

Technical and tactical determinants of serve success and rally outcomes in U14 Taiwanese junior tennis players

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Abstract:

Purpose: The aim of this study was to investigate the technical and tactical factors influencing serve performance and rally outcomes among junior tennis players. Specifically, (a) the relationship between serve types and serve-in success rates; (b) the association between serve types and return-shot techniques on the second stroke; and (c) the relationships among serve outcomes, rally shot counts, and techniques used in rally-winning strokes were examined. Performance data were collected from video recordings of singles matches (from the quarterfinals to the finals) during the 2024 YONEX National A-level U14 Junior Tennis Tournament in Taiwan. A total of 102 service games, played by seven male junior players, were analyzed using Simi Scout tagging software. Chi-square tests of independence and descriptive percentage comparisons were conducted to examine the distribution of performance outcome variables. **Results:** (a) Serve-In Performance: A statistically significant association was found between serve type and serve-in outcome, with a higher success rate for second serves (84.4%) than for first serves (69.3%). (b) Second-stroke return technique: The type of serve significantly influenced the return technique used on the second shot. For first serves, returns were distributed as 46.0% forehand and 54.0% backhand; for second serves, returns shifted to 60.1% forehand and 39.9% backhand. (c) Serve-point outcomes and rally analysis: First serves produced a 52.3% point-winning rate, whereas second serves were associated with a 59.7% error rate. The rally shot count was significantly associated with point outcomes, with rallies of 1–4 shots yielding the highest winning percentage (55.4%). Stroke technique was also significantly associated with outcomes, with the forehand volley demonstrating the highest point-winning rate of 63.6%. **Conclusion:** Key determinants of successful service games in U14 junior tennis include a high second-serve success rate, tactical use of backhand returns following first serves, a strong first-serve point-winning percentage, efficiency in short rallies (1–4 shots), and the effectiveness of forehand volleys in winning points. These findings provide valuable insights for optimizing serve strategies and rally planning in youth tennis development.

Key Words: Junior tennis players, service games, tennis big data, technical skills, tactical skills

Introduction

Adolescence is a critical phase in the developmental trajectory of tennis players and exerts a profound influence on their future athletic careers (Filipcic et al., 2021). A notable example is Rafael Nadal, who secured his first ATP victory at the age of 15 and captured his inaugural Grand Slam title at the French Open by the age of 19. Achieving elite-level performance is the ultimate objective of competitive athletes and is shaped by a complex interplay of individual development, environmental factors, and task-related demands, all of which manifest as measurable athletic outcomes (Elferink-Gemser et al., 2007; Deng et al., 2022). During adolescence, technical skills are often still in the process of refinement, whereas physical attributes such as muscular strength, explosive power, and motor coordination are undergoing continuous maturation.

This developmental stage introduces variability in performance consistency and efficiency compared to adult athletes (Deng et al., 2022). Furthermore, adolescent players typically exhibit limitations in decision-making and tactical execution because of their relative inexperience, which constrains their responsiveness to dynamic in-game situations. Nonetheless, these findings highlight adolescents' considerable potential for growth and adaptability. Tennis is a multifaceted sport that integrates physical capacity, psychological attributes, technical proficiency, and tactical intelligence. These components are particularly influential in the developmental pathways of junior athletes (Elferink-Gemser et al., 2004; Kovacs, 2007; Alnedral et al., 2024). As Crespo et al. (2024) observed, players who demonstrate superior shot-making abilities and match strategy execution are more likely to succeed at the competitive level.

The capacity to manage stroke selection, anticipate ball trajectories, and implement effective tactics is essential for gaining competitive advantage. Within the technical domain, skills such as serving, volleying, and baseline rallying are fundamental to success, extending beyond the basic act of shot return (Söğüt, 2017; Kolman et al., 2019). Tactical skills, as defined by Elferink-Gemser et al. (2010), involve adaptive decision-making

processes developed through accumulated match experience and post-performance evaluations. These skills are vital for maintaining composure in high-pressure scenarios and achieving strategic superiority. This study focused on Taiwanese national-level junior tennis players, a cohort selected for their advanced technical foundations and eligibility for international competition. These athletes occupy a pivotal developmental stage between junior and professional play, making them a significant population for performance analysis. The integration of technical and tactical competencies not only differentiates performance levels, but also facilitates the identification of high-potential athletes, ultimately contributing to long-term performance enhancement (Meylan et al., 2010; Smeeton & Huys, 2011).

Given the pivotal role played by technical and tactical performance in the transition from junior- to professional-level tennis, developing a powerful and consistent serve and the ability to win points within a limited number of strokes is essential. These abilities can help mitigate the challenges associated with poor tactical adaptation and technical deficiencies during this transitional stage. Among various assessment tools, match performance analysis is recognized as one of the most direct and efficient methods for evaluating these competencies. It enables a detailed examination of key performance indicators such as serve success rates, point-winning percentages, second-shot selection, rally length, and the effectiveness of return shots, all of which are fundamental to competitive tennis performance (Gillet et al., 2009; Colomar et al., 2022). Physical and technical disparities between junior and adult players may influence the tactical execution efficacy. Therefore, incorporating data-driven feedback to identify performance weaknesses during matches can significantly support the developmental process of junior athletes (Klaus et al., 2017; Bozděch & Zháněl, 2024). Contemporary tennis increasingly emphasizes power-oriented play, in which control over the service game is often synonymous with control over the match (Deng et al., 2024). Consequently, a growing body of literature has focused on the analysis of first and second serves along with return shots, identifying these elements as critical determinants of match outcomes. Serving accuracy, placement, and success rates are frequently highlighted as key components of winning strategies (Reid et al., 2010). Furthermore, Carboch et al. (2019) and Garcia et al. (2021) demonstrated that the effectiveness of the first serve and the stroke following the second serve exert a significant influence on point construction and match dynamics. These actions are closely tied to the players' tactical execution. Notably, in elite-level tennis, over 50% of points are concluded within short rallies lasting fewer than five strokes or eight seconds, underscoring the increasing importance of short-rally tactical proficiency in modern play. Beyond the serve, the capacity to execute point-winning strokes during rallies is another decisive factor in competitive success. Forehand returns are particularly influential. Research indicates that approximately 75% of the points involve either serving or forehand returns, and the forehand side accounts for nearly 65% of court coverage because of its extended reach. These findings highlight the forehand return as one of the two most impactful strokes in tennis performance (Martin-Lorente et al., 2017; Sanchez Mencia et al., 2024).

Post-match data analysis in tennis serves multiple critical functions, including the evaluation of tactical decisions, technical skill assessment, database and model development, and it provides a platform for discussion between coaches and players. These applications underscore the essential role of match analysis in advancing technical and tactical competencies. Increasingly, the integration of data analysis within routine training and competition settings is advocated to enable accurate forecasting of performance targets across various developmental stages (Bozděch et al., 2024). Internationally, post-match data analysis has gained substantial recognition among experts as an effective means of enhancing technical and tactical proficiency. The advantage conferred by a strong serve is now widely regarded as indispensable, necessitating junior players to understand the impact of data analysis on serve performance to remain aligned with global trends and optimize their competitive outcomes. Contemporary match analysis often employs artificial intelligence (AI)-based tracking systems that provide detailed insights into stroke velocity, point-winning rates, and player movement patterns. However, these advanced AI technologies are predominantly used in professional-level tournaments and remain underutilized in junior competitions. This disparity restricts junior athletes' abilities to comprehensively evaluate and refine their tactical and technical strategies (Ganser et al., 2021). In the developmental trajectory of junior tennis players, the execution of technical and tactical skills is widely regarded as the most critical determinant of a successful transition to professional-level competition. Previous research indicates that the high intensity and demands of professional tournament teams necessitate well-developed technical proficiency and tactical acumen. Notably, mastery of the serve and the ability to score efficiently during short rallies have emerged as the defining characteristics of contemporary elite tennis. These competencies must be cultivated during the junior development phase (Bozděch & Zháněl, 2017; Ganser et al., 2021). However, there is a paucity of systematic quantitative analyses focusing on the technical and tactical performance of Taiwanese junior tennis players in authentic matches. To address this gap, the present study aimed to analyze match data from the 2024 YONEX Cup A-Level U14 Boys' Singles Quarterfinals through Finals, with particular emphasis on serve performance and strategic execution within service games by Taiwanese junior athletes. The objective was to elucidate the relationship between technical scoring outcomes and strategic decision-making. Accordingly, three research questions were formulated: 1. What are the patterns and distributions of success and failure in the first and second services among the U14 players at the 2024 YONEX Cup A-Level? 2. How are stroke selections (forehand versus backhand) distributed after the first and second serves? 3. What correlations exist between serve points, rally shot counts, and scoring techniques during rallies that encompass both winning and erroneous

shots? By addressing these questions, this study seeks to provide comprehensive insights into the technical and tactical performances of Taiwanese U14 players during service games, thereby offering data-driven guidance to coaches and athletes to optimize performance.

Material & methods

Research Participants

This study recorded and analyzed the technical and tactical performances of each service game. Data were collected from singles matches of the 2024 YONEX Cup A-Level U14 Junior Tennis Tournament, specifically from the quarterfinals to finals, involving seven junior players. A total of 102 service games (2,269 data entries) were analyzed. Table 1 shows the distribution of the analyzed service games. The primary goal was to collect and analyze technical and tactical data related to service games.

Table 1. Distribution of Service Games Among Junior Tennis Players

Player	1	2	3	4	5	6	7
Number of Games n (%)	19 (18.6)	19 (18.6)	14 (13.7)	30 (29.4)	8 (7.8)	7 (6.9)	5 (4.9)

Note: The seven players are represented by numbers to maintain anonymity.

Research Procedure

The data for this study were obtained from video recordings of matches played during the 2024 YONEX Cup A-Level U14 Junior Tennis Tournament. The matches were recorded by a research team in public venues without disrupting the natural flow of the gameplay. The videos were subsequently analyzed and coded using the Simi Scout performance analysis software. The coding process included: (1) analysis of first and second serve outcomes (successful or unsuccessful), (2) analysis of return shot direction (forehand or backhand) on the second stroke following each serve, (3) classification of point outcomes (winners or errors) for both serve types, (4) evaluation of rally length categories (1–4 shots, 5–8 shots, and over 9 shots) and their associated outcomes, and (5) assessment of stroke types during rallies (forehand return, backhand return, forehand volley, backhand volley) and their effectiveness in point conclusion.

This study used publicly accessible footage from a nationally sanctioned U14 junior tennis event. Data collection was non-intrusive, and no interaction was observed between the researchers and participants. The players' identities were anonymized, and no personally identifiable information or sensitive data were collected at any stage. In accordance with institutional research guidelines, this study qualifies as a low-risk, non-invasive observational investigation and is therefore exempt from formal ethical review. All the procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Table 2. Data Coding Procedure

Category	Type	Serve Outcome	Technical Type of Second Shot After Serve	Serve Point Outcome	Rally Shot Count for Point Outcome	Technical Type of Scoring Shot in Rally
Game Number	Games 1-12	1	2	3	4	5
Serve	First Serve, Second Serve	First Serve	Second Serve	Second Serve	First Serve	First Serve
Serve Outcome	In, Out Winner, Error	In	In	In or Winner	In	In
Return Technique	Forehand, Backhand		Forehand	Backhand	Backhand	Backhand
Rally Shot Count	1-4 Shots, 5-8 Shots, over 9 shots	1	3	5	7	9
Rally Technique	Shot Backhand Groundstroke, Forehand Volley, Backhand Volley			Forehand Groundstroke	Backhand Groundstroke	Forehand Volley
Point Outcome	Winner or Error			Winner	Error	Winner
Data Extraction		First Serve In	Forehand return after a successful second serve	After a successful second serve followed by a backhand return, a forehand groundstroke winner was made on the 5th shot; categorized as a second serve point won.	After a successful first serve followed by a backhand return, a backhand groundstroke error occurred on the 7th shot; categorized as a 7th-shot error.	After a successful first serve followed by a backhand return, a forehand volley winner was made on the 9th shot; categorized as a forehand volley point won.

The technical and tactical performance indicators used in this study were primarily based on theoretical models from Klaassen and Magnus (2001) and Hughes and Bartlett (2002), including service outcome analysis, shot selection-following services, and performance theories related to rally length and technical patterns. These were combined with classification systems commonly used by coaches and players in practical settings.

These theoretical indicators provide an effective means for assessing differences in tactical performance during service games and are applicable to both training and match analyses. However, because Taiwan currently lacks a standardized theoretical framework for evaluating technical and tactical performance at the junior level, this study adapted existing theories to develop a conceptual model tailored to Taiwanese junior players, offering a more constructive and applicable framework for analysis.

Based on an analysis of technical and tactical performance in service games among Taiwanese U14 junior tennis players, this study proposes the following hypotheses: 1. There was a significant relationship between the first- and second-serve outcomes (in vs. out) in the junior players' service games. 2. There was a significant relationship between shot type (forehand or backhand) following first and second serves. 3. There was a significant relationship between the first and second servings and point outcomes (winners or errors). 4. There was a significant relationship between rally length (1–4 shots, 5–8 shots, and over 9 shots) and point outcomes (winners or errors). 5. There was a significant relationship between shot type during rallies (forehand return, backhand return, forehand volley, and backhand volley) and point outcomes (winners or errors).

Inter-Observer and Intra-Observer Reliability

Two observers participated in this study. One holds a Taiwan Level A tennis coaching license and a Ministry of Education certification as a primary school full-time tennis coach, whereas the other is a top-level (Category A) competitive tennis player with experience as a Taiwanese national junior team member. Both observers watched full matches and discussed their performances before cross-checking and verifying their observations. Intra-observer reliability was assessed by having each observer perform a second round of coding one week after the initial session, ensuring consistency between the two trials. A Kappa coefficient above 0.80 was used as the standard for acceptable reliability. For interobserver reliability, 30 service games were randomly selected from the tournament and analyzed by both observers. A Kappa coefficient above 0.80 was also required. If this standard was not met, the observers discussed the discrepancies again, re-coded the data, and repeated the inter-observer reliability test to ensure consistency between the raters (Klaus et al., 2017).

Data Processing

All data were analyzed using SPSS 23.0. To examine the distribution differences among the various categories, chi-square tests of independence and percentage comparisons were conducted to assess variations in technical and tactical performance among players. The analyses included: 1. Serve outcome distribution of first versus second serves and in versus out results. 2. Technical type of second shot after serve, including an analysis of forehand and backhand return choices following the opponent's first or second serve. 3. Serve point outcomes-distribution of winners and errors following the first and second serves. 4. Rally length and Outcome-Distribution of 1–4 shots, 5–8 shots, and over 9 shots in relation to winners and errors. 5. Scoring shot type during rallies-distribution of forehand groundstrokes, backhand groundstrokes (after the ball bounces), forehand volleys (including smashes), and backhand volleys, in relation to winners and errors. All statistical significance levels were set at $p < .05$.

Results

Analysis of Serve Success Results

According to Table 3 on serve success results, the chi-square test of independence shows that with $df = 1$, $\chi^2 = 18.53$, and $p < .05$, there is a significant difference. In terms of successful and unsuccessful serves: For first serves, 476 were successful (69.3%), and 211 were unsuccessful (30.7%). For second serves, 178 were successful (84.4%) and 33 were unsuccessful (15.6%).

Table 3. Serve Success Result Analysis

Serve	In	Out	χ^2	p
First Serve, n (%)	476 (69.3)	211 (30.7)	18.53	.000*
Second Serve, n (%)	178 (84.4)	33 (15.6)		

Note: * $p < .05$

Analysis of Stroke Type from Serve to Second Shot

According to Table 4 on stroke types from serve to second shot, the chi-square test of independence reveals that with $df = 1$, $\chi^2 = 10.35$, and $p < .05$, the result is statistically significant. Regarding forehand and backhand returns: After the first serve, 216 returns were forehand (46.0%) and 254 were backhand (54.0%). After the second serve, 107 returns were forehand (60.1%) and 71 were backhand (39.9%).

Table 4. Analysis Table of Stroke Types from Serve to Second Shot Return

Technical Type of Second Shot After Serve	Forehand	Backhand	χ^2	p
First Serve to Second Shot Return, n (%)	216 (46.0)	254 (54.0)	10.35	.001*
Second Serve to Second Shot Return, n (%)	107 (60.1)	71 (39.9)		

Note: * $p < .05$

Analysis of Serve Point Results, Rally Shot Count, and Rally Technique in Point Outcomes
According to the Serve Point Result Analysis Table (Table 5), the result of the chi-square test of independence with $df = 1$ is $\chi^2 = 8.47$, $p < .05$, indicating a statistically significant difference. Regarding the outcomes of the first and second serves in terms of points won and errors: First serves: 249 points won (52.3%) and 227 errors (47.7%). Second serves: 85 points won (40.3%) and 126 errors (59.7%).

According to the Rally Point Shot Count Analysis Table (Table 5), the chi-square test result with $df = 2$ is $\chi^2 = 12.46$, $p < .05$, showing a significant difference. For point outcomes based on rally length: 1–4 shots: 195 points won (55.4%) and 158 errors (44.6%). 5–8 shots: 91 points won (42.1%) and 125 errors (57.9%). Over 9 shots: 49 points won (41.5%) and 69 errors (58.5%).

According to the Rally Shot Technique Point Outcome Analysis Table (Table 5), the result of the chi-square test of independence with $df = 3$ is $\chi^2 = 9.19$, $p < .05$, indicating a statistically significant difference. In terms of point outcomes and errors across different stroke techniques: Forehand groundstrokes: 123 points won (41.0%) and 177 errors (59.0%). Backhand groundstrokes: 71 points won (40.8%) and 103 errors (59.2%). Forehand volleys: 28 points won (63.6%) and 16 errors (36.4%). Backhand volleys: 9 points won (34.6%) and 17 errors (65.4%).

Table 5. Analysis Table of Serve Point Outcomes, Rally Point Outcomes by Shot Count, and Rally Point Outcomes by Stroke Technique

Hitting technique			Winner	Error	χ^2	p
Serve Outcomes	Point	First Serve, n (%)	249 (52.3)	227 (47.7)	8.47	.005*
		Second Serve, n (%)	85 (40.3)	126 (59.7)		
Rally Outcomes by Shot Count	Point	1-4 shots, n (%)	195 (55.4)	158 (44.6)	12.46	.002*
		5-8 shots, n (%)	91 (42.1)	125 (57.9)		
		over 9 shots, n (%)	49 (41.5)	69 (58.5)		
		Forehand groundstrokes, n (%)	123 (41.0)	177 (59.0)		
Rally Outcomes by Stroke Technique	Point	Backhand groundstrokes, n (%)	71 (40.8)	103 (59.2)	9.19	.027*
		Forehand volleys, n (%)	28 (63.6)	16 (36.4)		
		Backhand volleys, n (%)	9 (34.6)	17 (65.4)		

Note: * $p < .05$

Discussion

Serve Success Result Analysis

Among Taiwanese junior tennis players, the serve success rate has a significant influence on the control of service games. The findings of this study revealed a statistically significant association between first- and second-serve outcomes, suggesting that the success rates for these serve types exhibit distinct trends. Descriptive statistics indicated that the second-serve success rate (84.4%) surpassed that of the first serve (69.3%). A plausible explanation for this discrepancy is the higher velocity of the first serve, which increases the risk of unstable contact and consequently leads to a lower success rate. Conversely, the higher success rate observed for second serves may be attributed to players deliberately reducing serve speed to minimize the likelihood of double faults. Comparable findings were reported by Klaus et al. (2017), who observed that European 14-year-old junior players demonstrated a first-serve success rate of 54.6%, which was notably lower than their second-serve success rate of 82.8%, which is consistent with the present results. It is postulated that due to physical maturation and developmental stage, junior players tend to increase their first-serve velocity to enhance their scoring potential, albeit at the expense of increased error rates.

In both European and Taiwanese contexts, junior players appear to adopt a conservative approach to second serves, prioritizing accuracy over speed to secure a higher success rate and avoid service errors. Chapelle et al. (2023) recommended benchmark thresholds exceeding 60% for first-serve success and 85% for second-serve success among junior players under 14 years of age. While Taiwanese juniors surpass the benchmark for first-serve success rate, their second-serve success falls marginally below the recommended standard. This shortfall may be partially explained by mental pressure exerted by opponents during the second serve, which could negatively affect performance. Furthermore, Landlinger et al. (2012) and Kolman et al. (2021) emphasize

that higher serve velocities constrain opponents' reaction times, thereby increasing opportunities for offensive play. Thus, a robust first-serve success rate facilitates greater control over the match dynamics. The integration of serve speed and accuracy is essential for competitive junior players, and targeted interventions such as core strengthening and plyometric training may enhance serve consistency and velocity, thereby augmenting serving advantages. In summary, although first-serve success rates are generally lower than second-serve success rates, this phenomenon likely reflects a strategic trade-off between velocity and accuracy aimed at applying pressure on opponents. These findings underscore the tactical benefits of an effective first serve and support the adoption of aggressive serving strategies to generate offensive opportunities.

Analysis of Technical Types of Return Shots from Serve to Second Shot

The quality of the opponent's return shot following the serve often has a critical influence on the subsequent third shot and can ultimately affect overall match strategy execution. This poses a considerable challenge for developing junior tennis players, whose technical and tactical skills are still maturing. This study identified a statistically significant association between the type of serve (first or second) and the distribution of return strokes (forehand versus backhand) in the second shot. Specifically, the data suggest differing trends in return shot selection contingent on serve type. Descriptive statistics reveal that following first serves, backhand returns occur more frequently (54.0%) than forehand returns (46.0%). Conversely, after second serves, forehand returns predominate (60.1%) over backhand returns (39.9%). One plausible explanation is that the higher velocity and precision of the first serve constrain the returner's options, often forcing a backhand return (Landlinger et al., 2012). In contrast, the reduced speed of the second serve affords returners greater temporal and positional adjustments, enabling more frequent use of forehand returns, which tend to be more offensive and threatening (Sanchez Mencia et al., 2024).

These findings underscore forehand return as a technically potent and potentially decisive stroke within serve-return dynamics. Consequently, servers must strategically consider and adapt to minimize their opponent's opportunities to execute forehand returns (Martin-Lorente et al., 2017). Given that the speed and accuracy of the first serve frequently compel backhand returns, it remains imperative to investigate methods by which servers can similarly induce backhand returns during second-serve scenarios. This study highlights the importance of serve spin, specifically bounce variation and serve accuracy, as key technical factors. Employing topspin and sidespin serves, although generally associated with reduced serve velocity, can increase the effective contact surface, and when executed with precision, force returners into less favorable backhand returns. This strategic approach neutralizes strong forehand returns during the second serves (Berhimpong et al., 2023; Lambrich & Muehlbauer, 2023; Kumar et al., 2024). The proportional data presented here emphasize the criticality of targeted service placement in effectuating strategic advantages. Backhand returns are typically less effective than forehand returns; thus, consistently directing serves toward the opponent's backhand side enhances the opportunity to seize offensive control. Achieving such tactical precision requires rigorous training aimed at improving serve accuracy, spin generation, and angular variation to optimize ball placement. Collectively, these results provide valuable insights into how mastery of serving technique—including spin and placement—contributes to match control and strategic execution (Lambrich & Muehlbauer, 2023).

Analysis of Serve Point Outcomes, Rally Shot Count Outcomes, and Rally Stroke Technique Outcomes

As the initiating stroke in every service game, the serve plays a critical role in shaping the trajectory and momentum of tennis matches. The present study revealed a statistically significant association between serve type (first vs. second serve) and point outcomes (points won vs. errors) among Taiwanese junior tennis players. This suggests that first and second serves yield distinct performance patterns in terms of scoring efficiency. Descriptive data indicated that the point-winning rate following first serves was 52.3%, which exceeded the corresponding error rate. By contrast, the second serves demonstrated an error rate of 59.7%, which surpassed the point-winning rate. These results suggest that the superior scoring efficiency of the first serve may be attributed to its higher velocity and precision, which likely constrain the returner's ability to respond effectively, thereby affording the server a tactical advantage. This observation aligns with the findings of Mecheri et al. (2016), who reported a first-serve-point winning rate of 69.46% and highlighted the serve's function as a primary offensive weapon in professional tennis. Accordingly, the development of an effective first serve is regarded as a pivotal component of match strategy, particularly for junior athletes seeking to successfully transition into elite-level competitions.

The diminished point-winning rate and elevated error frequency associated with the second serve are commonly observed trends in competitive play. Previous research has identified an inverse relationship between serve speed and success rate, along with a positive correlation between serve speed and point-winning probability (Ulbricht et al., 2016; Martin et al., 2013). Specifically, high-velocity serves have been shown to reduce returners' available reaction time and court positioning flexibility, thereby limiting the quality of returns. In contrast, second serves, which are typically delivered at a reduced pace to ensure consistency, may offer returners greater preparation times and tactical response options. This dynamic places increased pressure on the server, often resulting in less favorable outcomes. The results of this study reinforce the strategic importance of a high first-serve point-winning rate as the cornerstone of match success. The ability to consistently execute fast and accurate first serves not only facilitates more frequent scoring opportunities but also places the server in a proactive position throughout the rally. Tactical training interventions aimed at improving serve accuracy,

optimizing serve placement, and introducing variations in serve speed and spin may enhance overall serving effectiveness (Keller et al., 2021). For junior players, these skillsets are integral to developing a reliable and strategically advantageous serve that can be sustained under match conditions.

In contemporary power-based tennis, players unable to assert technical and tactical dominance during rallies are often at risk of losing points quickly. The present study identified a statistically significant association between rally shot counts (categorized as 1–4 shots, 5–8 shots, and over 9 shots) and point outcomes. Descriptive statistics revealed that rallies consisting of 1–4 shots produced the highest point-winning rate, at 55.4%. In contrast, as rally length increased, point-winning rates showed a declining trend. These findings are consistent with previous research by Kachel et al. (2015) and Filipčič et al. (2021), which similarly reported that shorter rallies (1–4 shots) are associated with higher point success rates compared to extended rallies. This underscores the prevailing tactical trend among junior players to emulate professional standards, namely securing direct points through powerful first serves or applying pressure via the third shot to conclude the rally efficiently. Such strategies demand a high level of technical precision and tactical decision-making and are especially pertinent in service games, where initial control can significantly influence point outcomes. Moreover, the data from this study indicate that rallies consisting of 1–4 shots accounted for the largest proportion of the total points played. This observation is consistent with prior findings from Klaus et al. (2017) and Filipčič et al. (2021), who reported that approximately 49% of points in junior tennis are concluded within four shots. The prevalence of short rallies reflects a broader shift in competitive match dynamics and emphasizes the increasing importance of early-rally dominance. Nevertheless, achieving a consistently high scoring rate within such brief exchanges is a considerable challenge, particularly for junior athletes. Effective execution in short rallies requires the integration of well-developed technical skills with rapid tactical responses, including shot accuracy, pace, and placement. Targeted training that emphasizes these components can enhance players' ability to capitalize on short rally opportunities, thereby optimizing scoring efficiency and competitive performance.

Technical skill remains a foundational element in competitive tennis performance. Beyond serving, groundstrokes and volleys are essential techniques that are frequently employed during rallies. This study identified a statistically significant relationship between stroke type and point outcomes during rally play, indicating that certain stroke techniques were more closely associated with successful point conclusions. Specifically, descriptive statistics revealed that forehand volleys were linked to the highest point-winning rate among all stroke types (63.6 %). This finding suggests that forehand volleys play a critical role in converting offensive opportunities into points. Previous studies have shown that junior players often adopt aggressive playing styles to create more offensive scenarios. However, due to ongoing technical developments and limited tactical experience, these efforts frequently result in increased error rates, particularly during baseline exchanges. Consistent with this, the current study found that both forehand and backhand groundstrokes exhibited higher error rates than point-winning rates. Despite this, players appear to tactically adjust stroke speed, power, and angle to approach the net and position themselves favorably for a more controlled finishing shot. This positioning increases the likelihood of successful forehand volleys, which may explain the superior point-conversion rate. This interpretation aligns with the findings of Pluim et al. (2023) and Torres-Luque et al. (2011), who emphasized the importance of net positioning and tactical foresight in point construction. The study also found that the forehand groundstroke was the most frequently used stroke in rallies.

This corroborates the observations of Chalakov (2020), who identified the forehand groundstroke as a dominant and adaptable component of tactical execution in match play, owing to its variability and offensive potential. The strategic objective of utilizing the forehand is to apply sustained pressure on opponents through aggressive yet controlled shot placement. This study further confirms the forehand groundstroke as the most frequently used technique leading to point outcomes among U14 junior players, a finding that is consistent with those reported by Klaus et al. (2017) and Filipčič et al. (2021). The frequent use of inside-out footwork by junior players to position themselves for forehand shots reflects a deliberate tactical emphasis on controlling play through this stroke. With focused training on shot combinations and imagery-based strategy modules, junior players may further enhance their capacity to capitalize on forehand groundstrokes and volleys as key scoring mechanisms. Moreover, a comparative analysis of Taiwanese U14 junior players and their European counterparts revealed several tactical parallels. In both groups, the second-serve success rate exceeded the first-serve success rate; however, the first serve consistently yielded a higher point-winning rate.

This suggests a common developmental pattern wherein players adopt conservative strategies on second serves while relying on the offensive strength of the first serves to initiate point dominance. Additionally, the proportion of points concluded within 1–3 shots among European players (49%) was similar to the proportion of points resolved within 1–4 shots among Taiwanese players (58%), reinforcing the growing emphasis on short-rally strategies in junior competitions.

The predominance of forehand returns across both populations further reflects a shared tactical orientation, wherein players prioritize shot-making opportunities on their dominant side. These tactical similarities suggest that Taiwanese junior players are closely aligned with the international performance standards. Nonetheless, the degree to which such strategies can be maintained and adapted effectively during the transition to professional competition remains a crucial area for further investigation and development (Klaus et al., 2017).

Conclusions

This study identified several key determinants of success in service games among 14-year-old junior tennis players in Taiwan. Critical performance factors include: (1) second-serve success rate, (2) frequency of backhand returns following the first serve, (3) point-winning rate on first serves, (4) point-winning rate within 1–4 shot rallies, and (5) forehand volley effectiveness. A higher second-serve success rate reduces the incidence of double faults and enhances service reliability. Additionally, the tendency of opponents to return first serves with their backhands provides tactical advantages, enabling the server to control the third shot and increasing the likelihood of winning points on the first serve. Furthermore, the predominance of short rallies (1–4 shots) as the most effective scoring sequence highlights the importance of early point construction. Players who consistently use forehand groundstrokes can create more opportunities to advance toward the net, where forehand volleys exhibit the highest point-winning efficiency.

These findings emphasize the value of systematic strategy implementation that allows junior players to respond adaptively to match dynamics and optimize their performance in service games. Based on these results, we recommend that coaches and players incorporate detailed match tagging and data analysis into their training and post-match evaluations. Targeted analyses, including serve outcome analysis, second-shot return-type analysis, serve point efficiency, rally length distribution, and stroke-type effectiveness, can provide actionable insights into the technical and tactical competencies required for success at the junior level. Such data-driven approaches offer a foundation for improving match preparation, decision-making, and individualized performance feedback. In line with global trends in high-performance tennis, the continued development of technical proficiency remains imperative for junior players. As athletes progress through the developmental stages and encounter increasingly competitive environments, integrating performance analytics into training is essential to align with the demands of professional-level play. The present findings underscore the strategic value of post-match data analysis as both a developmental and a competitive tool that facilitates the transition from junior to elite tennis.

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