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IMPROVING T-KICK ACCURACY IN PENCAK SILAT THROUGH ROPE LIMITER FOCUSED TRAINING: A TRAUMA-FREE APPROACH FOR BEGINNER STUDENTS

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ABSTRACT

This study examined the effectiveness of a focused training method using a rope barrier on the accuracy of T-kicks and training safety among beginner pencak silat students. The research was motivated by two common problems in beginner training, namely limited kicking accuracy and the risk of injury caused by the use of rigid training equipment. The study employed a quantitative approach with a quasi-experimental nonequivalent control group design. A total of 111 elementary school students participated in the study, consisting of 57 students in the experimental group and 54 students in the control group. The experimental group received focused training using a rope barrier, whereas the control group trained using chair-based media. T-kick accuracy was measured using a 5-point biomechanical assessment rubric that included stance position, kick trajectory, body balance, target accuracy, and follow-through movement. The collected data were analyzed using the Wilcoxon Signed Rank Test and Mann-Whitney U Test. The findings showed that both groups experienced significant improvement after the training program (experimental group: $p < 0.001$; control group: $p < 0.001$). However, no significant difference was found between the two groups ($p = 0.994$), indicating that both training methods produced comparable outcomes in improving T-kick accuracy. Even so, the rope barrier provided a safer and more flexible training environment because it reduced the risk of physical impact compared with rigid chair media. In conclusion, the rope barrier can be used as an alternative training medium that is simple, affordable, and safer for beginner-level pencak silat learning at the elementary school level.

Keyword: injury prevention, motor learning, pencak silat, rope limiter, focused training method, T-kick accuracy

INTRODUCTION

Pencak silat has evolved beyond its identity as a traditional Indonesian martial art into an internationally recognized competitive sport with standardized rules, scoring systems, and biomechanical performance demands. Since its inscription on the UNESCO Representative List of the Intangible Cultural Heritage of Humanity, pencak silat has increasingly been positioned within the global sport science framework as a combat sport requiring high levels of technical precision, tactical efficiency, and movement control (UNESCO, 2019). In modern competition settings, scoring success is strongly influenced by athletes' ability to execute accurate and efficient attack techniques under dynamic movement conditions. Consequently, technical mastery in pencak silat is no longer viewed solely as cultural preservation, but as a performance-

oriented competency closely related to biomechanical efficiency, neuromuscular coordination, and motor learning adaptation.

Among the various attack techniques used in pencak silat competitions, the T-kick represents one of the most strategic scoring tools because it enables athletes to generate direct points through fast lateral movement, broad attack reach, and difficult defensive anticipation. The execution of the T-kick requires simultaneous coordination between balance stabilization, lower limb trajectory control, hip rotation, body alignment, and contact precision during dynamic motion transitions. Biomechanical studies in combat sports indicate that successful kicking performance depends on the integration of movement speed and target accuracy under complex motor coordination demands (Wąsik et al., 2021). In martial arts performance, movement precision is strongly associated with proprioceptive control, postural stability, and repeated neuromuscular adaptation developed through systematic training processes. Furthermore, motor learning research demonstrates that repetitive movement exposure contributes to neural plasticity, enabling learners to refine movement efficiency and coordination through continuous proprioceptive feedback mechanisms (An & Wulf, 2024). Therefore, beginner T-kick training requires structured learning environments capable of simultaneously supporting movement repetition, body stabilization, and accurate movement guidance.

This issue becomes increasingly important in elementary school students because childhood represents a critical developmental period for motor skill acquisition and movement pattern formation. Previous studies have explained that school-age children experience rapid neuromuscular and coordination development, making this phase highly important for establishing fundamental movement skills and long-term motor competence (Messer et al., 2022). During the associative stage of motor learning, learners gradually refine movement quality by reducing errors, improving coordination, and stabilizing movement consistency through repeated corrective feedback. However, many beginner students still experience difficulties in performing accurate T-kicks due to unstable balance, poor inter-limb coordination, limited proprioceptive awareness, and inadequate learning media that fail to provide clear movement references. In addition, fear of injury caused by rigid training equipment may psychologically inhibit students from performing movements confidently, thereby disrupting the motor learning process and limiting movement exploration during practice sessions. Previous research has similarly reported that anxiety, fear of injury, and inadequate practice environments may negatively affect movement confidence and motor performance among beginner learners (Ramamoorthy et al., 2021).

In practical learning environments, teachers commonly use conventional media such as chairs or rigid barriers to guide kick height and movement direction. Although these media are intended to improve movement accuracy, they also create a pedagogical paradox in which efforts to increase technical precision may unintentionally expose students to greater physical and psychological risk. Rigid training objects increase the possibility of accidental collision, fear of impact, and movement hesitation among beginner learners. Such conditions are inconsistent with the concept of a trauma-free training environment, which emphasizes psychological safety and adaptive movement exploration during early motor learning stages. Recent global discussions in combat sport pedagogy and injury prevention increasingly emphasize the importance of safer and more adaptive training environments, particularly for children and novice athletes (Kirk et al., 2024). Injury prevention has become a major concern in martial arts because repetitive impact exposure and unsafe training conditions significantly contribute to training-related injuries among beginner practitioners (Virghani et al., 2025). Therefore, learning media should not only function as movement guides for technical accuracy, but also as safety-oriented tools capable of minimizing collision risk during repetitive kicking practice.

From a motor learning perspective, training media play an essential scientific role because they function as external task constraints capable of shaping learners' movement adaptation and attentional focus. According to the ecological dynamics approach, motor skill acquisition emerges through continuous interaction between the learner, the task, and the environment (Heuvelmans et al., 2024). Within this framework, movement boundaries or visual constraints help learners self-organize movement solutions more effectively by directing

attention toward external targets and environmental cues. This mechanism aligns with the concept of external focus of attention, where learners achieve more stable and efficient movement performance when concentration is directed toward movement outcomes rather than internal body mechanics alone. Recent studies demonstrated that external attentional focus significantly enhances movement automaticity, performance consistency, and motor learning effectiveness in sports contexts (Mohammadi Sanjani et al., 2023). Therefore, movement-limiting media may contribute not only to technical correction, but also to improved perceptual-motor adaptation during skill acquisition.

Previous studies reported that focused and repetitive training significantly improves technical mastery in pencak silat, particularly among beginner athletes (Satria et al., 2022). Similarly, movement-limiting training media improve kick direction understanding and movement consistency during basic technique practice (Dimas Abdulrahman, Edi Purnomo, 2021). However, existing studies predominantly focus on technical performance outcomes without simultaneously examining the safety implications of movement restriction media in beginner training contexts. In addition, conventional movement barriers used in previous training methods were generally rigid objects that may increase impact risk during repetitive kicking exercises. This indicates a clear research gap regarding the development of training media that are simultaneously effective for improving movement accuracy and adaptive for injury prevention among beginner learners. Mechanically, the rope limiter differs from other flexible training media because it provides adjustable spatial constraints while simultaneously minimizing rigid-body impact forces during repeated kicking movements. Unlike foam barriers or elastic pads that still generate direct rebound forces upon contact, the rope limiter functions primarily as a visual-spatial guide with minimal collision resistance, allowing learners to maintain movement exploration with lower psychological and biomechanical risk.

Based on these considerations, the present study proposes the use of a rope limiter as an alternative focused training medium for improving T-kick accuracy among beginner elementary school students. Unlike rigid conventional barriers, the rope limiter functions simultaneously as a task constraint for directing movement trajectory and as a safety guard for minimizing impact-related injury risk during repetitive practice. The flexibility of the rope creates a more adaptive, low-cost, and psychologically safer training environment while still maintaining movement guidance functions necessary for motor learning optimization. Therefore, this study aims to analyze the effect of focused training using a rope limiter on T-kick accuracy in pencak silat and to examine its practical implications as a functional-equivalent yet safer alternative to conventional training media in elementary-level martial arts instruction.

METHOD

This study employed a quantitative approach using a quasi-experimental method with a nonequivalent control group design. The design was selected because the research was conducted in a natural school setting where random assignment of students into groups was not possible due to existing classroom structures. The nonequivalent control group design is commonly applied in educational and school-based intervention research where random assignment is difficult to implement under natural classroom conditions (Creswell & Creswell, 2017). Methodologically, this design enabled the researchers to evaluate the effectiveness of the focused training method using a rope limiter as an intervention for improving T-kick accuracy while maintaining the ecological validity of the school learning environment. The design also allowed comparison between an experimental group receiving rope-limiter-based focused training and a control group receiving conventional chair-based training. The study was conducted from January to February 2026 during the extracurricular pencak silat training program at Margamukti Elementary School, Sumedang Regency.

The population consisted of all fifth- and sixth-grade students participating in beginner-level pencak silat extracurricular activities. Saturated sampling was employed, resulting in a total sample of 111 students consisting of 57 students in the experimental group and 54 students in the control group. Fifth-grade students were assigned to the experimental group, while sixth-grade students were assigned to the control group. Considering the potential risk of biological

maturation bias between grade levels, several mitigation procedures were implemented. Previous studies have reported that differences in biological maturation among school-age children may influence motor coordination, physical performance, and movement skill development, thereby potentially affecting the comparability of experimental groups in youth-based physical education research (Kim et al., 2021). First, all participants were classified as beginner practitioners who had never participated in professional pencak silat clubs or formal martial arts competitions. Second, baseline equivalence was examined through pretest analysis, which demonstrated relatively homogeneous initial T-kick accuracy scores between groups. Third, all participants trained under similar environmental conditions, training schedules, and instructional supervision to minimize external variability affecting motor performance.

The inclusion criteria were: (1) students aged 10–12 years, (2) physically healthy and able to participate in physical activity, (3) registered as active extracurricular pencak silat participants, and (4) not involved in external professional martial arts training programs. Exclusion criteria included: (1) students who experienced musculoskeletal injuries during the intervention period, (2) students absent for more than two intervention sessions, and (3) students who did not complete either the pretest or posttest assessment. Gender distribution was also documented because motor development characteristics in school-age children may differ between males and females. Previous studies have shown that biological and developmental differences between boys and girls may influence motor coordination, movement performance, and physical activity patterns during childhood and early adolescence (Barnett et al., 2022). The experimental group consisted of 31 male and 26 female students, while the control group consisted of 29 male and 25 female students.

The independent variable in this study was the focused training method using a rope limiter, while the dependent variable was T-kick accuracy in pencak silat. In this study, accuracy was operationally defined as the biomechanical correctness and movement precision demonstrated during T-kick execution, rather than solely target impact success. Accuracy assessment referred to movement quality indicators adapted from biomechanical movement analysis in martial arts, including the initial stance phase, body alignment and kick trajectory, balance stability, target-contact precision, and follow-through movement (Pratama & Candra, 2021). Assessment was conducted using a 5-point biomechanical rubric scale ranging from 1 (very poor execution) to 5 (excellent execution) for each movement component (Info, 2021).

The instrument validation process involved expert judgment from three specialists consisting of one sports biomechanics lecturer, one pencak silat coach licensed by IPSI, and one physical education assessment expert. Content validity was analyzed using Aiken's V coefficient, resulting in values ranging from 0.82 to 0.91 across all instrument components, indicating high content validity. Inter-rater reliability was examined using Cohen's Kappa coefficient involving two trained assessors, resulting in a reliability coefficient of $\kappa = 0.87$, categorized as "almost perfect agreement."

Data collection was conducted through direct observation and video-based analysis during pretest and posttest sessions. Video recording was performed using a smartphone camera with 1080p Full HD resolution at 60 frames per second positioned laterally at a distance of approximately 3 meters from the kicking area. Video-based assessment was employed to improve observational consistency and facilitate repeated movement analysis during scoring procedures. Previous studies indicate that video-based visual feedback and observational analysis improve the accuracy, reliability, and consistency of motor skill assessment in physical education and sports performance contexts (Chen et al., 2026).

The intervention program consisted of six training sessions conducted over three weeks with a frequency of two sessions per week. Each session lasted approximately 60 minutes, including warm-up, core training drills, and cooldown phases. The experimental group performed focused T-kick drills using a rope limiter as a movement boundary, while the control group used chair-based barriers as conventional training media. To ensure equivalence between groups, chair height in the control group was adjusted to correspond with the average rope height used in the experimental group. Both groups received identical training volume, movement repetitions, and instructional duration.

Session	Warm-up (10 min)	Core Drill (40 min)	Sets × Repetitions	Interval	Cooldown (10 min)
1	Dynamic stretching and mobility	Introduction to T-kick mechanics	3 × 8	60 sec	Static stretching
2	Dynamic movement drills	Balance and trajectory training	3 × 10	60 sec	Breathing exercises
3	Coordination drills	Focused T-kick practice using rope limiter/chair barrier	4 × 8	90 sec	Flexibility training
4	Agility warm-up	Repetitive directional T-kick practice	4 × 10	90 sec	Muscle relaxation
5	Dynamic balance exercises	Accuracy and follow-through drills	4 × 10	90 sec	Static stretching
6	Combined mobility drills	Integrated T-kick performance practice	5 × 8	120 sec	Recovery exercises

Table 1. Focused Training Program Structure

Safety observation procedures were implemented throughout the intervention period because injury prevention constituted one of the major focuses of the study. Researchers recorded all accidental collisions, unsafe movement incidents, and complaints of physical discomfort occurring during training sessions using structured observation sheets. The rope limiter was specifically selected because its flexible material minimized direct physical impact risk compared to rigid chair-based barriers.

This study received approval from the school administration and extracurricular sports coordinator. Written informed consent was obtained from parents or legal guardians before participants were involved in the study. All procedures were conducted in accordance with ethical principles for research involving children and educational participants.

Descriptive and inferential statistical analyses were conducted using IBM SPSS Statistics version 26 with a significance level of $\alpha = 0.05$. Prior to hypothesis testing, data normality was examined using both Kolmogorov-Smirnov and Shapiro-Wilk tests. Because the data distribution was not normal, non-parametric statistical analyses were employed. The Wilcoxon Signed Rank Test was used to examine within-group differences between pretest and posttest scores, while the Mann-Whitney U Test was used to analyze differences in gain scores between the experimental and control groups.

RESULTS

This study involved 111 elementary school students consisting of 57 students in the experimental group and 54 students in the control group. The experimental group received focused training using a rope limiter, while the control group participated in conventional chair-based training. Data were obtained through pretest and posttest assessments to evaluate changes in T-kick accuracy following the intervention period.

Prior to hypothesis testing, normality analysis was conducted using both the Kolmogorov-Smirnov and Shapiro-Wilk tests. The results indicated that several significance values were below 0.05, demonstrating that the data were not normally distributed. Therefore, non-parametric statistical procedures were applied for subsequent analyses.

Variable	Test	Statistic	df	Sig.
Experimental Pretest	Kolmogorov-Smirnov	0.178	57	0.000
Experimental Pretest	Shapiro-Wilk	0.901	57	0.001
Experimental Posttest	Kolmogorov-Smirnov	0.194	57	0.000

Experimental Posttest	Shapiro-Wilk	0.887	57	0.000
Control Pretest	Kolmogorov-Smirnov	0.169	54	0.001
Control Pretest	Shapiro-Wilk	0.912	54	0.002
Control Posttest	Kolmogorov-Smirnov	0.187	54	0.000
Control Posttest	Shapiro-Wilk	0.894	54	0.001

Table 2. Normality Test Results

The descriptive statistical analysis showed that the mean score increased from 3.07 in the pretest to 4.14 in the posttest, indicating improved T-kick accuracy after the intervention. In addition, the standard deviation values indicated more consistent movement performance following the training sessions.



Figure 1. Focused T-Kick Training Using Rope Limiter Media



Figure 2. Conventional Chair-Based Barrier Training During T-Kick Practice

Variable	N	Min	Max	Mean	Std. Deviation	Std. Error	Variance
Pretest	111	2	4	3.07	0.599	0.057	0.359
Posttest	111	3	5	4.14	0.681	0.065	0.464

Table 3. Descriptive Statistics of Pretest and Posttest Scores

Both groups demonstrated improvement in posttest scores following the intervention. The experimental group showed a slightly higher gain score compared to the control group, although both groups experienced similar patterns of improvement.

Group	Pretest Mean	Posttest Mean	Gain Mean	Std. Error	Variance
Experimental	3.09	4.16	1.07	0.072	0.381
Control	3.06	4.11	1.05	0.069	0.364

Table 4. Mean Scores by Group

To provide a clearer illustration of score improvement distribution among students, frequency distribution analysis was conducted to identify shifts in score categories between the pretest and posttest assessments.

Score	Pretest Frequency	Posttest Frequency
2	24	0
3	55	18
4	32	59
5	0	34

Table 5. Frequency Distribution of T-Kick Accuracy Scores

The frequency distribution results showed that students who initially obtained lower scores during the pretest shifted toward higher score categories in the posttest assessment. This finding indicates measurable improvement in T-kick performance following the intervention program. The results of the Wilcoxon Signed Rank Test showed that both groups experienced significant improvement in T-kick accuracy after the intervention.

Group	Z	Sig. (2-tailed)	Interpretation
Experimental	-6.688	0.000	Significant Improvement
Control	-6.364	0.000	Significant Improvement

Table 6. Wilcoxon Signed Rank Test Results

These findings indicate that both focused training using a rope limiter and conventional chair-based training were effective in improving T-kick accuracy. The consistent improvement in both groups supports the repetitive practice theory in motor learning, which explains that repeated and structured movement execution enhances neuromuscular coordination, movement consistency, and skill stabilization during the learning process. The Mann-Whitney U Test results showed no significant difference between the experimental and control groups.

Variable	Mean Rank Experimental	Mean Rank Control	Sig. (2-tailed)	Interpretation
Gain Score	55.98	56.02	0.994	No Significant Difference

Table 7. Mann-Whitney U Test Results

The results indicate that both training methods demonstrated functionally equivalent effectiveness in improving T-kick accuracy among beginner students. Considering that safety was one of the primary concerns highlighted in this study, safety observations were also conducted during the intervention sessions to identify collision incidents, physical discomfort, and movement hesitation during training activities.

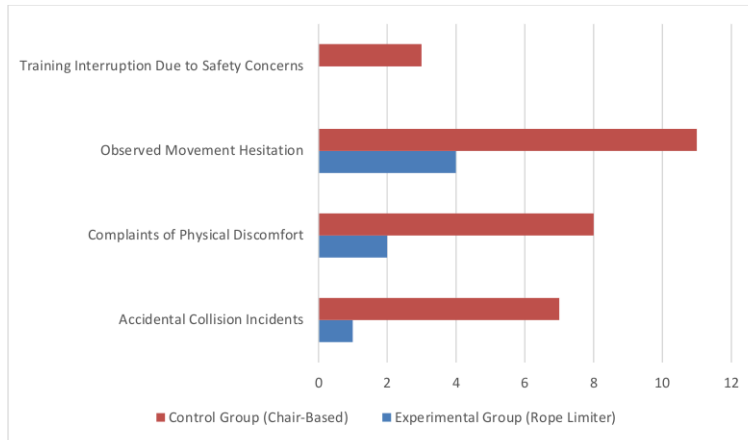


Figure 3. Safety Observation Results During Intervention

The safety observation results showed that the rope limiter created a safer training environment compared to the rigid chair-based media. The experimental group experienced fewer collision incidents, lower complaints of physical discomfort, and fewer movement hesitations during training sessions. These findings support the use of rope limiter media as a safer alternative for beginner-level T-kick training.

DISCUSSION

The findings of this study indicate that both focused training using a rope limiter and conventional chair-based training were effective in improving T-kick accuracy among elementary school students. However, the most important finding was related not only to technical improvement but also to the creation of a trauma-free training environment through the use of rope limiter media. The lower number of collision incidents, physical discomfort complaints, and movement hesitation observed in the experimental group demonstrated that flexible training media may reduce injury risk during beginner-level martial arts practice. This finding is relevant to current international concerns regarding injury prevention in combat sports and martial arts training environments. This finding aligns with previous research showing that collision- and impact-related injuries remain common in pencak silat training and competition, especially among beginner and adolescent athletes (Virghani et al., 2025). Therefore, the use of adaptive and low-impact training media may contribute to safer learning environments during early motor skill acquisition.

The safer training environment produced by the rope limiter may also have influenced students' psychological responses during practice sessions. Flexible media tend to reduce fear of impact and movement hesitation compared to rigid chair-based media. In beginner learners, fear of injury may interfere with confidence, movement exploration, and motor adaptation during skill acquisition (Blomqvist Mickelsson & Stylin, 2021). The lower hesitation frequency observed in the experimental group suggests that students were more willing to execute repeated kicking movements without excessive concern regarding collision risk. This condition supports the associative phase of motor learning, in which learners gradually refine movement efficiency and coordination through repeated corrective practice (Tassinon et al., 2021).

The improvement in T-kick accuracy observed in both groups supports the repetitive practice theory in motor learning. Repeated movement execution during the six intervention sessions likely contributed to neuromuscular adaptation and motor stabilization processes. Contemporary neuroscience studies explain that repetitive motor practice stimulates neural plasticity involving structural and functional adaptation within motor-related neural pathways. Continuous movement repetition strengthens sensory-motor integration and contributes to motor memory consolidation during skill acquisition (Azzarito et al., 2023).

The consistent improvement pattern observed in both groups may also be explained through proprioceptive feedback mechanisms. During repetitive kicking practice, students continuously received body-position feedback related to balance control, kicking trajectory, postural alignment, and target orientation. This repeated sensory feedback likely contributed to better movement consistency and kicking precision. The rope limiter provided a clearer spatial reference that helped students stabilize movement direction and body positioning during practice sessions. Stable proprioceptive feedback has been widely associated with improved coordination and adaptive motor control during motor learning activities (Mulloney et al., 2014).

Another important aspect of the rope limiter intervention relates to the concept of external focus of attention. The rope limiter encouraged students to focus on external movement targets rather than concentrating excessively on internal leg mechanics. Previous international studies consistently reported that external focus facilitates movement efficiency, balance control, motor performance, and skill acquisition more effectively than internal focus strategies. The rope limiter functioned as an external visual guide that helped students maintain kicking direction and target orientation during repeated practice sessions (Grgic et al., 2021).

Although the experimental group demonstrated a slightly higher gain score compared to the control group, the statistical analysis indicated statistical equivalence between both methods. Therefore, the findings should not be interpreted as evidence of failure for the rope limiter intervention. Instead, the results demonstrate that rope limiter media were equally effective compared to conventional chair-based methods in improving T-kick accuracy among beginner students. This finding is pedagogically important because the rope limiter simultaneously demonstrated equivalent functional outcomes while providing a safer training environment. Previous studies explained that the use of structured training media and guided movement practice can improve motor learning quality, movement accuracy, and learning safety among beginner students (Ramamoorthy et al., 2021).

The similarity of improvement outcomes between groups may also be influenced by equal practice volume during the intervention process. Both groups received the same number of sessions, exercise duration, repetitions, and instructional exposure. Consequently, practice volume itself may have become the dominant factor contributing to motor improvement rather than the media difference alone. Repeated exposure to similar movement patterns likely strengthened movement familiarity, coordination stability, and motor adaptation in both groups (Kweon et al., 2023).

The absence of negative ranks in the Wilcoxon analysis also represents an important pedagogical finding. No students experienced decreased performance following the intervention process, indicating that both training methods consistently supported skill improvement without negatively affecting movement performance. This finding strengthens the interpretation that the intervention procedures were adaptive and safe for beginner-level learners. Previous research on motor adaptation similarly reported that repetitive and progressive movement practice generally improves movement stability and reduces performance decline during learning phases (Bhatt et al., 2023).

Despite the positive findings, several factors should be interpreted cautiously. The posttest mean scores approached the upper limit of the assessment scale, indicating the possibility of a ceiling effect within the measurement instrument. Because the maximum score was limited to five points, the instrument may have become less sensitive in distinguishing higher-level movement improvements after repeated practice sessions. Future studies may therefore require more complex biomechanical assessment indicators to capture advanced performance variation more accurately. Previous measurement studies explained that ceiling

effects may reduce instrument sensitivity when participants achieve scores near the maximum assessment limit (Forero et al., 2023).

Several uncontrolled variables may also have influenced the results of this study. Factors such as student motivation, lower limb muscle strength, physical fitness, and previous movement experience were not statistically measured during the intervention process. Therefore, interpretations regarding these factors should remain cautious because their contribution to T-kick improvement cannot be empirically confirmed within the present study. Previous studies in motor performance and physical conditioning emphasized that muscular strength, physical fitness, and previous movement experience may substantially influence motor adaptation and skill performance outcomes (Park & Jeong, 2023).

Another limitation concerns the use of fifth-grade students as the experimental group and sixth-grade students as the control group. Although preliminary homogeneity testing indicated relatively similar baseline characteristics, biological maturation differences between grade levels may still introduce potential bias in motor coordination readiness and physical development. Nevertheless, the relatively homogeneous baseline characteristics and consistent improvement patterns observed in both groups contributed to the reliability and stability of the study findings. Previous developmental studies reported that maturation and age differences may influence coordination readiness, movement adaptation, and motor performance outcomes among school-age children (Purohit et al., 2023).

This study also has broader practical implications for physical education and martial arts learning contexts. The rope limiter represents a low-cost, scalable, and accessible instructional medium that can be implemented in elementary school environments with limited facilities. From a global educational perspective, flexible and safer training media may support inclusive sports participation while reducing injury risk among beginner learners. Such approaches align with international educational trends emphasizing child-friendly learning environments and injury prevention strategies in youth sports and martial arts education (Ghaderi et al., 2021).

Finally, future research should examine long-term motor retention following rope limiter interventions. Retention testing conducted several weeks or months after training would help determine whether the observed improvements represent temporary performance adaptation or permanent motor memory consolidation. Future studies are also encouraged to involve larger participant samples, biomechanical motion analysis, and more sensitive movement assessment instruments to strengthen the generalizability of findings.

CONCLUSION

This study demonstrated that focused training using a rope limiter and conventional chair-based training were both effective in improving T-kick accuracy among elementary school students. The Wilcoxon analysis showed significant improvement in both groups ($p < 0.001$), indicating that repeated and structured practice contributed positively to motor skill development during the intervention process. Furthermore, the Mann-Whitney analysis demonstrated functional equivalence between both training methods, suggesting that the rope limiter produced comparable effectiveness to conventional chair-based media in improving T-kick accuracy.

The findings of this study contribute to the development of physical education and martial arts pedagogy by demonstrating that flexible training media can simultaneously support performance improvement and injury prevention in beginner-level learning environments. The rope limiter was not only identified as a safer training medium, but also as a practical solution to the safety-performance dilemma frequently encountered in martial arts instruction, particularly among elementary school students. The lower incidence of collisions, physical discomfort, and movement hesitation observed during the intervention further supports the use of rope limiter media as a trauma-free training alternative for beginner learners.

From a practical perspective, the rope limiter also offers low-cost and easily accessible implementation for schools with limited sports facilities and equipment. Therefore, physical

education teachers and martial arts instructors are encouraged to utilize flexible and adaptive training media that can maintain movement accuracy while minimizing injury risk during practice sessions. The use of rope limiter media may also support more inclusive and psychologically safe learning environments for children during motor skill acquisition.

Despite the positive findings, this study still has several limitations. The intervention was conducted within a relatively short duration and involved a limited participant scope from specific grade levels. Future studies are therefore recommended to conduct long-term retention tests to evaluate the permanence of motor memory following rope limiter interventions. Further research involving larger sample sizes, biomechanical motion analysis, and broader participant characteristics is also necessary to strengthen the generalizability and scientific contribution of rope limiter-based training methods in physical education and martial arts learning contexts.

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