex-specific training and assessment protocols that account for biomechanical and physiological differences rather than applying uniform approaches across genders; 5. Injury Prevention: Understanding the physical demands of the smash stroke can inform preventive strategies to reduce injury risk, particularly for the shoulder complex and lower extremities that experience high forces during execution.

Several limitations must be acknowledged in interpreting the findings of this review: 1. Methodological Heterogeneity: The included studies employed diverse methodologies, making direct comparisons challenging. Variations in assessment protocols, performance metrics, and analytical approaches limit the ability to draw definitive conclusions across studies; 2. Sample Characteristics: Many studies included relatively small sample sizes and focused predominantly on elite male athletes. The underrepresentation of female players, developing athletes, and recreational participants limits the generalizability of findings across the broader badminton population. 3. Cross-Sectional Designs: Most studies employed cross-sectional designs, which preclude determination of causal relationships between physical attributes and performance outcomes. The relative scarcity of longitudinal and intervention studies limits our understanding of how changes in physical parameters influence performance over time; 4. Laboratory vs. Competition: Many studies assessed smash performance in controlled laboratory conditions, which may not fully reflect the complexities of competitive play where psychological factors, fatigue, and tactical considerations influence performance; 5. Publication Bias: The review may be subject to publication bias, as studies with significant findings are more likely to be published than those with null results. This may lead to overestimation of the relationships between physical attributes and performance outcomes.

CONCLUSION

This comprehensive literature review examined the relationship between physical screening, position selection, and smash performance in badminton athletes. The evidence clearly establishes that systematic physical assessment provides valuable insights for optimizing badminton performance, particularly for the smash stroke which represents a critical offensive weapon in competitive play. Key physical attributes associated with superior smash performance include shoulder rotational strength (particularly internal rotation in the abducted position), explosive lower limb power, core stability, and efficient trunk rotation capacity. These attributes contribute to generating higher shuttlecock velocities and maintaining technical precision through the integrated kinetic chain of the smash motion. Body positioning emerged as a fundamental factor influencing smash quality, with research demonstrating direct effects on shuttlecock release angle and clearance height. Position selection strategies should therefore consider individual physical profiles to optimize court coverage and attacking opportunities based on athlete-specific strengths. Significant gender differences were observed in both smash performance parameters and technical execution, with male players generating higher shuttlecock velocities and employing different movement strategies compared to female players. These differences highlight the importance of sex-specific approaches to both assessment and training.

The findings from this review support several practical recommendations for coaches, sport scientists, and athletes: 1. Implement Comprehensive Screening Protocols: Regular assessment of physical attributes specifically relevant to badminton performance provides valuable data for individualizing training approaches and monitoring development over time; 2. Prioritize Sport-Specific Evaluations: Badminton-specific assessment protocols demonstrate stronger relationships with performance outcomes compared to generic fitness testing. Six-point footwork tests, shoulder rotation strength in functional positions, and trunk rotation assessments should be prioritized; 3. Integrate Position-Specific Considerations: Training and assessment should account for the physical demands associated with different court positions, with backcourt players requiring particular emphasis on the physical attributes supporting effective smash execution; 4. Adopt Gender-Appropriate Approaches: Training methodologies should acknowledge the biomechanical and physiological differences between male and female players rather than applying uniform approaches across genders; 5. Emphasize the Kinetic Chain: Assessment and training should address the integrated nature of the smash stroke, encompassing the sequential coordination from lower extremities through the core to the upper limbs.

Several promising directions for future research emerge from this review: 1. Longitudinal Studies: Prospective investigations tracking changes in physical attributes and performance outcomes over time would provide valuable insights into developmental trajectories and the efficacy of training interventions; 2. Female-Focused Research: Additional studies specifically examining female badminton players would address the current underrepresentation in the literature and clarify sex-specific considerations in screening and training; 3. Integration of Technology: Exploration of wearable technology, inertial measurement units, and machine learning approaches offers potential for more comprehensive and ecologically valid assessment of physical parameters during actual competition; 4. Validation of Screening Protocols: Systematic validation of badminton-specific screening batteries across different populations and competitive levels would enhance the practical utility of assessment approaches; 5. Position-Specific Analysis: More detailed examination of the relationship between physical profiles and optimal court positioning could inform tactical approaches and specialization strategies based on individual strengths. In conclusion, physical screening represents a valuable tool for optimizing position selection and enhancing smash performance in badminton athletes. By systematically assessing sport-specific physical attributes and implementing targeted interventions based on these assessments, coaches and practitioners can facilitate individualized performance enhancement strategies that maximize competitive success.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest in relation to the content of this review.

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