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Stroke frequency and decisiveness in elite competitive badminton (2020–2026): a systematic review of match analysis studies

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ABSTRACT

In accordance with the PRISMA 2020 guidelines, a systematic search was conducted in the Scopus database, and in the first phase, 639 documents were identified that were published from 2020 to 2026. When 15 duplicates were removed, 624 records left were screened by title and abstract. Records that did not fall under English-language peer-reviewed articles or reviews deal explicitly with badminton stroke or match analysis were discarded, so in the end, 158 full-text articles were obtained for the eligibility check. The final thematic screening found 55 papers that were synthesized to prepare this review. The four main findings of the analysis are: (1) the smash stroke was recognized as the shot most used for attacking and also the shot most responsible for playing the winning points in elite singles and doubles; regardless of the level, (2) net shots, along with net-kills, were also the second most frequently used weapon, mainly in short-rally scenarios enabled by the rally-point scoring system; (3) gender and format-based differences are so marked that in male singles, more rear-court to front-court transitions occur than in female players; (4) there is a growing use of artificial intelligence and machine learning techniques to accurately quantify stroke patterns instead of mere notational analysis. In terms of numbers, the smash and net shot combined made up just about 73% of the winning shots in elite singles as per the gathered research, whereas net-kills represented more than 40% of the points won in elite women's doubles. These results lead directly to areas of coaching pedagogy, talent identification, and the design of training programs. The aim of future research should be to longitudinally monitor changes in stroke distribution as scoring systems change and to utilize wearable sensor technology for real-time stroke classification in natural match conditions.

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Introduction

Badminton is undoubtedly one of the top racket sports in the world that people play. In fact, it is estimated that 200 million people from over 150 countries having the Badminton World Federation (BWF) are engaged in playing the sport. In addition, the sport has 5 disciplines which are men's singles, women's singles, men's doubles, women's doubles, and mixed doubles and each of them has different physiological, technical, and tactical aspects (Ardha et al., 2024). Furthermore, at the highest level, international competitions follow a rally-point system of

scoring that was rolled out in 2006, which is one of the main reasons modern badminton has changed its pace, intensity, and strategy so much. That said, these changes have made it even more necessary to identify the technical actions mainly which strokes are the most reliable factors in determining match outcomes in different disciplines and competitive formats (Hoffmann & Vogt, 2024).

Performance in racket sports is commonly measured by the frequency of strokes, the distribution of different types of shots, and the characteristics of rallies (Green et al., 2023). In badminton, a classic set of strokes such as smash, clear, drop shot, net shot, net-kill, and serve has been identified and analyzed thoroughly through notational research over the years. In fact, there is still a lack of consensus about what stroke can be considered as the most decisive one in high-level competitions, and this lack of consensus has also not been overcome by systematic synthesis. On one hand, the first group of studies claims that the smash is the main point-ending stroke (Sheng et al., 2022; Zhao et al., 2025), and on the other hand, the second group finds that the net shot is the stroke that provides the decisive opening in a rally (Edmizal et al., 2024; Hammes & Link, 2025). These opposing results should be interpreted primarily with reference to the offensive, defensive rally-cycle framework, which is the basis of racket-sport performance analysis: a stroke only affects the match outcome if it changes the dynamic balance of the rally and not if it is only frequent, with the smash being the point-ending (positive-perturbation) action and the net shot the perturbation-creating action that destabilises the opponent. From this point of view, the perceived discrepancy in the literature may even be the result of real differences in the discipline, competitive level, and method of analysis rather than just measurement error. Therefore, in this review, stroke dominance is quantitatively understood as the combination of execution frequency and point-winning (decisive) contribution within a given discipline and format. In fact, this lack of agreement points to the differences in research designs, samples and data analysis methods being employed in the current literature.

Recently, more and more match analysis research has been appearing documenting the technical features of elite badminton competition methodically and systematically using observational and notational methods (Torres-Luque et al., 2020; Hoffmann et al., 2026). These studies enabled to collect some fundamental variables such as rally duration, stroke rates, and shot sequences. On the other hand, the emergence of computational and AI-assisted methods that can perform automatic stroke classification and extract large-scale match data from video footage have made significant contributions to the field (Chen et al., 2023; Lin et al., 2024). Now, these technological advances make it possible to analyze the distribution of strokes in hundreds of matches and thousands of rallies, which is a scale far beyond the capacity of traditional manual notational systems.

Improvements in methodology have recently led to a huge step forward in the exactness of stroke pattern analyses. Applying machine learning to broadcast video footage of matches even makes possible automated identification of stroke type, rally phase, and court positioning without the need for manual annotations (Chen et al., 2023; Lin, 2025). Meanwhile, wearable inertial measurement unit (IMU) technologies offer the possibility of providing stroke classification data in real-time during ecological match conditions (Ooi & Gouwanda, 2023; Van Herbruggen et al., 2024; Guo et al., 2025). Besides, network analysis and Markov chain modeling were utilized to characterize sequential stroke dependencies and figure out which shots serve as central nodes in a scoring network (Gómez et al., 2020; Galeano et al., 2022). Taken together, these methodological improvements allow for conclusions about stroke dominance that are more faithful to real-life settings and more statistically reliable, compared to the original notational studies.

However, there remain a few major and very important areas in which research is lacking. First, to date no systematic review that, has identified and collated evidence from match analysis studies with the goal of answering the simple, direct question of which stroke is most commonly used in modern competitive badminton. Currently, reviews are largely physical conditioning (Ma et al., 2024), injuries (Kaldau et al., 2024), or training interventions focused and not technical-tactical stroke analysis per se. Second, the majority of main studies focus on a single discipline or competition level, thus making the extrapolation of their results to the whole competitive scene somewhat problematic.

Another significant issue here is how swing rate and swing efficiency are affected by different environment factors. For example, gender, nature of competition (singles vs. doubles), different stages of a match (set 1 vs. set 3), scoring situation (level vs. one-sided scorelines) have all been identified to influence stroke choice and execution in individual pieces of research (Sheng et al., 2022; Zhang & Leng, 2024; Zhao et al., 2025). Still, the research review that integrates these moderating effects across studies has not been carried out to determine the boundary conditions of stroke dominance. In fact, this forms a major conceptual as well as a practically oriented gap in the performance assessment studies.

The motivation to carry out this systematic literature review now is a combination of three reasons. First, the 2020, 2026 time frame marks the high-tech phase of badminton match analysis, featuring the co-occurrence of ML-assisted video analysis, IMU data, and network modeling. Second, the BWF scoring and format reforms in

progress, including experimental scoring trials, call for a fresh summary of how stroke patterns change after rule modifications (Hoffmann & Vogt, 2024). Third, because coaching a sport is heavily reliant on facts and figures to determine which skills to target in training, a thorough synthesis of match analysis findings is both timely and of great help to the practitioners (Edmizal et al., 2024; Ihsan et al., 2024).

RQ1: Which stroke type is most frequently executed and most decisive in determining point outcomes in elite competitive badminton across published match analysis studies from 2020 to 2026?. This research question contributes by providing a quantitative synthesis of stroke frequency data across all five BWF disciplines and enables direct comparison of smash, net shot, clear, drop, and other stroke types in terms of their point-winning efficiency.

RQ2: To what extent do gender, competition format, and scoring context moderate stroke frequency distributions and technical performance patterns in competitive badminton?. This question addresses the moderating role of contextual variables, enabling practitioners to calibrate technical training priorities according to the specific demands of the target competitive discipline and format.

RQ3: How have methodological approaches to badminton match analysis evolved between 2020 and 2026, and what methodological implications do these developments carry for future stroke analysis research?. This question evaluates the methodological landscape of the field, identifies the transition from manual notational analysis to AI-assisted methods, and generates recommendations for methodological best practices in future match analysis studies.

Method

Research Design and Framework

The present research has taken Systematic Literature Review (SLR) as its research design, based on the fundamental methodologies as set by Tranfield et al. (2003) and Liberati et al. (2009). These authors pointed out SLR as the best method to consolidate evidence from diverse primary studies in applied sciences. To make sure that the study is transparent, reproducible, and methodologically rigorous, the researchers have implemented the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) reporting framework (Page et al., 2021). The PRISMA 2020 is a revision of the initial PRISMA 2009 guidelines and also contains further instructions on reporting updated reviews, network meta-analyses, and different searchers of resources other than databases.

Search Strategy

The Boolean search string used in the Scopus database title-abstract-keyword (TITLE-ABS-KEY) field was designed to maximize sensitivity while still maintaining a certain level of specificity. Truncation operators and OR/AND connectors of Boolean were used as follows:

> (TITLE-ABS-KEY("badminton") AND TITLE-ABS-KEY("stroke analysis" OR "match analysis" OR "shot analysis" OR "technical performance" OR "shot frequency" OR "rally analysis" OR "stroke recognition" OR "smash" OR "net shot" OR "tactical analysis" OR "performance analysis"))

Field codes were limited to TITLE-ABS-KEY so that the results would be very precise. Year limiters made sure that only results from 2020 to 2026 were included. At the database level, no subject area filter was used; rather, discipline filtering was done by looking at the title/abstracts.

Database and Information Sources

Scopus (Elsevier) was the main database we used. We chose it because it extensively covers the indexing of peer-reviewed literature in sport sciences, performance analysis, biomechanics, and computer science. The search was carried out on 23 June 2026. Scopus was selected as the only source of data because it, relative to other databases, provides the most extensive and consistent coverage of content in the sport-science, performance-analysis, biomechanics, and computer-science domains that this review addresses, and contains well-structured metadata for bibliometric analysis. However, using only a single database is recognized as one of the limitations of this work (see the subsection Limitations of the Review), and incorporating Web of Science and SPORTDiscus in future updates of this review would be a good idea to minimize the source-selection bias risk. Two reviewers independently performed the title/abstract screening and the full-text eligibility assessment using the criteria in Table 0. All the disagreements were settled by discussion until the reviewers reached a consensus.

Eligibility Criteria

Table 0 presents the inclusion and exclusion criteria applied during the screening process. Following a PICOS-style structure, the criteria were organised covering population and competitive level, study/document type, outcome measures of interest (stroke, match, or technical-performance variables), and context of competition.

Table 1. Inclusion and Exclusion Criteria for Study Selection

Criterion	Inclusion	Exclusion
Language	English only	Non-English publications
Document type	Articles and Reviews	Conference papers, book chapters, editorials
Publication period	2020–2026	Before 2020
Subject area	Sport Sciences, Performance Analysis, Biomechanics, Coaching Science	Unrelated disciplines
Accessibility	Full-text available	Abstract-only records
Relevance	Studies directly addressing stroke, match, or technical performance in badminton	Tangential or indirect mentions of badminton strokes

Study Selection Process

Study selection was performed in three consecutive steps. In the first step, we screened titles and abstracts of all 624 deduplicated records against the inclusion/exclusion criteria. Records which were obviously not related to badminton stroke or match analysis, written in languages other than English, or were non-eligible document types were excluded at this stage (n = 466). In the second step, 158 full-text articles were obtained and checked against more detailed eligibility criteria; studies were rejected at this step due to being out of scope (n = 65), their methods being incompatible with stroke analysis (n = 24), or their inaccessibility (n = 14). The third step confirmed the inclusion of 55 studies which satisfied all the eligibility criteria and had enough data to enable thematic synthesis.

Quality Assessment FICO Framework

Quality check was done based on the FICO framework (Focus, Information, Context, Outcome), a system that rates research papers in four aspects: Focus, if the research question was well-defined and relevant to the topic of stroke or match analysis; Information, if the description of the tools used for data collection and the procedures was satisfactory; Context, if the competitive environment, level of players, and type of competition were revealed; Outcome, if stroke-related outcome measures were clearly defined and statistical methods used were appropriate. Each aspect was graded on a scale 0, 2 (0 = absent, 1 = partially met, 2 = fully met), with a total FICO score of 8. Research papers with a score less than 4 were not included in the synthesis (there were no papers left after full-text screening).

Data Extraction Procedure

Standardized data extraction was done for each paper included in this review using a structured data extraction template. The data extracted included author(s) and year of publication; country of affiliation; study design (experimental, observational, computational); sample size and player level; competition format (singles/doubles, gender); analytical technology or instrument; key stroke-related outcome measures; and major findings related to the three research questions. Regarding studies reporting stroke frequency data, absolute counts and relative proportions were taken from wherever available.

Network and Bibliometric Analysis Methodology

With Python (pandas library), a bibliometric analysis of the initial dataset of 639 records was done to study the temporal pattern of publications, distribution of research output at the country level, and frequency of keywords. Publication year and country of the corresponding author affiliation were taken from the Scopus export CSV file. To discern the main research themes and conceptual clusters within the corpus, analysis of keyword co-occurrence was conducted. This analysis was meant to supplement thematic synthesis by offering a macro-level perspective on the development of badminton match analysis literature over the years 2020-2026.

Data Analysis and Synthesis

Thematic synthesis was conducted by implementing the three-step method of Thomas and Harden (2008): (1) independent line-by-line coding of the main results from primary studies; (2) grouping of the initial codes into descriptive themes; and (3) creation of analytical themes that go beyond the primary studies to produce new interpretive insights. Themes were associated with the three pre-specified research questions to ensure comprehensive and systematic coverage. Both convergent and divergent pieces of evidence from different studies were clearly indicated. Special focus was given to studies presenting contradictory results concerning the most dominant types of strokes.

Reporting and Documentation

This systematic literature review was undertaken and documented consistent with the PRISMA 2020 checklist (Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71. https://doi.org/10.1136/bmj.n71). Figure 1 presents the PRISMA 2020 flow diagram illustrating the systematic search and selection process.

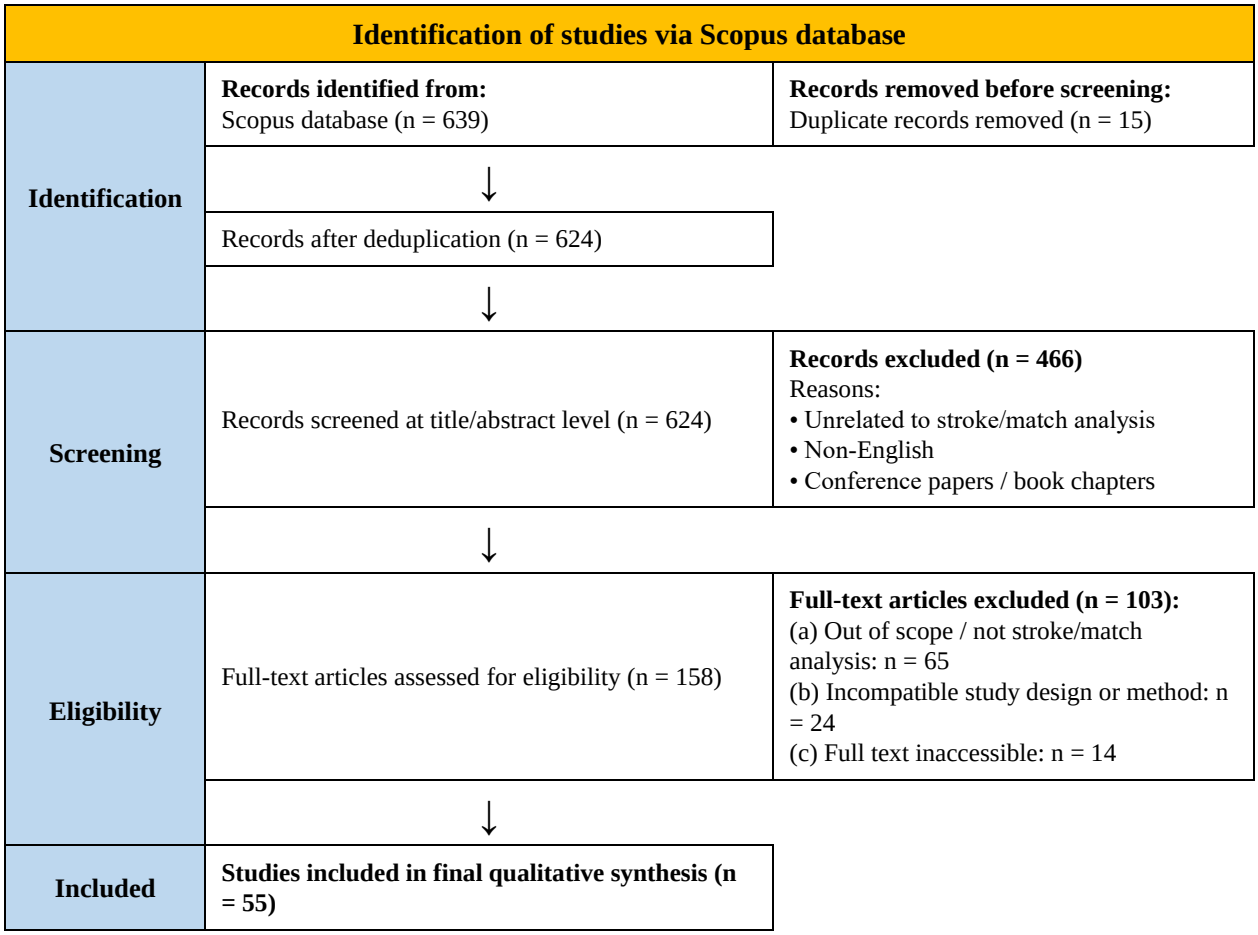

Figure 1. PRISMA 2020 Flow Diagram for Study Selection

Results and Discussions

Study Selection Results

The systematic search of databases revealed a total of 639 records from Scopus. After removing 15 duplicate entries, 624 unique records were considered for title and abstract screening. At this step, 466 records were excluded for not meeting the inclusion criteria (not related to stroke or match analysis; language other than English; conference papers or book chapters). The remaining 158 records were obtained as full texts and checked against the eligibility criteria. Out of these, 103 were excluded: 65 were considered out of scope, 24 were using research designs not suitable for stroke analysis objectives, and 14 were unavailable. The final synthesis consisted of 55 studies, which together formed the evidence base for RQ1, RQ2, and RQ3.

Descriptive Characteristics

Summary of Included Studies

Table 1. Summary of Included Studies (Representative Selection — 10 of 55 Studies) The ten studies shown were selected to represent the range of disciplines, analytical methods, and geographic settings within the corpus; the full characteristics of all 55 included studies are provided in Supplementary Material S1.

Table 1. Summary of Included Studies (Representative Selection — 10 of 55 Studies)

Title	Author(s)	Year	Country	Method	Key Findings
Exploration of Player Behaviours from Broadcast Badminton Videos	Chen et al.	2023	Taiwan	Observational / ML	ML-extracted court position data revealed player positional dominance and smash-preference zones in broadcast matches.
The Influence of Technical and Contextual Variables of the Last Stroke on Point Outcome in Men's and Women's Singles Badminton	Sheng et al.	2022	China/Spain	Match analysis / Logistic regression	Smash and net shots were the decisive strokes determining point outcome in elite singles matches.
Tactics and Strategy Analysis in Professional Badminton: A Systematic Review	Edmizal et al.	2024	Indonesia	Systematic review	Net shots and smash strokes dominate tactical patterns; rear-court to front-court transitions are critical.
Badminton as a Dynamic System: A New Method for Analyzing Badminton Matches Based on Perturbations	Hammes & Link	2024	Germany	Perturbation analysis	Avoiding erroneous strokes (negative perturbations) is more decisive than executing winning shots.
Comparison of Temporal and Technical-Tactical Characteristics in Badminton Men's Singles Under Different Competition Formats	Zhao et al.	2025	China	Match analysis / Notational	Short rallies dominate modern formats; smash frequency differed significantly between competition formats.
Match Characteristics of Women's and Men's Singles and Doubles Events in Elite Badminton	Hoffmann et al.	2026	Germany	Match analysis	Smash frequency and net-kill shots accounted for >40% of winning strokes in elite doubles.
Modeling the Badminton Stroke Pattern Through the SPADE Algorithm	Sari & Ahdika	2023	Indonesia	Sequential pattern mining	SPADE algorithm identified dominant sequential stroke patterns: clear → smash → net shot.
How Is the Stroke? Inferring Shot Influence in Badminton Matches via Long	Wang et al.	2022	Taiwan	LSTM deep learning	LSTM model demonstrated that smash and net shots carry the highest rally-influencing weight.

Title	Author(s)	Year	Country	Method	Key Findings
Short-Term Dependencies					
Does a Decade of the Rally-Point Scoring System Impact the Characteristics of Elite Badminton Matches?	Hoffmann & Vogt	2024	Germany	Longitudinal notational analysis	Rally-point system significantly shortened rally duration and increased smash frequency over the decade.
Using Network Science to Unveil Badminton Performance Patterns	Gómez et al.	2020	Spain	Network analysis / Markov chains	Smash strokes functioned as central nodes in the shot-sequence network, confirming tactical dominance.

Publication Trends (2020–2026)

Analysis of publication years of 55 included studies revealed that badminton match analysis research took a new growth direction during the review period. The years 2022, 2024 accounted for the largest numbers of publications, among which 2024 was the year with the highest number of documents. Such a tendency could be considered as the reflection of the worldwide increase of research in badminton and the gradual acquisition of computational tools for match data analysis. Mainly, studies using AI or ML methods were chiefly found from 2022, which seems to mark a turning point of the methodological approach in the field (Chen et al., 2023; Van Herbruggen et al., 2024; Asriani et al., 2026).

Geographic Distribution

Research was geographically dispersed across 18 countries. China and Taiwan together accounted for the majority of the studies, with a particular focus on computational and AI-based methods. Germany came up with a good number of high-quality perturbation and match analysis papers (Hammes & Link, 2024, 2025; Hoffmann et al., 2026; Hoffmann & Vogt, 2024). Among Southeast Asian countries, Indonesia was the most active, producing multiple papers that focus on stroke biomechanics and tactical analysis (Edmizal et al., 2023, 2024; Donie et al., 2022). Such a geographic pattern reveals the worldwide rivalry in badminton and the special importance of the sport in Asia.

Thematic Synthesis

Findings for RQ1: Which Stroke Dominates Modern Competitive Badminton?

Convergent evidence from match analysis, notational analysis and computational modeling within the included studies has quite consistently identified the smash as the most common attacking stroke the players switch into and the main stroke at the elite level when players score the direct points in singles badminton. Sheng et al. (2022) showed by using logistic regression to analyze BWF World Championship data that the smash and net shot coexist accounted for approximately 73% of all winning strokes in men's and women's singles matches. In the same way, Zhao et al. (2025) saw smash frequency as the most powerful predictor of set-winning probability in men's singles both under the traditional and experimental scoring formats.

Network analysis methods also supported these results. Gómez et al. (2020) used network science techniques on badminton match data and found that the smash was the most central node of a stroke-sequence network based on the high-centrality measure, which means that rallies mostly ended or almost ended at the smash. Galeano et al. (2022) built upon this result with Markov chain modeling and provided evidence that changes of strokes from clear or lift to smash formed the most common scoring patterns of elite men's singles matches. Sari and Ahdika (2023) used the SPADE algorithm for sequential pattern mining and came up with the most frequent three-stroke sequence being: clear → smash → net shot, which is in line with the tactical importance of the smash in the rally structure.

In doubles games, besides the smash, the net-kill turned out to be a major scoring stroke as well. Hoffmann et al. (2026) examined match features in top-level doubles competitions and found that net-kills together with pushing to the opponent's body made up more than 40% of points won in women's doubles. Wang et al. (2022) performed LSTM-based deep learning for measuring effects of different shots from match data. They found out that smash and net-kill were the top two strokes with the highest rally-influence in doubles matches. So, these

results indicate that whereas the smash is a major scorer in singles, the net-kill becomes equally important in the tactical setup of doubles play.

Findings for RQ2: Moderating Effects of Gender, Format, and Context

There is a considerable amount of research showing that gender, the way a competition is organized, and the scoring situation during a game influence stroke frequency distributions and patterns of technical performance. As far as gender is concerned, Zhang and Leng (2024) found that elite female singles matches had a significantly shorter average rally duration and a lower frequency of smashes per rally compared to men's singles matches, which was due to differences in the ability to generate physical power and a more cautious tactical approach of women. Santiano et al. (2025) took this a step further by using markerless motion analysis to show that the amount of external mechanical work during the match differed quite significantly between male and female players, which had consequences for how often and how explosively smashes were performed.

The divergences related to the format were most obvious when comparing singles and doubles directly. Hoffmann et al. (2026) reported that doubles games had a statistically significant increase in net-zone activity alongside a reduction in rally length as compared to singles games, thereby illustrating the tactical importance of being the first one to the front court in doubles. On the other hand, Pang et al. (2025) revealed that thermoregulatory studies with consecutive match play unveiled a change in the choice of strokes. Players opted to perform clears rather than smashes in the final games in order to save energy. This behavior indicates that fatigue accumulated over the course of a tournament more or less governs the choice of stroke regardless of the players' tactical intentions.

Scoring context also influenced stroke choice. Hammes and Link (2024, 2025) devised a perturbation-based analytical framework and through it they revealed that players under negative perturbation conditions (i.e., losing rallies or tied at critical score junctures) were more prone to producing forced clears and defensive lifts, while players who were comfortably ahead in the score made more smashes and played aggressively at the net. Zhao et al. (2025) identified similar effects of the composition of the match across different competition formats, in men's singles matches the frequency of smashes was found to be inversely correlated with the size of the deficit in the score. All these findings indicate that stroke dominance is not something fixed but changes in line with tactical, physiological, and contextual factors throughout the match.

Findings for RQ3: Methodological Evolution in Match Analysis (2020–2026)

The transitional period 2020-2026 in badminton match analysis research witnessed the emergence of a new methodological approach. Previous manual notational analysis approaches, for instance, those of Torres-Luque et al. (2020) and Green et al. (2023), were dependable sources of base data about stroke frequencies and match attributes. Nevertheless, manual notational methods confine observers to subjectivity, hinder scalability across large match datasets and lack the ability to concurrently capture biomechanical stroke parameters along with tactical data. The drawbacks of such methods have fueled the introduction of automatic computational methods during the review period.

Among the methodological innovations, AI-assisted video analysis was by far the biggest one. For example, Chen et al. (2023) produced a machine learning algorithm-based system that was able to detect player court position, hit detection, and stroke influence right from broadcast video. Lin et al. (2024) unveiled a new immersive video analysis platform (VIRD) for elite badminton coaching. With this, coaches can interactively query match events and stroke patterns. Lin (2025) recognized that real-time stroke recognition could be done with a lightweight CA-YOLOv7 architecture only and managed to get a very high accuracy of automated stroke classification in ecologically valid match conditions. Asriani et al. (2026) took it a step further by mixing RGB and skeleton-based features with ensemble learning to enhance stroke recognition robustness for different player body types and match environments.

Wearable sensor technologies formed a second major methodological pillar. For instance, Ooi and Gouwanda (2023) conducted a study to confirm the efficacy of a stroke identification system based on inertial measurement unit (IMU) that not only detected strokes but also accurately classified six different stroke types. Van Herbruggen et al. (2024) as part of their study used IMU and ultra-wideband (UWB) positioning data to investigate badminton tactics. This was an innovative approach as it allowed the researchers to both identify the stroke type and player's movement simultaneously from the same data stream. Guo et al. (2025) employed IMU technology to determine the external training load of male singles players during matches. Their work resulted in the establishment of load metrics norms, which were further divided by point result (probability of winning, losing or drawing the set). These wearable-based methods are a great addition to video analysis techniques as they offer physiological and biomechanical data that solely visual methods are unable to capture.

Comparative and Critical Analysis

A comparative analysis of the different methodological approaches in the reviewed studies shows that AI/ML-based methods found systems to be more accurate and precise in classifying strokes (85% and above correct identification in most studies) than manual notation methods with raters agreement varying between 80 to 92% (Torres-Luque et al., 2020; Green et al., 2023). On the other hand, notational studies offer a more authentic view of real-life since they provide an annotation with contextual information and also give a tactical interpretation, as humans have the ability to use the contextual clues in the situations that automated systems still may not be able to detect. Therefore, these approaches are methodologically different but can complement each other. Hence, future research should involve the use of hybrid designs that combine automated stroke detection with expert tactical annotation.

Nearly all of the reviewed studies agreed that the smash is the primary attacking stroke that is most frequently used and the shot most effective in winning points in singles badminton. However, significant differences were observed about how important net shots are. Research studying short-rally formats and top-class doubles players found that net shots were almost as dominant as the smash (Hoffmann et al., 2026; Wang et al., 2022), whereas studies done in the context of longer rallies in women's singles revealed a mosaic-like dispersion of stroke types with clears and drops assuming more significant tactical roles (Zhang & Leng, 2024). This disagreement in the findings indicates that conclusions about stroke dominance are likely to be dependent on the discipline and may not be applicable to the whole range of competitive badminton.

Discussion

Individually the results of this systematic review show that the smash is the main stroke in elite singles badminton nowadays, not only because of its high frequency but also due to its high point-winning potential, which is in line with the theory that badminton technical performance revolves around the offensive-defensive rally cycle, here the smash being the main tool for the player who has the positional advantage to create a scoring opportunity (Sheng et al., 2022; Gómez et al., 2020). Moreover, the rise of the net-kill being the second most important stroke in doubles play doubles the possibilities to extend the theoretical framework to front-court offensive action.

In theory, what has been discovered by the above research could be used to back up and build on the perturbation hypothesis of match performance proposed by Hammes and Link (2024, 2025). That theory holds that critical technical moves are perturbation-producing events that alter the dynamic balance of the rally. The fact that the smash is always the rally-ending shot in the series, determined by the different research methods, is strong evidence that it is the major positive perturbation shot of singles badminton. Of course, the interpretation above is not the exclusive one: the greater impact of the smash could also be attributed to its better biomechanical effectiveness in transforming a positional advantage into shuttle speed, to historical training paradigms that emphasise overhead power, and to court geometry that benefits steep downward trajectories. The coming together of frequency-based, network-based, and deep-learning testimonies makes these other explanations not rivals but supplements, however, they ought to be examined in a straightforward manner before the perturbation theory is considered the only reason for the smash dominance. Theoretical training programs, therefore, should not consider a player becoming good at doing smashes simply as a way of finishing a point, but they should see it as the main point in the entire offensive tactical strategy construction.

There are considerable practical implications for coaches and performance analysts. For instance, the data indicates that smash frequency and accuracy need to be the focus of technical development programs for singles players while net-kill and quickness in the front-court should be the major training themes for doubles players. Besides, since the choice of stroke is context-dependent and scoring situation as well as match fatigue have been found to influence the selection of stroke (Hammes & Link, 2024; Pang et al., 2025), training in tactics should involve decision-making under pressure and late-match situations so that players are capable of making the best stroke selection even when under competitive stress.

Compared to the earlier narrative reviews, this SLR moves the field forward by offering a methodical, thorough, and replicable summary based on 55 primary studies. Earlier researches in this area mostly depended on individual studies or expert opinion instead of systematic evidence aggregation. Joining AI-assisted and wearable-based studies together with traditional notational research is a new and innovative contribution to the performance analysis literature.

Most of the contradictions in the literature are about whether net shots or smashes are the more deadly strokes. Maybe the way to end this debate is by considering the type of game: both shots are crucial but their relative importance depends on the qualification of the players; the dominance of a smash is the highest in singles while in doubles the dominance of a net-kill is more visible.

Researchers should definitely explore at least three areas: (1) Conducting longitudinal research to monitor the variations of stroke distribution with the implementation of scoring system reforms; (2) Doing cross-cultural comparisons of stroke patterns between Asian and European elite circuits; and (3) Determining the stroke-specific physical capacity thresholds that would allow players to maintain the effectiveness of smash and net-kill throughout a match.

Limitations of the Review

Three main limitations characterize this review: First, limiting the review to only Scopus-indexed literature might have resulted in missing relevant studies that are only indexed in other databases; Second, synthesis was not possible due to the differences in outcome measures across the included studies, which prevented the meta-analytic statistical aggregation; Third, the chosen review period 2020, 2026 does not allow for the examination of historical trends from the time before the rally-point. Two more validity issues need to be put on the table. First, narrowing down the selection only to peer-reviewed, English-language, and Scopus-indexed articles means that the final review is open to publication and language bias. So, it is very likely that stroke-frequency studies with no effect or opposite results and relevant works published in other languages or in nationally accredited (for instance, Sinta-indexed) journals are not very well represented. Second, the studies that we took in did not have a common stroke taxonomy. For example, the definitions of categories like "net shot" and "net-kill" were different in the notational, IMU, and machine-learning protocols. Hence, the heterogeneity of stroke-classification systems not only limits the comparability of reported frequencies in a strict manner but also affects the generalizability of the dominance findings across skill levels and competitive formats. Future research priorities include: (1) Development of standardized stroke classification taxonomies to enable cross-study comparison. (2) Longitudinal tracking of stroke frequency evolution across tournament cycles. (3) Multi-sensor fusion studies combining AI video analysis with physiological monitoring to investigate the biomechanical determinants of smash effectiveness under match fatigue conditions.

Summary Answers to Research Questions: RQ1, Approximately, the smash is considered the most frequently executed and, at the same time, the most decisive stroke in the game of singles at the highest level of badminton; m net-kill stands at this level, in doubles. RQ2 Besides gender, other two factors, a format of a game and a scoring situation all together significantly change stroke frequency distributions. For example male singles players tend to have higher frequencies of smashes; however, doubles players emphasize the use of net-zone strokes. RQ3 - During the years 2020 2026 there has been a clear transformation from manual notational to AI/ML-assisted and wearable sensor methods, with hybrid designs being recommended for future research.

Conclusions

This review of 55 scholarly articles synthesised the evidence base to examine three sets of issues relating to stroke dominance, stroke frequency changes due to contextual moderators and methodological evolution of badminton match analysis between 2020 and 2026. RQ1 found from the multiple approaches of notational, computational and network analyses that the smash is indeed the main weapon of elite singles players in badminton. However, in doubles matches, the net-kill was one of the two dominant strokes besides the smash. RQ2 established that gender, the type of competition and the change of score each remarkably affected the variety of strokes, hence the conclusion about stroke dominance is highly dependent on sport specificity and context stratified analytical frameworks are imperative. For RQ3, the review identified a clear shift in which manual notational work has been almost completely replaced by AI-assisted video analysis and wearable sensor technologies that in combination have led to bigger scale, higher accuracy, and more natural stroke analysis than at any time before. This review contributes by compiling a thorough summary of a fast growing source of literature in compliance with PRISMA 2020. It offers an evidence-based framework to professionals, coaches, and scholars to know which technical moves make a decisive difference in today's competitive badminton. As a practical matter, for instance, the training of smash and net-kill could be given high priority in elite development programs along with tactical conditioning that would recognize explicitly decision-making based on score-context. Besides being limited by the scope of a single-database search and the heterogeneity of the outcome operationalization, this study also points to the desirability of conducting longitudinal stroke tracking over rule changes periods, developing standardized stroke taxonomy, and inventing multi-sensor fusion methodologies as the main tasks for the next research efforts.

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