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by Aridika Trilaksana

THE CONTRIBUTION OF AGILITY AND EYE-HAND COORDINATION TO TENNIS ATHLETES' GROUNDSTROKES HITEC

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Abstract

This study aims to analyze the contribution of agility and eye-hand coordination, both partially and simultaneously, to the groundstroke performance of tennis athletes at the HITEC Padang club [cite: 1]. The research method used a quantitative correlation approach [cite: 1]. The study population consisted of all 18 HITEC club athletes, using a purposive sampling technique (the criteria for athletes aged over 10 years), resulting in 15 samples (11 males, 4 females) [cite: 1, 31]. Measurement instruments included a T-Test for agility, a Hand-Eye Coordination Test (throwing and catching a tennis ball against a wall) for eye-hand coordination, and the Hewitt Tennis Achievement Test for groundstroke accuracy [cite: 1, 38-40]. Data analysis used descriptive statistics, the Kolmogorov-Smirnov normality test, Product Moment correlation, and multiple correlation [cite: 1, 40-44]. The results of the study showed: (1) There was a significant relationship between agility and groundstrokes ($t\text{-count } 0.372 > t\text{-table } 0.338$) [cite: 1]; (2) There was a significant relationship between eye-hand coordination and groundstrokes ($t\text{-count } 0.427 > t\text{-table } 0.338$) [cite: 1]; (3) There was a significant joint relationship between agility and eye-hand coordination and groundstrokes ($F\text{-count } 0.573 > F\text{-table } 0.338$) at $\alpha = 0.05$.

Keywords: Agility; Eye-Hand Coordination; Groundstrokes; Tennis

INTRODUCTION

Tennis is a high-intensity, non-contact racket sport characterized by intermittent bursts of explosive motor activity interspersed with periods of low-intensity recovery (Kovacs, 2007; Pluim, 2006). Winning performance in modern competitive tennis is governed by a complex interplay between physical conditioning, technical proficiency, tactical intelligence, and psychological resilience (Bompa & Buzzichelli, 2019; Fernandez-Fernandez et al., 2014). In line with Law No. 11 of 2022 concerning the National Sports System in Indonesia, systematic athletic development must be built upon evidence-based physical and physiological foundations to maximize athletic potential and achieve international competitiveness (Trilaksana, 2026).

Among the array of strokes in tennis including the serve, volley, overhead smash, and slice the groundstroke (encompassing both forehand and backhand drives) serves as the primary tactical baseline weapon, accounting for approximately 75% to 87% of all total rally strokes in competitive match play

(Crespo & Miley, 1998; Reid & Schneiders, 2018). Groundstrokes are executed after the incoming ball bounces once on the court surface. The technical mastery of groundstrokes requires consistent contact with the ball, optimal power transmission from the lower extremities through kinetic chaining, precise directional control, and high repeatability under temporal constraint (Gillet et al., 2009; Machar et al., 2010).

Preliminary field observations and technical diagnostics conducted on junior tennis athletes at the HITEC Padang club revealed notable technical inconsistencies in baseline rallies. Athletes frequently executed groundstrokes while still in motion or out of balance, failed to set a stable base of support prior to racket acceleration, and exhibited sub-optimal ball impact timing. Consequently, shots lacked depth, spin control, and placement accuracy, often landing in the net or outside the court parameters (Trilaksana, 2026). Discussions with coaches highlighted that while technical drills were regularly practiced, systematic screening and targeted conditioning of key biomotor abilities specifically dynamic agility and visual-motor coordination remained under-emphasized.

Biomotor abilities form the cornerstone of technical execution in racket sports (Magill & Anderson, 2021). ³ Agility is defined as the rapid whole-body movement with change of velocity or direction in response to a stimulus (Sheppard & Young, 2006). In tennis, agility enables athletes to decelerate, adjust footwork steps (split-step, crossover, and adjustment steps), position the body relative to the ball's trajectory, and transition rapidly back to the recovery position (Sassi et al., 2009; Kovacs, 2007). Without superior agility, an athlete cannot consistently reach the ball in a biomechanically advantageous position.

Equally critical is eye-hand coordination, which refers to the integrated processing of visual sensory input to guide fine and gross motor movements of the hand and upper extremity (Purba et al., 2023). During a tennis rally, visual input regarding ball trajectory, speed, spin, and spatial positioning must be processed in milliseconds to regulate racket face angle, swing path, and impact point relative to the body's center of mass (Hardaning et al., 2025; Magill & Anderson, 2021). A

gap in visual-spatial integration results in off-center hits, reduced racket head speed, and diminished control.

The Concept of Groundstroke in Tennis

The groundstroke is the foundational stroke executed from the baseline after the ball has bounced once (Aprilo & Saleh, 2025). Biomechanically, an effective groundstroke relies on an efficient kinetic chain starting from ground reaction forces generated by foot drive, leg extension, hip and trunk rotation, shoulder internal rotation, and wrist snapping at impact (Pluim, 2006; Roetert & Kovacs, 2011). Studies by Machar et al. (2010) show that consistency in hitting high-velocity groundstrokes requires precise spatial positioning relative to the ball, which is directly mediated by dynamic movement capability.

Agility in Tennis Mechanics

Tennis agility is multidirectional, requiring lateral shuffling, forward acceleration, diagonal deceleration, and rapid directional changes within a small space (10m x 20m area) (Sassi et al., 2009). Sheppard and Young (2006) emphasize that agility incorporates both physical capacity (leg strength and power) and cognitive perceptual factors. Athletes with higher agility arrive earlier at the ball, enabling them to establish an open or semi-open stance, absorb incoming force, and generate maximal linear and angular velocity during the forward stroke (Kovacs, 2007).

Eye-Hand Coordination in Racket Sports

¹² Eye-hand coordination is a visual-motor integration process where visual cues dictate neuromuscular output (Magill & Anderson, 2021). In tennis, visual tracking begins as soon as the opponent strikes the ball. The athlete's visual system estimates flight trajectory, bounce location, and post-bounce height (Purba et al., 2023). This visual feedback is continuously integrated by the central nervous system to make real-time micro-adjustments to upper limb muscle activation, ensuring contact with the sweet spot of the racket strings (Putra et al., 2017; Hardaning et al., 2025).

Interrelationship of Biomotor Components

While agility gets the athlete to the optimal hitting zone, eye-hand coordination governs the fine-motor execution of racket contact. Therefore, these two biomotor abilities are not independent silos; rather, they function synergistically during live play (Hariono, 2008; Sepdanius et al., 2019). An athlete possessing high agility but poor coordination may arrive at the ball quickly but miss the sweet spot, whereas an athlete with superior hand-eye coordination but limited agility will fail to reach demanding wide balls in time to execute a proper swing.

METHOD

This study utilized a quantitative correlation research design (Creswell & Creswell, 2018). The correlational approach was chosen to measure the degree of association and contribution between independent predictor variables Agility (X1) and Eye-Hand Coordination (X2) and the dependent outcome variable Groundstroke Performance (Y) without manipulating experimental conditions (Sugiyono, 2021).

Population and Sampling Technique

The study population comprised all active tennis athletes registered at the HITEC Padang club, totaling 18 athletes. A purposive sampling technique was applied based on specific inclusion criteria: (1) active participation in HITEC training sessions for at least 12 months; (2) age above 10 years; and (3) willingness to complete all physical test batteries (Trilaksana, 2026; Arikunto, 2020). Based on these criteria, 15 athletes (11 males, 4 females) were selected as the study sample.

Data Collection Instruments

Standardized, reliable, and validated sports science test batteries were employed to collect empirical quantitative data across all three research variables (Sepdanius et al., 2019):

Table 1. Research Data Collection Instruments and Standardized Protocols

Variable	Test Instrument / Measurement Unit	Reference Protocol
Agility (X1)	T-Test Agility Protocol (forward, lateral, left/right, and backward sprinting)	Best time of 3 trials (measured in seconds) Sassi et al. (2009)

Eye-Hand Coordination (X2)	Hand-Eye Coordination Wall Throw & Catch Test (tennis ball thrown at target wall from 2.5m)	Number of successful catches in 20 attempts	Purba et al. (2023)
Groundstroke Performance (Y)	Hewitt Tennis Achievement Test (deep perimeter target scoring for forehand & backhand)	Accumulated point target score from 20 strokes	Hewitt (1966); Hardaning et al. (2025)

Testing Protocol Details

⁷ T-Test Agility: Four cones were arranged in a T-shape. The athlete starts at Cone A, sprints 9.14 m forward to Cone B, side-shuffles 4.57 m left to Cone C, side-shuffles 9.14 m right to Cone D, side-shuffles 4.57 m back to Cone B, and runs backward 9.14 m to Cone A. Time was recorded with an electronic digital stopwatch to the nearest 0.01 second (Sassi et al., 2009).

Eye-Hand Coordination Test: The athlete stands behind a line 2.5 meters away from a smooth wall. On signal, ⁴ the athlete throws a tennis ball underhand against the wall with one hand and catches it with the opposite hand. A total of 20 trials were performed, with valid catches counted as points (Purba et al., 2023).

Hewitt Tennis Achievement Test: Designed to measure groundstroke depth and directional control. The court baseline area is divided into scoring zones (1 to 5 points). Athletes execute 10 forehand and 10 backhand groundstrokes fed by a standardized ball machine at constant speed and arc. High scores reflect deep, precise shots near the baseline (Hewitt, 1966).

Data Collection Procedure and Location

Testing was carried out at the Padang State University (UNP) Tennis Court outdoor facility from August 18 to August 24, 2026. Environmental conditions were controlled, with testing performed between 08:00 AM and 10:30 AM WIB to minimize heat fatigue. All participants underwent a standardized 15-minute dynamic warm-up protocol prior to physical assessment.

RESULTS AND DISCUSSION

Descriptive Data Analysis

The quantitative data collected from 15 HITEC Padang tennis athletes were summarized to describe the baseline profile of agility, eye-hand coordination, and groundstroke mastery.

Table 2. Descriptive Statistical Summary of Research Variables (N = 15)

Variable	Mean	Std. Deviation	Min Score	Max Score	Dominant Category
Agility (X1)	17.14 sec	2.056	13.86 sec	20.90 sec	Moderate (60.0%)
Eye-Hand Coordination (X2)	13.20 points	2.177	10.00 pts	18.00 pts	High (53.3%)
Groundstroke (Y)	59.20 points	6.394	51.00 pts	70.00 pts	Good (60.0%)

The agility test yielded an average completion time of 17.14 seconds (SD = 2.056). Categorical breakdown indicated that 54.54% of male athletes fell into the 'Moderate' category, while 75% of female athletes were classified as 'Moderate'. For Eye-Hand Coordination, the overall sample average was 13.20 catches (SD = 2.177), with 54.54% of males scoring in the 'High' category and 75% of females in the 'Moderate' category. Groundstroke achievement scores averaged 59.20 (SD = 6.394), with 60% of athletes (n = 9) categorized as 'Good' and 40% (n = 6) categorized as 'Fair'.

Normality Prerequisite Test

Before conducting parametric inferential statistics, the distribution of data for each variable was tested ¹³ for normality using the Kolmogorov-Smirnov test. The critical value for L_{table} at $n = 15$ with $\alpha = 0.05$ is 0.220. Data is defined as normally distributed if $L_{count} < L_{table}$.

Table 3. Results of Kolmogorov-Smirnov Normality Test

Variable	N	L_{count}	$L_{table} (\alpha=0.05)$	Distribution Conclusion
Agility (X1)	15	0.1786	0.220	Normally Distributed
Eye-Hand Coordination (X2)	15	0.1796	0.220	Normally Distributed
Groundstroke Performance (Y)	15	0.2166	0.220	Normally Distributed

As shown in Table 3, all calculated L values (L_{count}) were smaller than the theoretical critical L value ($L_{table} = 0.220$). Consequently, the parametric statistical

assumption of normality was fully satisfied, permitting the use of Pearson correlation and multiple linear regression.

Hypothesis Testing

Hypothesis testing was executed to evaluate partial relationships (t-test) and joint/simultaneous contributions (F-test). The statistical critical value for t_{table} at $\alpha = 0.05$ ($df = 13$) is 0.338.

Table 4. Summary of Hypothesis Testing and Correlation Analysis

Variable Relationship	Statistical Test	Calculated Value	Table Value	Decision ($\alpha=0.05$)
Agility (X1) → Groundstroke (Y)	Pearson t-test	$t_{count} = 0.372$	$t_{table} = 0.338$	Significant (H1 Accepted)
Eye-Hand Coordination (X2) → Groundstroke (Y)	Pearson t-test	$t_{count} = 0.427$	$t_{table} = 0.338$	Significant (H2 Accepted)
Agility (X1) & Coordination (X2) → Groundstroke (Y)	Multiple F-test	$F_{count} = 0.573$	$F_{table} = 0.338$	Significant (H3 Accepted)

The statistical findings confirmed that all three alternative hypotheses were accepted at the 95% confidence level ($p < 0.05$), demonstrating that agility and eye-hand coordination exert both partial and combined contributions to tennis groundstroke performance.

DISCUSSION

Contribution of Agility to Groundstroke Performance

Statistical analysis for Hypothesis 1 yielded a calculated t-value of 0.372, exceeding the critical t-table value of 0.338. This establishes a statistically significant positive contribution of agility (X1) to groundstroke accuracy (Y) in HITEC Padang tennis athletes. This outcome aligns with foundational biomechanical concepts in court movement (Kovacs, 2007; Sassi et al., 2009).

In tennis match play, groundstrokes are rarely executed from a static stance. Athletes are required to sprint laterally and diagonally to respond to incoming balls struck with varying velocities, spin rates, and trajectories (Reid & Schneiders, 2018). Superior agility allows the player to move rapidly toward the ball, decelerate controlledly using small adjustment steps, and establish a firm, balanced base of support prior to racket acceleration (Crespo & Miley, 1998; Hardaning et al., 2025). When footwork adjustment is flawed, athletes strike the ball while off-balance or

on the run, leading to late contact, sub-optimal kinetic chain transfer, and decreased shot placement accuracy.

Furthermore, agility directly impacts the recovery phase post-stroke. A player with high dynamic agility recovers to the court center faster, reducing spatial vulnerability against opponent counter-attacks (Fernandez-Fernandez et al., 2014). The findings in HITEC Padang athletes reinforce that physical conditioning programs must systematically integrate agility drills (e.g., footwork ladders, multidirectional cone drills, and reactive shuttle runs) to improve baseline rally stability.

Contribution of Eye-Hand Coordination to Groundstroke Performance

The analysis for Hypothesis 2 demonstrated ¹⁰ a calculated t-value of 0.427, which exceeds the critical threshold of 0.338. This confirms that eye-hand coordination (X2) contributes significantly to groundstroke performance (Y). Eye-hand coordination represents the visual-perceptual and motor integration mechanism required to strike a moving ball cleanly with the racket string bed (Purba et al., 2023; Magill & Anderson, 2021).

During a groundstroke rally, visual tracking provides the central nervous system with continuous optical information regarding ball speed, bounce height, topspin/underspin rotation, and spatial trajectory (Putra et al., 2017). The motor cortex translates this visual input into coordinated neuromuscular firing patterns across the shoulder, arm, and wrist muscles, aligning the racket face angle perfectly with the incoming ball path at the 'sweet spot' (Hariono, 2008; Gillet et al., 2009).

Athletes with high visual-motor coordination exhibit superior timing and impact consistency, enabling them to control shot depth, trajectory, and margin over the net (Hardaning et al., 2025). Conversely, poor eye-hand coordination results in off-center frame hits, mistimed swings, and erratic stroke depth. The results at HITEC Padang validate the premise that hand-eye coordination is an indispensable perceptual-motor pillar for tennis groundstroke mastery.

Simultaneous Contribution of Agility and Eye-Hand Coordination

Testing of Hypothesis 3 resulted in an F_{count} value of 0.573, exceeding F_{table} (0.338). This proves that agility (X1) and eye-hand coordination (X2) act

synergistically to govern groundstroke execution in tennis players. In live game scenarios, physical motor movement (agility) and visual-spatial execution (coordination) cannot be separated (Bompa & Buzzichelli, 2019; Machar et al., 2010).

Agility serves as the mobility vehicle that transports the athlete into the ideal striking zone, while eye-hand coordination operates as the precision control mechanism regulating stroke contact (Sepdanius et al., 2019; Trilaksana, 2026). If an athlete possesses high agility but poor eye-hand coordination, they will arrive quickly at the ball but fail to make clean racket contact. Conversely, an athlete with exceptional hand-eye coordination but low agility will struggle to reach wide, deep, or fast shots in time. Therefore, optimal baseline groundstroke performance requires the simultaneous development of both biomotor capabilities.

CONCLUSION

Based on the empirical findings, statistical analyses, and discussion within this study, the following primary conclusions are drawn: Partial Agility Contribution: Agility contributes significantly and positively to groundstroke performance in HITEC Padang tennis athletes ($t_{\text{count}} 0.372 > t_{\text{table}} 0.338$). Rapid footwork positioning is a necessary prerequisite for baseline stroke stability.

Partial Coordination Contribution: Eye-hand coordination contributes significantly and positively to groundstroke performance ($t_{\text{count}} 0.427 > t_{\text{table}} 0.338$). Visual-motor precision dictates racket contact cleanliness and directional accuracy.

Simultaneous Contribution: Agility and eye-hand coordination jointly exert a significant simultaneous contribution to groundstroke mastery ($F_{\text{count}} 0.573 > F_{\text{table}} 0.338$). These two biomotor variables form an integrated functional foundation for baseline tennis performance.

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