



The Effect of Tiki-Taka Game-Based Training on Passing Accuracy Improvement among Under-13 Football Players

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Abstract

Passing accuracy underpins effective tactical execution in youth football, yet young players frequently struggle with spatial consistency during competitive match play. This study evaluated how a Tiki-Taka game-based training regimen affects passing accuracy in Under-13 (U13) players at SSB PSAN Neusu Banda Aceh. Utilizing a quantitative pretest–post-test control group design, we allocated 30 U13 athletes into either an experimental group (n = 15) that underwent Tiki-Taka training or a control group (n = 15) that followed a conventional training curriculum. We assessed passing proficiency via the Soccer Passing Accuracy Test before and after the intervention. Statistical analysis comprised descriptive metrics, Shapiro-Wilk normality verifications, Levene’s homogeneity checks, Wilcoxon Signed Rank Tests, and Independent Samples t-tests. The experimental cohort demonstrated significant post-intervention gains, with mean passing accuracy scores climbing from 4.73 to 6.20 (p = .001). Conversely, the control group showed no meaningful improvement (p = .180). Post-test comparisons revealed a stark performance divergence between the two cohorts (p = .001), establishing that Tiki-Taka game-based intervention outperforms standard drills. Integrating high-density, short-passing games into youth academies enhances immediate technical execution. It also nurtures spatial awareness and rapid collaborative processing, offering coaches a structured framework to optimize tactical development.

Keywords: Game-Based Training, Tiki-Taka, Passing Accuracy, Youth Football of Aceh, Motor Learning

Introduction

Global football participation exceeds 265 million active individuals according to FIFA data, positioning the sport as a vital vehicle for cultivating physical literacy, collaborative dynamics, and tactical discipline in youth athletes. Within the Indonesian context, structured youth development has expanded rapidly via grassroots football schools (Sekolah Sepak Bola/SSB), which serve as the primary incubator for technical and tactical foundational competencies from an early age (Schmidt & Lee, 2019). Among foundational technical mechanics, passing accuracy dictates possession maintenance, tempo modulation, and subsequent attacking transitions remains paramount. Precision passing demands a fluid synthesis of motor execution and cognitive faculties, including rapid spatial mapping, anticipated trajectory, and immediate decision-making under environmental pressure (Aprianto et al., 2020; Listanto & Muhtarom,



2025). Consequently, contemporary pedagogical paradigms emphasize training methodologies that holistically merge motor skills with cognitive and collective socio-tactical dimensions.

Motor Learning Theory posits that stable skill acquisition depends on targeted, repetitive practice coupled with immediate feedback mechanics in ecological environments that replicate competitive match constraints (Schmidt & Lee, 2019). Complementing this perspective, Social Learning Theory indicates that athletic development is accelerated through peer observation, imitation, and immediate interaction within a structured team cohort (Bandura, 2010). Cognitive learning frameworks further dictate that proficient football performance relies on an athlete's capacity to filter complex environmental cues and execute rapid decisions.

A specialized pedagogical method that synthesizes these multidimensional criteria is the Tiki-Taka game-based training framework. This intervention emphasizes high-density short passing, continuous off-ball relocation, structural positional play, and collective possession maintenance. By exposing players to frequent ball touches and highly volatile decision-making scenarios, this model targets technical passing accuracy while expanding spatial and tactical literacy. While prior empirical work demonstrates that game-based models, particularly small-sided games, improve passing metrics among youth players (Aprianto et al., 2020; Listanto & Muhtarom, 2025), localized research addressing targeted Tiki-Taka protocols within the Under-13 (U13) demographic remains scarce. Existing literature heavily favors generic small-sided game configurations rather than isolating the unique, hyper-frequent passing loops and fluid positional shifts definitive of Tiki-Taka. Furthermore, empirical documentation exploring these systems within Indonesian youth academies is critically lacking, representing a distinct empirical gap regarding localized player development frameworks.

To address this gap, this investigation examined the efficacy of a structured Tiki-Taka game-based training regimen in optimizing passing accuracy among U13 players at SSB PSAN Neusu Banda Aceh. Specifically, this study contrasted the intervention's technical outcomes against a conventional training matrix to determine whether a dedicated Tiki-Taka protocol yields statistically superior technical performance compared to standard training methods. To what extent does the implementation of a structured Tiki-Taka game-based training regimen significantly improve passing accuracy among Under-13 youth football players? Does a conventional, drill-centric training curriculum yield statistically meaningful enhancements in passing accuracy within the same demographic over the intervention period? Is there a statistically significant difference in post-intervention passing accuracy between youth football players subjected to Tiki-Taka game-based training and those who undergo a conventional training program?

We deployed a quantitative experimental framework utilizing a pretest-posttest control group design. Thirty U13 football athletes were assigned to either an experimental cohort receiving the targeted Tiki-Taka game-based intervention or a control group following a standardized, drill-centric training curriculum. Baseline and post-intervention passing accuracy were quantified via the Soccer Passing Accuracy Test. Quantitative data was subjected to robust inferential statistical testing to isolate the specific impact of the independent training variables.

Passing Accuracy: The technical capacity of an athlete to deliver the ball with appropriate velocity and trajectory to a pre-determined target area during active play. **Tiki-Taka Game-Based Training:** A targeted instructional methodology characterized by high-density, low-touch short passing, constant off-ball spatial redistribution, and fluid collective possession structures. **Under-13 (U13) Players:** Youth football athletes aged 13 years or younger enrolled in a formalized, competitive youth academy system.

Theoretical Framework

This investigation is anchored in an integrative theoretical framework that synthesizes Motor Learning Theory, Social Learning Theory, and Cognitive Theory in Sports Learning. Passing accuracy in football extends beyond mere mechanical execution; it represents a complex, multi-dimensional skill that simultaneously demands precise motor control, interpersonal synergy, and rapid cognitive processing.

Motor Learning Theory posits that stable motor skill acquisition, refinement, and retention rely on deliberate, repetitive practice coupled with immediate feedback within ecological

environments that mirror actual match constraints (Schmidt & Lee, 2019). Within the context of this study, the high-density passing loops inherent to Tiki-Taka game-based training provide the volume and variability of technical execution necessary to enhance neuromuscular coordination and passing consistency.

Complementing the motor domain, Social Learning Theory emphasizes that athletic development is fundamentally accelerated through observation, imitation, and interpersonal synchronization within a team cohort (Bandura, 2010). Tiki-Taka training operationalizes these social mechanisms by requiring continuous collective possession, off-ball spatial redistribution, and fluid verbal and non-verbal communication among peers.

Finally, cognitive perspectives in sports learning dictate that elite performance relies on an athlete's capacity to perceive volatile environmental cues, manage attentional resources, and execute rapid decisions under pressure. Accurate short passing requires players to read the tactical landscape, calculate teammate and defender trajectories, and modulate pass velocity. Consequently, passing proficiency must be understood as an integrated socio-cognitive and physical process rather than an isolated drill response.

Traditional instructional methods heavily favor isolated technical repetitions in fixed, static environments. While conventional drills allow youth athletes to grasp basic biomechanical movements, they fail to cultivate spatial awareness or tactical adaptability due to the absence of active defensive opposition. Conversely, game-based training frameworks place players in authentic match-like scenarios that mandate immediate problem-solving and environmental tracking. Previous empirical work on small-sided games (SSGs) and game-based models confirms that these formats significantly enhance technical execution, player engagement, and positional understanding (Aprianto et al., 2020; Listanto & Muhtarom, 2025; Maulana Yusuf et al., 2023).

The Tiki-Taka model represents a highly specialized evolution of game-based learning. Characterized by rapid short passing, continuous off-ball movement, and strict positional support, Tiki-Taka acts as a dynamic system of coordinated collective interaction (Ab. Rashid, 2021). When adapted into small-sided game configurations (such as 3 vs. 3 or 4 vs. 4 grid formats), the restricted playing area amplifies ball-touch frequency and accelerates the decision-making cycle.

The material focus of this study was passing accuracy within the Under-13 (U13) demographic at SSB PSAN Neusu Banda Aceh. This specific developmental stage (ages 12 to 13 years) represents a critical neuromuscular window where athletes transition from rudimentary motor control to advanced tactical literacy. Baseline observations at the academy indicated that many players struggled with velocity regulation, spatial orientation, and decision-making speed during competitive matches.

To quantify technical proficiency, we utilized the Soccer Passing Accuracy Test. Participants completed 10 short-passing attempts toward a target positioned at a standardized distance of 5 to 7 meters, with performance recorded using a binary scoring system (1 for a successful target hit, 0 for failure). This operational metric isolates a player's ability to control pass direction and force consistently.

While existing sports science literature validates the general efficacy of SSGs and rondo variations in youth development (Aprianto et al., 2020; Ridha Ansyari et al., 2024), empirical studies isolating structured Tiki-Taka frameworks within Indonesian youth schools remain scarce. Most literature investigates broad, non-specific game-based models. This study addresses this empirical gap by evaluating a dedicated training paradigm that fuses short-passing density, rapid off-ball relocation, and cognitive load into a singular instructional framework tailored for Indonesian youth player development.

Methods

Research Design

This investigation implemented a quantitative experimental framework utilizing a randomized pretest-posttest control group design. True experimental setups are uniquely suited for establishing internal validity and determining whether a specific, isolated instructional intervention causes systematic shifts in a targeted behavioral outcome (Creswell & Creswell,

2018). Within this study, the independent variable was operationalized as the structured Tiki-Taka game-based training model, whereas the dependent variable was defined as the passing accuracy metric of the Under-13 football players.

Selecting a concurrent control group configuration served two primary methodological objectives. First, the baseline pretest measurements allowed for the empirical verification of initial group equivalence, ensuring that subsequent performance deltas were not artifacts of pre-existing skill variances among the young athletes. Second, tracking a control cohort undergoing standard training isolated the experimental intervention from potential confounding variables, such as natural physical maturation, external athletic activities, or test-retest familiarity effects. By contrasting the post-intervention performance disparities between the experimental and control groups, this research blueprint provides a systematically rigorous framework to validate the exact causal impact of Tiki-Taka training on youth technical execution.

Data Sources

The study cohort comprised 30 active Under-13 (U13) male football players drawn from SSB PSAN Neusu Banda Aceh, Indonesia. Given the relatively small, highly specific pool of available athletes at the academy, we applied a total sampling approach to capture the entire accessible population. To eliminate systematic assignment bias, we utilized a true random allocation protocol to distribute the 30 participants equally into either an experimental cohort (n = 15) or a conventional training control group (n = 15). All included athletes met the requisite baseline eligibility criteria, which mandated active enrollment in the academy, regular attendance at standard weekly training sessions, and an absence of any pre-existing physical injuries during the intervention timeline.

Instrument

Technical proficiency was quantified using the Soccer Passing Accuracy Test. This protocol required each participant to execute 10 consecutive short-passing attempts toward a standardized, designated target zone positioned at a fixed distance of 5 to 7 meters. Performance was recorded using a binary scoring system, where a successful strike hitting the target area yielded 1 point, and an unsuccessful or off-target attempt received 0 points. Cumulative scores for the evaluation ranged from a minimum of 0 to a maximum potential score of 10 points, with higher aggregate values representing superior technical precision and spatial consistency.

Data Collection Procedures

The data collection architecture was structured across three sequential phases: baseline pre-testing, the designated intervention timeline, and post-testing evaluation. During the initial pre-test phase, we quantified the baseline passing accuracy of all 30 participants across both cohorts under standardized conditions. Following baseline establishment, the intervention period commenced, spanning a multi-week timeline with a training frequency of three sessions per week. The experimental cohort engaged in the structured Tiki-Taka game-based protocols, while the control group simultaneously underwent conventional, drill-centric football training. Upon completion of the training cycle, the post-test phase re-evaluated passing proficiency using identical testing protocols to capture post-intervention performance deltas.

To supplement these quantitative technical metrics, structured observation sheets were deployed throughout each active training session. These instruments allowed for the continuous, qualitative evaluation of contextual behavioral variables, specifically tracking participant engagement, intrinsic motivation, collaborative teamwork, and tactical discipline. A representative matrix of the behavioral observation sheet utilized by the coaching staff is detailed in Table 1.

Table 1: Observation Sheet Indicators

No	Observation Aspect	Indicator	Rating Scale
1	Participation	Actively involved in training activities	1-4
2	Motivation	Demonstrates enthusiasm during training	1-4
3	Teamwork	Cooperates effectively with teammates	1-4
4	Communication	Communicates appropriately during play	1-4
5	Discipline	Follows training instructions and rules	1-4

6	Decision-Making	Selects appropriate passing options during play	1-4
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Scale: 1 = Poor, 2 = Fair, 3 = Good, 4 = Excellent

Data Analysis

Inferential and descriptive statistical operations were executed utilizing IBM SPSS Statistics (Version 26.0). The analytical pipeline proceeded through multiple sequential phases to ensure statistical rigor and appropriate model selection. Initially, descriptive statistics summarized the raw technical metrics, generating the mean (M), minimum and maximum values, and standard deviation (SD) for both pretest and posttest measurements across both cohorts.

Prior to hypothesis evaluation, diagnostic tests verified underlying parametric assumptions. Due to the small sample size (N = 30), data normality was evaluated via the Shapiro-Wilk protocol. Concurrently, Levene’s test assessed the homogeneity of variance between the experimental and control conditions, with the alpha threshold for both diagnostics set at $\alpha > .05$ to confirm compliance with parametric assumptions.

Because the initial diagnostic screening indicated that the within-group data distribution violated normality assumptions, non-parametric inferential statistics were required for intra-group comparisons. Consequently, the Wilcoxon Signed Rank Test evaluated the localized, pre-test-to-post-test performance deltas within the experimental and control cohorts individually. Conversely, for the primary between-group evaluation, an Independent Samples t-test contrasted the post-intervention scores between the two groups to determine the comparative efficacy of the Tiki-Taka protocol against the conventional baseline.

The threshold for statistical significance across all inferential tests was maintained at $p < .05$. To contextualize these quantitative outcomes, qualitative metrics derived from the behavioral observation sheets tracking participant engagement, intrinsic motivation, peer communication, teamwork, and operational discipline were synthesized descriptively, providing an integrated socio-technical interpretation of the statistical findings.

Ethical Considerations

Institutional clearance to conduct this field experiment was formally granted by the administrative management of SSB PSAN Neusu Banda Aceh. Given that the study cohort involved minors, ethical protocols were strictly enforced to safeguard participant autonomy. Athletic participation was entirely voluntary, with a clear provision that individuals could withdraw from the training cycles at any juncture without institutional penalty. Prior to the baseline data collection phase, comprehensive briefings were conducted, and written informed consent was secured from the parents or legal guardians of all 30 youth athletes, alongside verbal assent from the players themselves.

Findings

Descriptive Statistics of Passing Accuracy

The descriptive analysis revealed an overall improvement in players’ passing accuracy following the training intervention. As presented in Table 2, the mean pretest score was 4.80 (SD = 0.887), indicating that most players successfully completed fewer than half of the ten passing attempts. After the intervention period, the mean post-test score increased to 5.87 (SD = 0.730), representing an average improvement of 1.07 points.

The increase in mean scores suggests that the training program contributed positively to the development of passing accuracy among U13 football players. Furthermore, the reduction in standard deviation from 0.887 to 0.730 indicates that players’ performances became more homogeneous after training, suggesting that the improvement occurred across most participants rather than only among a few highly skilled players.

Table 2: Descriptive Statistics of Passing Accuracy

Variable	N	Minimum	Maximum	Mean	SD
Pre-test	30	3	6	4.80	0.887
Post-test	30	4	7	5.87	0.730

The findings indicate that players demonstrated better control, consistency, and accuracy in passing performance after participating in the training program.

Comparison Between Experimental and Control Groups

A comparison between the experimental and control groups showed notable differences in passing performance improvements. Before the intervention, both groups displayed relatively similar passing abilities, with mean pretest scores of 4.73 and 4.87 for the experimental and control groups, respectively (Table 3).

Following the intervention, the experimental group, which participated in Tiki-Taka game-based training, achieved a mean post-test score of 6.20, representing an improvement of 1.47 points. In contrast, the control group, which followed conventional training methods, achieved a mean post-test score of only 5.13, corresponding to an improvement of 0.26 points.

Table 3: Comparison Between Experimental and Control Groups

Group	Mean Pretest	Mean Posttest	Improvement
Experimental	4.73	6.20	1.47
Control	4.87	5.13	0.26

These results suggest that Tiki-Taka game-based training produced substantially greater gains in passing accuracy than conventional technical drills. The larger improvement observed in the experimental group may be attributed to the nature of Tiki-Taka exercises, which emphasize continuous passing, movement without the ball, spatial awareness, and rapid decision-making in game-like situations.

Within-Group Analysis

To determine whether the observed improvements were statistically significant, a Wilcoxon Signed Rank Test was conducted because the data were not normally distributed according to the Shapiro-Wilk normality test. The results are presented in Table 4.

Table 4: Wilcoxon Signed Rank Test Results

Comparison	p-value
Experimental Pretest–Posttest	0.001
Control Pretest–Posttest	0.180

The experimental group demonstrated a statistically significant improvement in passing accuracy ($p = 0.001 < 0.05$). This finding indicates that participation in Tiki-Taka game-based training significantly enhanced players' ability to perform accurate passes.

Conversely, the control group did not demonstrate a statistically significant improvement ($p = 0.180 > 0.05$). Although a slight increase in mean score was observed, the magnitude of change was insufficient to be considered statistically meaningful. This suggests that conventional passing drills alone may not provide adequate opportunities for players to develop passing accuracy within realistic game contexts.

Between-Group Analysis

To examine whether the two training approaches produced different outcomes, an Independent Samples t-Test was performed on the post-test scores (Table 5).

Table 5: Independent Samples t-Test

Comparison	p-value
Experimental vs Control Post-test	0.001

The analysis revealed a significant difference between the experimental and control groups ($p = 0.001 < 0.05$). Therefore, the null hypothesis was rejected, indicating that the Tiki-Taka game-based training program was significantly more effective than conventional training in improving passing accuracy among U13 football players.

The superiority of the Tiki-Taka approach can be explained by its integration of technical execution, tactical awareness, and cognitive engagement. During training sessions, players were required to make rapid decisions, maintain possession under pressure, communicate with teammates, and execute accurate passes in restricted spaces. These conditions closely resemble actual match situations and facilitate the transfer of learning from training to competition.

Conceptual Interpretation

The findings support the theoretical assumptions of Motor Learning Theory, Social Learning Theory, and Cognitive Theory in Sports Learning. Tiki-Taka training exposed players to a high frequency of ball contacts and repeated passing actions within dynamic game situations. Such repeated practice facilitated motor skill acquisition and strengthened passing consistency.

In addition, the game-based environment encouraged interaction, observation, and cooperation among teammates, supporting social learning processes. Players learned not only through direct practice but also through communication, observation, and imitation of successful passing behaviours.

From a cognitive perspective, players continuously processed environmental information, identified passing options, interpreted teammates' movements, and selected appropriate passing decisions. These cognitive demands likely contributed to the observed improvement in passing accuracy (Figure 1). The conceptual mechanism underlying the findings can be summarized as follows:

Figure 1: Conceptual Summary of Findings



The findings demonstrate that Tiki-Taka game-based training is an effective instructional approach for improving passing accuracy among U13 football players because it simultaneously develops technical, cognitive, and social components of football performance within an authentic game environment.

Discussion

This investigation demonstrated that a structured Tiki-Taka game-based training regimen yields significantly greater advancements in passing accuracy among Under-13 (U13) youth football players than a conventional, drill-centric curriculum. These results indicate that the high-density,

multi-directional interactions characteristic of the Tiki-Taka framework offer a superior instructional ecology for technical skill acquisition in grassroots youth academies.

The pronounced technical improvements observed in the experimental cohort, moving from a baseline mean of 4.73 to a posttest mean of 6.20 ($p = .001$), validate the core tenets of Motor Learning Theory. Stable motor skill acquisition occurs most effectively when repetitive training variables are embedded within ecological contexts that closely replicate competitive match constraints (Schmidt & Lee, 2019). The structural configuration of the Tiki-Taka intervention subjected players to high-frequency passing loops, requiring immediate ball circulation and coordinated spatial realignments. This constant exposure accelerated the refinement of localized movement patterns, adjusted mechanical timing, and stabilized technical motor consistency under pressure.

From a cognitive perspective, soccer proficiency depends on an athlete's perceptual capacity to filter volatile environmental cues and make split-second choices. Traditional isolated drills minimize cognitive load by removing defensive opposition. Conversely, the constrained grids and rapid tempos of Tiki-Taka demand continuous environmental scanning, spatial mapping, and anticipatory tracking. The posttest performance divergence suggests that the experimental cohort developed superior decision-making architectures, allowing them to regulate passing trajectory and velocity effectively within congested playing areas.

Furthermore, these findings align with Bandura's (2010) Social Learning Theory, which asserts that behavioral mastery is optimized through peer observation, modeling, and interpersonal interaction. During the collaborative possession sequences of Tiki-Taka, young athletes actively observed successful technical behaviors executed by their peers, adjusted their positioning based on verbal and non-verbal communication cues, and received immediate social reinforcement. This collective learning dynamic created a socio-technical feedback system that is fundamentally absent in isolated, linear passing lines.

The static performance of the control cohort ($p = .180$) highlights the pedagogical limitations of traditional training methodologies. While repetitive, closed-loop technical exercises remain valuable for introducing basic biomechanical movements to novice athletes, they strip away the open-loop cognitive and tactical volatility required in modern match environments. Consequently, while standard drills might preserve a player's mechanical kicking form, they fail to cultivate the spatial literacy needed to execute accurate passes during dynamic game play.

The clear advantage of the Tiki-Taka approach corroborates previous research validating game-based learning models over traditional training designs. Aprianto et al. (2020) demonstrated that small-sided games (SSGs) enhance passing accuracy by expanding individual player engagement and active decision-making opportunities. Similarly, Listanto and Muhtarom (2025) reported that integrated game-centered interventions optimize tactical positioning and passing execution in adolescent players. This study extends this body of literature by isolating a specialized tactical style (Tiki-Taka) and proving its technical efficacy within an Indonesian football school context.

However, our findings contrast with specific historical intervention studies which argue that conventional technical drills can produce equivalent technical gains if sustained over prolonged timelines. These contrasting outcomes are likely explained by variations in baseline participant age, overall training volume, and specific instructional designs. For youth athletes in critical developmental phases (ages 12 to 13), training designs that simultaneously engage motor, cognitive, and tactical faculties provide rapid, compounded technical benefits compared to prolonged mechanical isolation.

From a practical standpoint, these outcomes offer actionable frameworks for youth academy directors and soccer coaches. Grassroots programs should transition away from an over-reliance on closed, non-oppositional passing drills. Instead, curricula should incorporate contextual small-sided setups modeled on Tiki-Taka principles, ensuring that every technical execution is paired with a tactical problem-solving requirement to maximize skill transfer to competitive matches.

Despite these positive findings, several limitations must be acknowledged. First, the sample size ($N = 30$) was drawn from a single localized academy, which restricts the immediate generalizability of the results to broader youth soccer populations. Second, the intervention

window spanned a relatively brief four-to-six-week timeframe, preventing an evaluation of long-term skill retention or decay. Finally, the assessment criteria focused strictly on short-passing accuracy, omitting other vital performance metrics such as off-ball relocation velocity, peripheral scanning frequency, and spatial decision-making speed.

To address these limitations, future research trajectories should employ larger, multi-site cohorts over extended longitudinal tracking periods to measure long-term retention. Additionally, researchers should integrate advanced sports performance variables, such as matches analyzed via video tracking or wearable telemetry. Comparing Tiki-Taka protocols directly against other contemporary pedagogical frameworks, such as Teaching Games for Understanding (TGfU), will help establish robust, evidence-based guidelines for youth player development.

Conclusion

This investigation established that a structured Tiki-Taka game-based training model significantly optimizes passing accuracy among Under-13 youth football players at SSB PSAN Neusu Banda Aceh. While the experimental cohort achieved substantial technical gains, with mean accuracy scores climbing from 4.73 to 6.20 ($p = .001$), the control group undergoing conventional drills exhibited no statistically meaningful improvement. The post-intervention divergence between the two cohorts confirms that the Tiki-Taka framework offers a superior pedagogical environment compared to traditional, non-oppositional training regimens for refining technical precision in grassroots youth athletes.

Theoretically, this study expands the contemporary literature on game-based sports pedagogy by illustrating that technical mastery is an emergent property of integrated motor execution, cognitive processing, and socio-tactical interaction. Methodologically, the empirical data validate the assumption that training environments replicating competitive match constraints facilitate rapid skill acquisition. Practically, these findings serve as an actionable framework for academy directors and youth coaches seeking to transcend isolated mechanical repetition. Incorporating high-density, low-touch short passing matrices into regular training curricula creates an engaging, contextual learning landscape that accelerates the transfer of motor skills to active match play.

Although limited by a small sample size ($N = 30$) and a brief four-to-six-week intervention window, this research offers robust preliminary evidence for the efficacy of holistic instructional designs. Future investigations should utilize larger, multi-site demographic samples and extended longitudinal tracking to assess long-term skill retention. Additionally, comparative analyses pitting Tiki-Taka protocols directly against other specialized game-centered paradigms, such as Teaching Games for Understanding (TGfU) or isolated rondo variations, will help establish comprehensive, evidence-based training standards for youth soccer development.

Ethics approval

The study was conducted in compliance with the Declaration of Helsinki. Permission to conduct the research was obtained from the management of SSB PSAN Neusu Banda Aceh. Participation in this study was voluntary, and informed consent was obtained from the players and their parents or legal guardians prior to data collection. The participants' identities were kept confidential, and all data were used only for academic and research purposes.

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Competing interests

The author declares that there are no conflicts of interest.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

Declaration of artificial intelligence use

This study used artificial intelligence (AI) tools in the following capacity: manuscript writing support. AI-based language models, including ChatGPT, were employed to assist with language refinement, improvement of grammar, sentence structure, readability, content organization, and technical writing support during manuscript preparation.

The AI tools were not used for data collection, statistical analysis, hypothesis testing, or interpretation of the original research data. All statistical results, including descriptive statistics, normality testing, Wilcoxon Signed Rank Test, and Independent Samples t-test, were derived from the research data prepared by the author.

The authors confirm that all AI-assisted processes were critically reviewed to ensure the integrity, accuracy, and reliability of the manuscript. The final decisions, interpretations, arguments, and conclusions presented in this article were solely made by the authors.

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