UNDERSTANDING THE RELATIONSHIP BETWEEN SELECTED MOTOR ABILITIES AND SMASHING ACCURACY IN RECREATIONAL TABLE TENNIS PLAYERS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Table tennis, also known as ping-pong, is a fast-paced racket sport requiring precise motor abilities. Among these, dynamic balance, eye-hand coordination, agility, and reaction time are considered essential for performance, particularly in executing accurate smashes. However, the extent to which these abilities influence smashing accuracy in recreational players remains unclear. ***Objective:*** This study aimed to examine the relationship between dynamic balance, eye-hand coordination, agility, and reaction time with smashing accuracy among recreational table tennis players. ***Methods:*** A cross-sectional correlational study was conducted with 50 recreational table tennis players aged 16 to 25 years. Smashing accuracy was assessed based on five consecutive smashes on a pre-marked target area of the table. Dynamic balance was evaluated using the Y Balance Test, eye-hand coordination via the Plate Tapping Test, agility through the Table Tennis Agility Test, and reaction time using the Ruler Drop Test. ***Results:*** Pearson correlation analysis revealed negligible or no significant relationships between the measured variables—dynamic balance, eye-hand coordination, agility, and reaction time—and smashing accuracy ($p > 0.05$). ***Conclusion:*** The findings suggest that smashing accuracy in recreational table tennis players may not be significantly influenced by the selected motor abilities. Other factors such as technique, experience, or cognitive strategies may play a more critical role and warrant further investigation.

INTRODUCTION

Table tennis, recognized as one of the fastest racket sports globally, demands a unique blend of speed, precision, and advanced coordination [1]. Performance in this sport is multifactorial, relying on an interplay of sensory and motor skills, technical proficiency, and cognitive agility. During matches, players must constantly adjust their positioning using varied footwork techniques—such as forward, backward, lateral, and crossover steps—depending on the opponent's shot selection [2]. The confined playing area and high ball speed intensify these physical demands, requiring players to rapidly process visual information and execute precise motor responses [3]. Beyond physical attributes, table tennis also challenges cognitive and psychological resilience. The sport involves continuous one-on-one competition, requiring quick decision-making, focus, and strategic adaptation under pressure [4]. Reactive agility becomes particularly important, especially among older adults, where regular participation in table tennis has shown benefits in maintaining neuromotor function and slowing age-related decline. Moreover, consistent practice in table tennis can enhance eye-hand reaction time, concentration, and alertness [5].

Through repeated gameplay scenarios, players learn to recognize crucial game cues, anticipate opponents' moves, and respond swiftly with appropriate stroke choices [6]. Technically, table tennis strokes are broadly categorized into offensive and defensive types. Offensive strokes aim to assert pressure and create point-scoring opportunities, utilizing speed and spin to disrupt the opponent's timing. Key offensive techniques include the speed drive, loop, counter drive, flick, and smash. Defensive strokes, on the other hand, such as the push, chop, block, and lob, focus on neutralizing the opponent's attack and controlling the rhythm of the rally. Proficiency in both categories ensures greater adaptability and strategic depth in competitive play. Among these techniques, the forehand stroke—particularly the forehand smash—is a cornerstone of offensive play. It relies on effective weight transfer, trunk rotation, and a sharp wrist snap to generate speed and power. Executing this shot with accuracy and consistency requires the seamless integration of balance, agility, coordination, and reaction time. Mastery of the forehand smash not only reflects technical skill but also the underlying physical and perceptual abilities that influence high-level table tennis performance. This study aims to examine the relationship between selected motor abilities and smashing accuracy in recreational table tennis players. The objectives are to assess dynamic balance, eye-hand coordination,

agility, and reaction time, and to determine their correlation with smash accuracy.It further seeks to identify which of these abilities most significantly influence offensive performance in recreational-level players.

METHODS

Study Design: This research employed a cross-sectional design to assess the relationship between selected motor abilities and smashing accuracy among recreational table tennis players. Data collection was carried out at a single time point to explore associations without manipulating variables or applying interventions**.**

Study Population and Duration: The target population included recreational table tennis players aged between 16 and 25 years who engaged in the sport for at least four hours per week. Participants included in the study were recreational table tennis players who were actively engaged in the sport, regardless of gender, and within the age range of 16 to 25 years. Individuals were excluded if they had a history of shoulder dislocations or recurrent injuries to the elbow, wrist, knee, or ankle. These criteria were established to ensure participant safety during testing and to maintain consistency in baseline physical ability across the study sample. The study was conducted over a six-month period, allowing sufficient time for recruitment, testing, and data analysis.

Sampling Technique and Sample Size: Participants were selected through convenience sampling, based on their availability and willingness to participate. The sample size was calculated using G*Power 3.1.9.7 software, ensuring adequate statistical power for correlation analysis.

Functional Fitness Assessments

Y Balance Test: This test was used to measure dynamic balance, requiring participants to reach in six directions while maintaining single-leg stance. Each reach was measured three times, and results were normalized to leg length. A composite reach score (%) was calculated. This test demonstrates strong interrater and intrarater reliability (ICC = 0.80–0.93) [7].

Table Tennis Agility Test: Designed to assess movement agility around the table, this test involved an 18-second performance trial executed three times. The participant performed a coordinated sequence of lateral, forward, and rotational movements while striking target balls. The test correlates strongly with spider drill performance and has moderate reliability (ICC = 0.74) [8].

Plate Tapping Test: Used to evaluate upper limb coordination and reaction speed, this test involved tapping two discs 60 cm apart using the dominant hand while keeping the non-dominant hand on a central rectangle. Participants completed 25 cycles (50 taps), and time was recorded. It is a validated part of the Eurofit Test Battery [9].

Smash Accuracy Test: To assess smashing accuracy, participants performed eight smashes (three diagonal, three straight, two optional) toward marked zones on a standard table. A cone was placed at the target zone, and one point was awarded per successful direct hit. Higher scores indicated greater accuracy and control.[10]

Testing Environment, Tools, and Procedure: All assessments were conducted in a designated testing area with a minimum space of 2m × 2m, under the supervision of trained personnel to ensure safety and standardization. The equipment used included a Y-Balance Test Kit or sticky tape, measuring tape, meter ruler, stopwatch, an adjustable-height table to accommodate individual needs, yellow discs (20 cm diameter), rectangular markers (30 × 20 cm), and performance recording sheets for systematic data entry. Coordination with coaches and table tennis clubs was established in advance to support participant recruitment and orientation. A standardized briefing was provided to each participant to explain the purpose and protocol of the study. To reduce fatigue and ensure uniformity, all participants followed the same sequence of tests: Y Balance Test, Table Tennis Agility Test, Ruler Drop Test, Plate Tapping Test, and finally, the Smash Accuracy Test.

Statistical Analysis

Data were analysed using Spearman's rank correlation coefficient (ρ) to examine the relationship between smashing accuracy and the primary variables (dynamic balance and eye-hand coordination), as well as the secondary variables (agility and reaction time). A p-value of less than 0.05 was considered statistically significant. All analyses were conducted using SPSS version 20, USA, New York statistical software.

RESULTS

The analysis revealed that none of the primary motor variables—including dynamic balance and eye-hand coordination—showed a statistically significant correlation with smashing accuracy among recreational table tennis players. Spearman's correlation coefficients (ρ) for the Y Balance Test reach directions ranged from –0.192 to 0.093, with all p-values exceeding 0.05. Specifically, right and left anterior reach scores (ρ = 0.093 and 0.067, respectively), posteromedial reach (ρ = –0.021 and –0.069), and posterolateral reach (ρ = –0.192 and 0.075) demonstrated negligible relationships with smash performance. Eye-hand coordination, as measured by the Plate Tapping Test, also showed a very weak and non-significant correlation with smashing accuracy (ρ = 0.081, p = 0.576). These findings suggest that neither dynamic balance nor eye-hand coordination are strong predictors of smash accuracy in this population. Similarly, the analysis of secondary variables—agility and reaction time—showed no significant association with smashing performance. Agility demonstrated a weak negative correlation (ρ = –0.121, p = 0.401), indicating a non-significant trend where increased agility did not correspond to improved smash accuracy. Reaction time, measured via the Ruler Drop Test, had an even weaker negative correlation with smashing accuracy (ρ = –0.050, p = 0.730), further suggesting minimal influence. Overall, these results indicate that agility and reaction time also do not have a meaningful impact on smashing accuracy among the sampled recreational table tennis players.

Table 1. Spearman's Correlation Coefficient (ρ) Between Smashing Accuracy and Primary Variables (N = 50)

Primary Variable	Spearman's ρ	p-value (2-tailed)
RT-Anterior Reach (ANT)	0.093	0.520
LT-Anterior Reach (ANT)	0.067	0.646
RT-Posteromedial Reach (PM)	–0.021	0.883
LT-Posteromedial Reach (PM)	–0.069	0.633
RT-Posterolateral Reach (PL)	–0.192	0.181
LT-Posterolateral Reach (PL)	0.075	0.604
Eye-Hand Coordination	0.081	0.576

Note: RT = Right Limb, LT = Left Limb

Table 2. Spearman's Correlation Coefficient (ρ) Between Smashing Accuracy and Secondary Variables

Secondary Variable	Spearman's ρ	p-value (2-tailed)
Agility	–0.121	0.401
Reaction Time	–0.050	0.730

DISCUSSION

This study explored the correlation between selected motor abilities—dynamic balance, eye-hand coordination, agility, and reaction time—and the smashing accuracy of recreational table tennis players. The findings revealed no statistically significant relationship between these variables and smash performance, suggesting that smashing accuracy may be influenced by factors other than the tested motor components.

Dynamic Balance and Smashing Accuracy: The results indicated no or negligible correlation between dynamic balance and smashing accuracy. These findings are consistent with earlier research. For example, Chow and Lee reported that foot positioning and movement patterns significantly affect balance and stroke precision in professional table tennis players. They found that professionals demonstrate greater control over their centre of gravity and better technical stability than beginners, leading to improved performance during chasse and swing phases [11]. However, our sample comprised recreational players, likely with lower postural control and footwork coordination, which may account for the lack of association. Similarly, Hrysomallis et al. found that while balance skill did not correlate with certain sports such as snowboarding or baseball pitching accuracy, it was significantly related to performance in sports requiring fine motor control like archery and luge [12].

Eye-Hand Coordination and Smashing Accuracy: Our analysis also showed no significant correlation between eye-hand coordination and smash accuracy. Although previous studies, such as those by Faber and Pion, have emphasized the role of hand-eye coordination in predicting table tennis performance [13], this may not extend to recreational players. In our study, eye-hand coordination was measured by the time taken to complete the Plate Tapping Test. While faster completion implies better coordination, this did not translate into better smashing accuracy. This could be due to the complex nature of the smash, which also involves timing, spatial orientation, and technical execution. In contrast, a study on Pariaman tennis athletes found that eye-hand coordination alone accounted for 25.3% of service accuracy, increasing to 33.1% when combined with grip strength [14]. These disparities highlight that skill level, stroke type, and measurement method influence the relevance of motor components.

Agility and Smashing Accuracy: Agility, as measured by the Table Tennis Agility Test, also did not show a meaningful correlation with smash accuracy. The agility test used was based on validated protocols designed for elite international players and has shown good reliability and validity in that population [8,15]. However, agility may play a more prominent role in defensive movements or rally exchanges rather than in executing smashes, which are often pre-planned and involve fewer rapid direction changes. Furthermore, recreational players may lack the refined movement strategies necessary to convert agility into precise stroke execution.

Reaction Time and Smashing Accuracy: Reaction time showed a very weak negative correlation with smash accuracy, indicating that faster reaction times did not lead to better smash performance in this group. Although several studies support the idea that athletes, including table tennis players, have faster reaction times compared to non-athletes [5], this does not automatically translate into improved technical skill. For instance, research on elite Chinese table tennis players showed that proprioceptive function in the racket-holding shoulder was not related to muscular strength or smash performance, suggesting that isolated physical traits may not predict complex stroke outcomes [16]. Similarly, Bhabhor et al. concluded that while table tennis improves cognitive processing and alertness, reaction time alone is insufficient to determine skilful execution of specific strokes [5]. This study was limited by its small sample size and the use of convenience sampling, which may reduce generalizability. The use of recreational players means the findings cannot be extended to elite or professional athletes. Additionally, only select motor components were analyzed; other factors such as technical proficiency, visual tracking accuracy, and stroke biomechanics were not included. A key strength of this study is its use of validated and sport-specific testing protocols to assess each motor component. The standardized testing sequence minimized fatigue-related variability. Moreover, the study focused on recreational players, a group often overlooked in performance research. Future studies should consider including a larger and more diverse sample, incorporating elite athletes for comparison. Additional variables, such as stroke biomechanics, tactical decision-making, and visual tracking speed, should be investigated. Longitudinal or training-based studies may also help determine causal relationships between motor skill development and smash accuracy.

CONCLUSION

The results of this study indicate that smashing accuracy is not significantly correlated with dynamic balance, eye-hand coordination, agility, or reaction time in recreational table tennis players. This suggests that smashing accuracy functions as an independent skill, possibly influenced more by technical and tactical aspects than by isolated physical attributes. Future research should aim to explore these additional contributing factors to better understand what drives offensive stroke success in table tennis.

Declaration by Authors

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