

Reaction Time Effect: For Foot Agility in Takraw Athletes

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ABSTRACT

Objectives: Sepak takraw is a traditional Southeast Asian sport requiring exceptional foot agility, rapid decision-making, and precise motor control. Reaction time plays a crucial role in athletic performance, particularly in sports demanding quick foot movements and ball control. However, limited research has examined the specific relationship between reaction time and foot agility performance in takraw athletes. This study aimed to investigate the correlation between reaction time and foot agility performance in sepak takraw athletes, and to determine whether reaction time training could enhance foot agility skills in this population.

Methods: Twenty-eight male sepak takraw athletes (age: 22.4 ± 3.2 years) from a takraw club in Deli Serdang, North Sumatra, participated in this cross-sectional study. Participants underwent reaction time assessment using computerized testing and foot agility evaluation through standardized takraw-specific agility tests. Pearson correlation analysis and multiple regression were performed using SPSS v27.

Results: Significant negative correlations were found between reaction time and foot agility performance ($r = -0.742$, $p < 0.001$). Athletes with faster reaction times (≤ 250 ms) demonstrated superior foot agility scores (18.4 ± 2.1) compared to those with slower reaction times (> 300 ms) (14.2 ± 2.8 , $p < 0.001$). Reaction time explained 55.1% of the variance in foot agility performance.

Conclusion: Reaction time significantly influences foot agility performance in sepak takraw athletes. These findings suggest that incorporating reaction time training into sepak takraw training programs may enhance athletic performance and foot agility skills.

Key Words: sepak takraw, reaction time, foot agility, athletic performance, motor control, sports training

INTRODUCTION

Contextual Framework of the Research

Sepak takraw, also known as kick volleyball, is a traditional Southeast Asian sport that combines elements of volleyball, soccer, and gymnastics. The sport requires players to manipulate a rattan ball using only their feet, knees, chest, and head, with exceptional emphasis on foot agility and precision. The dynamic nature of sepak takraw demands rapid motor responses, quick decision-making, and precise execution of complex foot movements within milliseconds (Aziz et al., 2020).

Reaction time, defined as the interval between stimulus presentation and the initiation of a voluntary response, is a fundamental component of athletic performance across various sports disciplines. In takraw, players must respond rapidly to ball trajectories, opponent movements, and game situations while executing precise foot techniques. The relationship between cognitive processing speed and motor execution becomes particularly critical in sports requiring fine motor control and rapid decision-making (Thompson & Martinez, 2019).

The biomechanical demands of sepak takraw involve complex coordination patterns, with the feet serving as the primary tools for ball manipulation. Unlike conventional sports where hand-eye coordination predominates, takraw athletes must develop exceptional foot-eye coordination and spatial awareness. This unique requirement makes the study of reaction time and its relationship to foot agility particularly relevant for understanding performance optimization in this sport (Lim et al., 2021).

Critical Examination of Existing Literature

Previous research has established the importance of reaction time in various sports contexts. Schmidt and Lee (2019) demonstrated that athletes with superior reaction times consistently outperformed their peers in sports requiring rapid responses. However, most studies have focused on traditional Western sports, with limited attention to Southeast Asian traditional sports like sepak takraw. Studies examining reaction time in racquet sports have shown correlations between faster reaction times and improved performance outcomes (Chen et al., 2018). Similarly, research in soccer has indicated that reaction time training can enhance foot agility and ball control skills (Rodriguez & Kumar, 2020). These findings suggest potential transferability to sepak takraw, given the sport's emphasis on foot-based techniques.

Neuromuscular research has indicated that reaction time involves complex interactions between sensory input processing, decision-making, and motor output execution. The speed of these processes can be influenced by training, experience, and individual

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physiological factors (Williams & Hodges, 2020). However, the specific neural pathways involved in foot-based reactions, as required in sepak takraw, remain understudied.

Recent advances in sports science have highlighted the role of sport-specific training in optimizing reaction time performance. Traditional reaction time training methods may not directly transfer to sport-specific contexts, emphasizing the need for targeted research in individual sports disciplines (Johnson et al., 2021).

Identification of Research Gaps

Despite the growing interest in sepak takraw as a competitive sport, there remains a significant gap in scientific literature addressing the physiological and performance aspects of the sport. Specifically, no previous studies have systematically examined the relationship between reaction time and foot agility performance in takraw athletes.

Existing reaction time research has predominantly focused on hand-based responses or gross motor movements, with limited attention to the fine motor control required for foot-based techniques. The unique demands of sepak takraw, where feet serve as the primary manipulative tools, require specialized investigation to understand the specific reaction time-agility relationships in this context.

Furthermore, the lack of standardized assessment tools for measuring foot agility in takraw athletes represents a significant methodological gap. Most agility assessments are designed for sports involving running and direction changes, rather than the stationary foot manipulation skills crucial in sepak takraw.

Rationale for the Research

Understanding the relationship between reaction time and foot agility in sepak takraw athletes has significant implications for training optimization and performance enhancement. If reaction time proves to be a key determinant of foot agility performance, targeted training interventions could be developed to improve athlete capabilities.

The findings from this research could contribute to the development of sport-specific training protocols, talent identification programs, and performance assessment tools. Additionally, the results may provide insights applicable to other sports requiring fine motor control and rapid decision-making.

Given the increasing international recognition of sepak takraw and its inclusion in major sporting events, scientific research supporting evidence-based training methods becomes crucial for advancing the sport's competitive standards and athlete development programs.

Objectives

The primary objectives of this study were to:

1. Examine the correlation between reaction time and foot agility performance in sepak takraw athletes
2. Determine the extent to which reaction time explains variance in foot agility performance
3. Compare foot agility performance between athletes with different reaction time capabilities
4. Provide evidence-based recommendations for training program development in sepak takraw.

MATERIALS AND METHODS

Participants

Twenty-eight male sepak takraw athletes (age: 22.4 ± 3.2 years; height: 168.5 ± 6.8 cm; weight: 62.3 ± 7.5 kg; training experience: 4.7 ± 2.1 years) from a registered sepak takraw club in Deli Serdang, North Sumatra, Indonesia, voluntarily participated in this study. All participants were active competitive players with minimum two years of organized training experience and regular participation in regional competitions.

Inclusion criteria comprised: (1) male gender, (2) age between 18-30 years, (3) minimum two years of competitive sepak takraw experience, (4) current active training status with minimum three sessions per week, (5) absence of lower limb injuries in the preceding six months, and (6) signed informed consent. Exclusion criteria included: (1) history of neurological disorders affecting reaction time, (2) current medication affecting cognitive function, (3) recent lower limb injury or surgery, and (4) incomplete testing protocols.

Ethical approval was obtained from the Institutional Review Board of the Universitas Sumatera Utara (Approval No: 245/KEP/USU/2024). All participants provided written informed consent after receiving detailed explanation of the study procedures, risks, and benefits.

Study Organization

This cross-sectional observational study was conducted over a four-week period during the competitive season. Testing sessions were scheduled during regular training times to minimize disruption to athletes' routines. All assessments were performed in the club's standard training facility under consistent environmental conditions (temperature: 28-30°C, humidity: 65-70%).

The study protocol consisted of two main assessment sessions separated by 48-72 hours to ensure adequate recovery. Session one included anthropometric measurements, medical screening, and reaction time assessment. Session two involved foot agility testing using sport-specific protocols. This separation prevented fatigue effects from influencing either assessment.

Test and Measurement Procedures

Anthropometric Measurements Standard anthropometric measurements were collected following International Society for the Advancement of Kinanthropometry (ISAK) protocols. Height was measured using a stadiometer (Seca 213, Hamburg, Germany) to the

nearest 0.1 cm. Body weight was recorded using calibrated digital scales (Tanita BC-545N, Tokyo, Japan) to the nearest 0.1 kg. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m²).

Reaction Time Assessment Reaction time was measured using a computerized testing system (Reaction Timer Pro, Sports Science Instruments, USA). The assessment protocol included:

1. Simple Reaction Time (SRT): Participants responded to a visual stimulus (white circle appearing on black screen) by pressing a foot pedal as quickly as possible. Twenty trials were conducted with random intervals (2-5 seconds) between stimuli.
2. Choice Reaction Time (CRT): Participants responded to different colored stimuli (red, blue, green) using corresponding foot pedals. Thirty trials were administered with equal representation of each color.
3. Foot-Specific Reaction Time: A novel protocol was developed where participants responded to visual cues by performing specific foot movements (toe touch, heel lift, lateral movement) on pressure-sensitive platforms. This test aimed to simulate sport-specific response requirements.

All reaction time assessments were preceded by standardized warm-up procedures including light jogging (5 minutes) and dynamic stretching (5 minutes), followed by practice trials to ensure familiarity with equipment and procedures.

Foot Agility Assessment A comprehensive foot agility test battery was developed specifically for sepak takraw athletes, incorporating sport-specific movement patterns:

1. Takraw Ball Control Test: Participants maintained control of a regulation takraw ball using only feet for maximum duration. Three trials were conducted with the best score recorded.
2. Foot Coordination Ladder Test: A specialized ladder sequence requiring precise foot placement patterns mimicking takraw techniques. Time to completion and accuracy scores were recorded.
3. Multi-directional Foot Agility Test: Participants navigated through a course requiring rapid foot direction changes while maintaining ball control. Total time and technical execution scores were assessed.
4. Sport-Specific Technique Assessment: Standardized evaluation of fundamental takraw techniques (sepak sila, sepak kuda, sepak badek) for speed and accuracy.

All agility tests were video-recorded for subsequent analysis by certified takraw coaches using standardized scoring criteria. Inter-rater reliability was established prior to data collection (ICC = 0.92-0.96).

Statistical Analysis

Quantitative analyses were conducted using SPSS version 27.0 (IBM Corporation, Armonk, NY, USA). Descriptive statistics including means, standard deviations, and ranges were calculated for all variables. Data normality was assessed using the Shapiro-Wilk test and visual inspection of histograms and Q-Q plots.

Pearson product-moment correlation analysis was performed to examine relationships between reaction time measures and foot agility performance scores. Multiple regression analysis was conducted to determine the predictive value of reaction time variables on foot agility outcomes.

Independent samples t-tests were used to compare foot agility performance between participants grouped by reaction time capabilities (fast vs. slow reaction time groups based on median split). Effect sizes were calculated using Cohen's d to determine practical significance.

Statistical significance was set at $\alpha = 0.05$ for all analyses. Post-hoc power analysis confirmed adequate statistical power ($\beta > 0.80$) for detecting medium to large effect sizes given the sample size.

RESULTS

Descriptive Statistics

Table 1 presents the descriptive statistics for all measured variables. Participants demonstrated normal distributions for anthropometric measures and moderate variability in performance variables, indicating a heterogeneous sample representative of club-level takraw athletes.

Table 1. Descriptive Statistics of Participant Characteristics and Performance Variables

<i>Variable</i>	<i>Mean ± SD</i>	<i>Range</i>	<i>95% CI</i>
Age (years)	22.4 ± 3.2	18.2-29.8	21.2-23.6
Height (cm)	168.5 ± 6.8	156.3-182.1	166.0-171.0
Weight (kg)	62.3 ± 7.5	48.5-78.2	59.4-65.2
Training Experience (years)	4.7 ± 2.1	2.0-9.5	3.9-5.5
Simple Reaction Time (ms)	267.4 ± 28.3	218.5-325.2	256.5-278.3
Choice Reaction Time (ms)	298.7 ± 35.6	242.1-385.4	285.0-312.4
Foot-Specific Reaction Time (ms)	312.8 ± 41.2	251.7-402.3	296.9-328.7
Composite Foot Agility Score	16.2 ± 3.4	9.8-22.5	14.9-17.5

Correlation Analysis

Significant negative correlations were identified between all reaction time measures and foot agility performance, indicating that faster reaction times were associated with superior agility scores. The strongest correlation was observed between foot-specific reaction time and composite foot agility scores.

Table 2. Correlation Matrix Between Reaction Time and Foot Agility Variables

Reaction Time Measure	Foot Agility Score	p-value	95% CI
Simple Reaction Time	-0.623**	<0.001	-0.789 to -0.385
Choice Reaction Time	-0.689**	<0.001	-0.831 to -0.472
Foot-Specific Reaction Time	-0.742**	<0.001	-0.866 to -0.548

Note: ** Correlation is significant at the 0.01 level (2-tailed)

Regression Analysis

Multiple regression analysis revealed that reaction time variables collectively explained 55.1% of the variance in foot agility performance ($R^2 = 0.551$, $F(3,24) = 9.83$, $p < 0.001$). Foot-specific reaction time emerged as the strongest predictor ($\beta = -0.521$, $p < 0.001$), followed by choice reaction time ($\beta = -0.298$, $p = 0.024$).

Table 3. Multiple Regression Analysis Predicting Foot Agility Performance

Predictor Variable	B	SE B	β	t	p-value
Constant	45.267	6.834	-	6.624	<0.001
Simple Reaction Time	-0.024	0.026	-0.201	-0.923	0.365
Choice Reaction Time	-0.028	0.012	-0.298	-2.387	0.024*
Foot-Specific Reaction Time	-0.043	0.011	-0.521	-3.945	<0.001**

Note: $R^2 = 0.551$, Adjusted $R^2 = 0.495$, * $p < 0.05$, ** $p < 0.001$

Group Comparisons

Participants were divided into fast ($n = 14$, reaction time ≤ 280 ms) and slow ($n = 14$, reaction time > 280 ms) reaction time groups based on median split of composite reaction time scores. Independent samples t-tests revealed significant differences in foot agility performance between groups.

Table 4. Comparison of Foot Agility Performance Between Reaction Time Groups

Variable	Fast RT Group (n=14)	Slow RT Group (n=14)	t-value	p-value	Cohen's d
Foot Agility Score	18.4 $\pm$ 2.1	14.2 $\pm$ 2.8	4.293	<0.001	1.67
Ball Control Time (s)	47.3 $\pm$ 8.2	32.1 $\pm$ 6.9	5.124	<0.001	2.00
Technique Accuracy (%)	84.7 $\pm$ 7.3	71.2 $\pm$ 9.1	4.178	<0.001	1.62

Performance Distribution Analysis

Figure 1 illustrates the distribution of foot agility scores across different reaction time quartiles, demonstrating a clear trend of declining agility performance with increasing reaction time. Athletes in the fastest reaction time quartile (Q1) achieved significantly higher foot agility scores compared to all other quartiles ($p < 0.05$).

The data revealed that 78.6% of athletes with reaction times below 250ms scored above the group median for foot agility, while only 21.4% of athletes with reaction times above 320ms achieved above-median agility scores ($\chi^2 = 9.14$, $p = 0.003$).

DISCUSSION

Interpreting the Outcomes of Research Endeavors

The results of this study provide compelling evidence for a strong relationship between reaction time and foot agility performance in sepak takraw athletes. The significant negative correlations observed across all reaction time measures suggest that faster neural processing and motor response capabilities directly translate to superior foot agility skills in this sport.

The finding that foot-specific reaction time showed the strongest correlation with agility performance ($r = -0.742$) supports the principle of training specificity. This suggests that reaction time assessments and training interventions should closely mirror the movement patterns and response requirements of the target sport. The development of sport-specific reaction time protocols appears to be crucial for both assessment and training purposes.

The multiple regression analysis revealed that reaction time variables explained 55.1% of the variance in foot agility performance, indicating that while reaction time is a significant contributor, other factors also influence agility capabilities. These may include technical skill level, physical conditioning, experience, and psychological factors such as concentration and confidence.

Evaluating in Relation to Antecedent Studies

The magnitude of correlation between reaction time and agility performance observed in this study ($r = -0.742$) is notably higher than correlations reported in previous research examining similar relationships in other sports. Chen et al. (2018) reported correlations of $r = -0.52$ between reaction time and performance in badminton, while Rodriguez and Kumar (2020) found $r = -0.48$ in soccer players.

This stronger relationship in sepak takraw may be attributed to the sport's unique demands, where feet serve as the primary manipulative tools requiring precise timing and coordination. Unlike sports where gross motor movements predominate, sepak takraw demands fine motor control that may be more sensitive to reaction time variations.

The group comparison results align with findings from Thompson and Martinez (2019), who demonstrated significant performance differences between fast and slow reaction time groups in various sports contexts. However, the effect sizes observed in the current study (Cohen's $d = 1.67-2.00$) were substantially larger, suggesting that reaction time may play a more critical role in sepak takraw performance compared to other sports.

Elucidating the Ramifications of the Discoveries

The practical implications of these findings extend beyond academic understanding to direct applications in training and talent development. The strong predictive value of reaction time suggests that incorporating reaction time assessment into talent identification protocols could enhance the selection of promising takraw athletes.

Training program modifications should emphasize reaction time development alongside traditional technical and physical training. The specificity principle suggests that reaction time training should incorporate sport-specific movement patterns and response requirements to maximize transfer to performance.

The development of standardized reaction time benchmarks for sepak takraw athletes could provide valuable assessment tools for coaches and sports scientists. The performance thresholds identified in this study (reaction times ≤ 250 ms associated with superior agility) could serve as targets for training interventions.

From a broader perspective, these findings contribute to the understanding of motor control and skill acquisition in sports requiring fine motor coordination. The results may have applications in other sports and activities involving precise foot-based movements, such as dance, martial arts, and certain traditional games.

Recognizing the Constraints of the Research

Several limitations should be acknowledged when interpreting these results. The cross-sectional design precludes causal inferences about the relationship between reaction time and foot agility. Longitudinal studies examining the effects of reaction time training on agility performance would provide stronger evidence for causal relationships.

The sample was limited to male athletes from a single club, which may restrict the generalizability of findings to female athletes, different skill levels, or other geographical regions. Cultural and training methodology differences might influence the observed relationships. The foot agility assessment protocols, while developed specifically for this study, lack established validity and reliability data from multiple populations. Further validation studies are needed to confirm the utility of these assessment tools across diverse takraw populations.

The study did not control for potentially confounding variables such as motivation, fatigue state, nutritional status, or psychological factors that might influence both reaction time and agility performance. Future research should incorporate these variables to provide a more comprehensive understanding of performance determinants.

Additionally, the reaction time assessment was conducted in a laboratory setting that may not fully replicate the complex visual and auditory stimuli present during actual takraw competition. Developing more ecologically valid assessment protocols remains a priority for future research.

CONCLUSION

This study provides the first empirical evidence demonstrating a strong relationship between reaction time and foot agility performance in sepak takraw athletes. The significant correlations observed, particularly with sport-specific reaction time measures, highlight the importance of rapid neural processing capabilities for success in this traditional Southeast Asian sport. The findings reinforce the fundamental principle of training specificity, as evidenced by the superior predictive value of foot-specific reaction time compared to general reaction time measures. This suggests that training interventions and assessment protocols should closely mirror the movement patterns and response requirements specific to sepak takraw.

The practical implications extend to talent identification programs, where reaction time assessment could serve as a valuable screening tool for identifying athletes with potential for success in sepak takraw. Additionally, the integration of reaction time training into traditional coaching programs may enhance overall athletic performance and foot agility capabilities. The establishment of performance benchmarks indicating that reaction times ≤ 250 ms are associated with superior foot agility provides coaches and sports scientists with concrete targets for training interventions. These findings contribute to the evidence-based approach to sepak takraw training and development.

Future research directions should include longitudinal intervention studies examining the effects of targeted reaction time training on foot agility performance, validation of assessment protocols across diverse populations, and investigation of the neural mechanisms underlying foot-specific reaction time capabilities.

The correlation between reaction time and agility performance in sepak takraw athletes supports the integration of neuromuscular training approaches that address both cognitive processing speed and motor execution capabilities. As sepak takraw continues to gain international recognition, scientific research supporting evidence-based training methods becomes increasingly important for advancing competitive standards and athlete development.

Author-submitted suggestions for future research: Investigation of gender differences in reaction time-agility relationships; Development of age-specific reaction time training protocols; Examination of the effects of different training modalities on foot-specific reaction time; Cross-cultural validation of assessment tools and performance benchmarks; Integration of neurophysiological measures to understand underlying mechanisms.

CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this research. No financial or personal relationships with individuals or organizations could inappropriately influence the content of this work. All authors contributed equally to the conception, design, data collection, analysis, and manuscript preparation.

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