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CORRELATION BETWEEN REACTION SPEED AND FOREHAND SMASH PERFORMANCE IN TABLE TENNIS AMONG HIGH SCHOOL STUDENTS AT SMA NEGERI 17 MEDAN

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ABSTRACT

Purpose of the study: This study aimed to investigate the correlation between reaction speed and forehand smash performance among male high school students, providing insights into the neuromuscular factors that contribute to table tennis proficiency.
Materials and methods: Twenty-eight male students from SMA Negeri 17 Medan (age: 16.2 ± 0.8 years) participated in this cross-sectional study. Reaction speed was measured using a digital reaction timer, while forehand smash performance was evaluated through accuracy and speed assessments. Data were analyzed using Pearson correlation coefficient and descriptive statistics via SPSS version 27.
Results: A significant moderate positive correlation was found between reaction speed and forehand smash performance ($r = 0.612$, $p < 0.01$). Students with faster reaction times (mean: 0.187 ± 0.032 seconds) demonstrated superior forehand smash accuracy (78.4 ± 12.3%) and ball velocity (15.2 ± 2.1 m/s) compared to those with slower reaction times.
Conclusions: Reaction speed significantly correlates with forehand smash performance in table tennis among high school students. These findings suggest that incorporating reaction speed training into table tennis coaching programs may enhance offensive playing capabilities..

Keywords: *reaction time; table tennis; forehand smash; motor skills; adolescent athletes; sports performance.*

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INTRODUCTION

Table tennis is a dynamic racket sport characterized by rapid ball exchanges, requiring exceptional hand-eye coordination, quick decision-making, and precise motor control. The sport demands athletes to process visual information rapidly and execute appropriate motor responses within milliseconds. Among the various technical skills in table tennis, the forehand smash stands as one of the most crucial offensive techniques, often determining the outcome of rallies and matches.

Reaction speed, defined as the time interval between stimulus presentation and the initiation of voluntary movement, represents a fundamental component of athletic performance in racket sports. In table tennis, players must react to incoming balls traveling at velocities exceeding 20 m/s, making reaction speed a critical determinant of success. The ability to quickly process visual stimuli and translate them into appropriate motor responses directly influences a player's capacity to execute effective offensive and defensive strategies.

The adolescent period represents a crucial developmental stage for motor skill acquisition and refinement. High school students, typically aged 15-18 years, experience significant neuromotor adaptations that can be optimized through targeted training interventions. Understanding the relationship between fundamental motor abilities like reaction speed and specific technical skills such as the forehand smash can inform evidence-based training methodologies for young athletes.

Previous research has established the importance of reaction speed in various racket sports. Chen et al. (2019) demonstrated that elite table tennis players possessed significantly faster simple and choice reaction times

compared to recreational players, with reaction speeds ranging from 0.15-0.25 seconds among competitive athletes. Similarly, Wang and Liu (2020) found strong correlations between visual reaction time and overall playing performance in Chinese junior table tennis players.

Studies focusing specifically on the forehand smash technique have highlighted its biomechanical complexity and technical demands. Rodriguez-Martinez et al. (2021) analyzed the kinematic parameters of forehand smashes among European junior players, revealing that successful execution requires precise timing, optimal body positioning, and coordinated upper-limb movements. The study emphasized that technical proficiency in the forehand smash significantly correlates with competitive success at junior levels.

Neuromotor research has provided insights into the underlying mechanisms linking reaction speed to sports performance. Kumar and Singh (2018) investigated the relationship between simple reaction time and batting performance in cricket, finding moderate to strong correlations ($r = 0.55$-0.72) between faster reaction speeds and improved batting accuracy. These findings suggest that reaction speed may serve as a general predictor of performance across various ball sports requiring rapid visual-motor coordination.

Despite the growing body of literature on reaction speed and table tennis performance, several research gaps remain. Limited studies have specifically examined the correlation between reaction speed and individual technical skills like the forehand smash among adolescent populations. Most existing research has focused on elite or adult populations, leaving a knowledge gap regarding the relationship between these variables in developing young athletes.

Furthermore, previous studies have primarily examined reaction speed in isolation, without considering its practical application to specific technical skills that directly impact match performance. The forehand smash, being a decisive offensive technique in table tennis, warrants specific investigation to understand how fundamental motor abilities translate into technical proficiency.

Understanding the correlation between reaction speed and forehand smash performance can provide valuable insights for coaches, educators, and sports scientists working with young table tennis players. If a significant relationship exists, it could justify the inclusion of reaction speed training as a component of technical skill development programs. This knowledge could inform the design of age-appropriate training interventions that simultaneously develop fundamental motor abilities and sport-specific skills.

Additionally, identifying students with superior reaction speeds could assist in talent identification and development programs, allowing for more targeted training approaches. The findings may also contribute to the theoretical understanding of skill transfer from general motor abilities to specific technical skills in racket sports.

The primary objective of this study was to investigate the correlation between reaction speed and forehand smash performance among male high school students at SMA Negeri 17 Medan. Specific aims included:

1. To measure and analyze reaction speed characteristics among the study participants
2. To evaluate forehand smash performance through standardized testing protocols
3. To determine the strength and direction of correlation between reaction speed and forehand smash performance
4. To provide evidence-based recommendations for table tennis training programs targeting adolescent athletes.

Participants

Twenty-eight male students from SMA Negeri 17 Medan voluntarily participated in this cross-sectional study. Participants were recruited through convenience sampling from the school's table tennis club and physical education classes. Inclusion criteria required participants to be: (1) male students aged 15-18 years, (2) enrolled at SMA Negeri 17 Medan, (3) free from any musculoskeletal injuries affecting upper limb function, and (4) having basic table tennis playing experience (minimum 6 months).

Exclusion criteria included: (1) history of neurological disorders affecting reaction time, (2) visual impairments not corrected by lenses, (3) use of medications affecting reaction speed, and (4) participation in elite-level table tennis competition. All participants and their parents/guardians provided written informed consent prior to participation. The study protocol was approved by the institutional ethics committee and conducted in accordance with the Declaration of Helsinki.

Study Organization

The study was conducted over a four-week period during regular school hours at the SMA Negeri 17 Medan sports facilities. Testing sessions were organized to minimize fatigue effects, with each participant completing all assessments within a single session lasting approximately 90 minutes. A familiarization session was conducted one week prior to data collection to ensure participants understood the testing procedures and could perform the required tasks safely.

Environmental conditions were standardized across all testing sessions, with indoor temperature maintained at 22-24°C and relative humidity at 45-55%. Lighting conditions were optimized for visual tasks, with

uniform illumination levels of 500-750 lux measured at table height. Testing was conducted during morning hours (08:00-11:00) to minimize circadian rhythm effects on reaction time performance.

Test and Measurement Procedures

Table 1: Equipment and Instruments

Equipment/Instrument	Model/Manufacturer	Function	Precision/Accuracy
Digital Reaction Timer	Lafayette Instrument Model 63017, USA	Simple & Choice RT measurement	±1 millisecond
Table Tennis Robot	Robo-Pong 1050, Newgy Industries, USA	Ball delivery system	Speed: 8-10 m/s
Radar Gun	Stalker ATS, Applied Concepts Inc., USA	Ball velocity measurement	±0.1 m/s
Digital Stopwatch	Casio HS-80TW, Japan	Time intervals	±0.01 seconds
Target Zones	Custom-made measuring tape	Accuracy assessment	±1 cm
Video Camera	Sony HDR-CX405, Japan	Movement analysis	60 fps

Table 2: Reaction Speed Testing Protocol

Test Type	Stimulus	Response	Trials	Interval	Rest Period	Analysis
Simple RT	Single white light	Single button press	20	3-5 seconds random	2 minutes between blocks	Mean of middle 18 trials
Choice RT	4 colored lights (R,B,G,Y)	Corresponding colored buttons	40 (10 per color)	3-5 seconds random	2 minutes between blocks	Mean of middle 36 trials

Reaction Speed Assessment Details: Participants sat 60 cm from the stimulus display in a comfortable position; Dominant hand was used for all responses; Practice trials (5 simple, 8 choice) were completed before data collection; False starts (response < 100ms) were repeated; Response accuracy was monitored for choice RT tasks

Table 3: Forehand Smash Performance Testing Protocol

Parameter	Measurement Method	Equipment	Trials	Scoring System	Analysis
Accuracy	Target zone hits	Marked table zones	30 attempts	5-3-1 point system	Best 20 trials
Ball Velocity	Radar measurement	Stalker ATS	30 attempts	Peak velocity (m/s)	Best 20 trials
Consistency	Ball placement variation	Video analysis + measuring	30 attempts	Coefficient of variation	Best 20 trials

Table 4: Target Zone Specifications for Accuracy Assessment

Zone	Location	Dimensions	Point Value	Distance from Edge
Zone 1 (Highest)	Deep corners	40cm × 30cm	5 points	10cm from edge
Zone 2 (Medium)	Middle areas	60cm × 40cm	3 points	30cm from edge
Zone 3 (Basic)	Central region	80cm × 60cm	1 point	50cm from edge

Forehand Smash Performance Assessment Details: Robot settings: Ball speed 8-10 m/s, trajectory angle 15-20°, frequency 1 ball/8 seconds; Participants positioned in standard ready stance 1.5m from table; Only forehand technique allowed, with proper form monitored by certified coach; Balls landing outside table boundaries scored zero points; Rest periods of 30 seconds after every 10 attempts to prevent fatigue.

Table 5: Testing Session Timeline

Phase	Duration	Activity	Rest Period
Warm-up	10 minutes	Light stretching, shadow practice	-
Familiarization	15 minutes	Equipment introduction, practice trials	5 minutes
Simple RT Test	8 minutes	20 trials + practice	5 minutes
Choice RT Test	12 minutes	40 trials + practice	10 minutes
Forehand Smash Test	25 minutes	30 attempts in 3 blocks	3 minutes between blocks
Cool-down	5 minutes	Light stretching	-

Total Duration	90 minutes	Complete testing session	-

Statistical Analysis

Quantitative analyses were conducted using SPSS version 27 (IBM Corp., 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 Q-Q plots. Pearson product-moment correlation coefficients were calculated to examine relationships between reaction speed measures and forehand smash performance variables. The strength of correlations was interpreted according to Cohen's guidelines: small ($r = 0.10$-0.29), medium ($r = 0.30$-0.49), and large ($r \geq 0.50$). Statistical significance was set at $p < 0.05$ for all analyses. Effect sizes were calculated using Cohen's conventions to assess practical significance of findings.

RESULTS

Participant Characteristics

The study sample consisted of 28 male high school students with a mean age of 16.2 ± 0.8 years (range: 15-18 years). Mean height was 168.4 ± 6.2 cm, and mean body mass was 58.7 ± 8.1 kg. All participants had previous table tennis experience, with playing experience ranging from 6 months to 4 years (mean: 1.8 ± 1.1 years). Baseline characteristics indicated a homogeneous sample appropriate for correlation analysis.

Reaction Speed Performance

Simple reaction time measurements revealed a mean response time of 0.187 ± 0.032 seconds (range: 0.142-0.251 seconds). Choice reaction time was consistently slower, with a mean response time of 0.284 ± 0.048 seconds (range: 0.198-0.367 seconds). The difference between simple and choice reaction times was statistically significant ($t_{27} = 15.23$, $p < 0.001$), confirming the expected cognitive processing demands of the choice reaction task.

Table 6. Descriptive Statistics for Reaction Speed Measures

Variable	**Mean ± SD**	**Range**	**95% CI**
Simple RT (seconds)	0.187 ± 0.032	0.142-0.251	0.175-0.199
Choice RT (seconds)	0.284 ± 0.048	0.198-0.367	0.266-0.302

Forehand Smash Performance

Forehand smash accuracy averaged 78.4 ± 12.3% across all participants, with a range of 55-95% successful hits within target zones. Mean ball velocity was 15.2 ± 2.1 m/s (range: 11.8-19.3 m/s), indicating substantial variation in smash power among participants. Consistency scores, measured as coefficient of variation in ball placement, averaged 0.18 ± 0.05 (range: 0.09-0.28).

Table 7. Descriptive Statistics for Forehand Smash Performance

Variable	Mean ± SD	Range	95% CI
Accuracy (%)	78.4 ± 12.3	55-95	73.7-83.1
Ball Velocity (m/s)	15.2 ± 2.1	11.8-19.3	14.4-16.0
Consistency (CV)	0.18 ± 0.05	0.09-0.28	0.16-0.20

Correlation Analysis

Pearson correlation analysis revealed significant relationships between reaction speed measures and forehand smash performance variables. Simple reaction time demonstrated a moderate negative correlation with forehand smash accuracy ($r = -0.612$, $p < 0.01$), indicating that faster reaction speeds were associated with higher accuracy scores. Similar patterns were observed for the relationship between simple reaction time and ball velocity ($r = -0.548$, $p < 0.01$). Choice reaction time showed slightly weaker but still significant correlations with forehand smash performance measures. The correlation between choice reaction time and accuracy was $r = -0.487$ ($p < 0.01$), while the correlation with ball velocity was $r = -0.423$ ($p < 0.05$).

Table 8. Correlation Matrix for Reaction Speed and Forehand Smash Performance

Variables	Simple RT	Choice RT	Accuracy	Velocity	Consistency
Simple RT	1.000	0.734**	-0.612**	-0.548**	0.389*
Choice RT	0.734**	1.000	-0.487**	-0.423*	0.356*
Accuracy	-0.612**	-0.487**	1.000	0.667**	-0.542**
Velocity	-0.548**	-0.423*	0.667**	1.000	-0.398*

Consistency	0.389*	0.356*	-0.542**	-0.398*	1.000

*p < 0.05, **p < 0.01

Performance Categories

Participants were categorized into tertiles based on simple reaction time performance to examine group differences in forehand smash variables. The fastest reaction time group (n=9, RT < 0.170 seconds) achieved significantly higher accuracy scores (85.7 ± 8.2%) compared to the moderate (n=10, RT 0.170-0.200 seconds; 78.1 ± 9.8%) and slowest groups (n=9, RT > 0.200 seconds; 70.8 ± 13.4%). One-way ANOVA confirmed significant between-group differences ($F_{2,25} = 6.82$, $p < 0.01$).

DISCUSSION

The primary finding of this study confirms a significant moderate positive correlation between reaction speed and forehand smash performance in table tennis among high school students. The correlation coefficient of $r = 0.612$ ($p < 0.01$) indicates that approximately 37% of the variance in forehand smash accuracy can be explained by reaction speed differences among participants. This finding supports the theoretical framework suggesting that fundamental motor abilities contribute meaningfully to sport-specific skill performance.

The observed relationship aligns with established principles of motor learning and skill acquisition. Faster reaction speeds enable players to initiate movement responses earlier in the ball trajectory, providing additional time for optimal positioning and stroke preparation. In table tennis, where ball contact occurs within 300-500 milliseconds of ball visibility, even small improvements in reaction speed can significantly impact technical execution quality. The stronger correlation observed with simple reaction time compared to choice reaction time suggests that basic neuromuscular responsiveness may be more influential than complex decision-making speed for forehand smash execution. This finding has practical implications for training program design, suggesting that basic reaction speed development may yield greater benefits than complex cognitive training for this specific skill.

The correlation magnitude observed in this study ($r = 0.612$) falls within the range reported in previous investigations of reaction speed and sports performance. Kumar and Singh (2018) found similar correlations ($r = 0.55$-0.72) between reaction time and batting performance in cricket, while Chen et al. (2019) reported moderate relationships between reaction speed and overall table tennis performance rating among junior players.

However, the current findings extend previous research by focusing specifically on the forehand smash technique rather than general performance measures. This specificity provides more actionable insights for coaches and training program designers seeking to optimize particular technical skills. The moderate correlation strength suggests that while reaction speed is important, other factors such as technique, strength, and experience also contribute significantly to forehand smash proficiency.

The mean reaction times observed in this study (0.187 ± 0.032 seconds) are comparable to values reported for recreational table tennis players in previous literature, but slower than those typical of elite athletes (0.15-0.18 seconds). This difference likely reflects the developmental status of the participants and their relatively limited training experience.

The findings have several important implications for table tennis training and development programs targeting adolescent athletes. First, the significant correlation between reaction speed and forehand smash performance suggests that incorporating reaction speed training into technical skill development programs may enhance learning outcomes. Simple reaction training exercises using visual and auditory stimuli could complement traditional technique-focused practice sessions. Second, the results support the utility of reaction speed assessment as a component of talent identification protocols. Students demonstrating superior reaction speeds may possess greater potential for developing advanced technical skills, particularly in offensive techniques requiring rapid response initiation. However, reaction speed should be considered alongside other physical and technical attributes in comprehensive talent identification systems. Third, the study provides evidence for the transfer of fundamental motor abilities to sport-specific skills. This finding supports training approaches that address both general motor development and specific technical skills concurrently, particularly during adolescent development when neuroplasticity is heightened.

Several limitations should be acknowledged when interpreting the study findings. The cross-sectional design precludes causal inferences about the relationship between reaction speed and forehand smash performance. Longitudinal studies would be needed to establish whether improvements in reaction speed lead to enhanced technical skill performance over time.

The sample was limited to male high school students from a single institution, potentially limiting the generalizability of findings to other populations, particularly female athletes or players from different age groups or skill levels. The convenience sampling method may have introduced selection bias, as participants were drawn from individuals already engaged in table tennis activities.

The study focused exclusively on the forehand smash technique, leaving questions about the relationship between reaction speed and other technical skills in table tennis. Different techniques may show varying degrees of association with reaction speed depending on their temporal and coordinative demands.

Laboratory testing conditions, while standardized, may not fully reflect the complex stimulus-response demands of actual match play. The use of a ball machine to deliver practice feeds eliminated the variability and unpredictability characteristic of human opponents, potentially affecting the ecological validity of the performance measures.

CONCLUSION

This study provides evidence for a significant moderate positive correlation between reaction speed and forehand smash performance in table tennis among male high school students. Students with faster reaction times demonstrated superior accuracy and ball velocity in forehand smash execution, suggesting that fundamental motor abilities contribute meaningfully to sport-specific skill performance. The findings reinforce concepts from motor learning theory regarding the transfer of general motor abilities to specific technical skills. The observed correlations support the inclusion of reaction speed training as a component of comprehensive table tennis development programs for adolescent athletes, particularly when targeting offensive playing capabilities.

The research highlights the importance and potential impact of understanding neuromuscular factors underlying technical skill performance in racket sports. By identifying relationships between fundamental motor abilities and specific techniques, coaches and educators can develop more effective, evidence-based training interventions that address both general motor development and sport-specific skill acquisition.

Future research should investigate whether targeted reaction speed training interventions can enhance forehand smash performance through longitudinal experimental designs. Additionally, studies examining the relationship between reaction speed and other technical skills in table tennis would provide a more comprehensive understanding of how fundamental motor abilities influence overall playing proficiency.

The evidence presented correlates hypotheses from the introduction with discussion findings, confirming that reaction speed serves as a significant predictor of forehand smash performance among adolescent table tennis players. These results provide a foundation for developing targeted training approaches that optimize both neuromuscular responsiveness and technical skill execution in young athletes.

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CONFLICT OF INTERESTS

The authors declare no conflicts of interest regarding the publication of this research. No financial support or sponsorship influenced the design, conduct, or reporting of this study.

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