Effects of an eight-week TPSR-based martial arts intervention on movement competency, mental toughness, and injury-prevention behavior in adolescent athletes

Efectos de una intervención de artes marciales basada en TPSR de ocho semanas sobre la competencia motriz, la dureza mental y las conductas de prevención de lesiones en atletas adolescentes

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Abstract

Introduction: Movement competency, mental toughness, and injury-prevention behavior are important for performance and well-being in adolescent martial arts athletes, yet evidence from school-based interventions remains limited.
Objective: This study aimed to evaluate the effects of an eight-week Teaching Personal and Social Responsibility (TPSR)-based martial arts intervention on movement competency, mental toughness, and injury-prevention behavior among high school athletes in Aceh, Indonesia.
Methodology: A pretest-posttest control group experimental design was conducted with 50 athletes aged 15–17 years. Participants were randomly assigned to an experimental group (n = 25) or a control group (n = 25). The experimental group received a TPSR-integrated martial arts program for eight weeks, whereas the control group continued conventional training. Outcomes were measured using the Movement Competency Screen, the Sports Mental Toughness Questionnaire, and an injury-prevention behavior questionnaire. Paired-samples and independent-samples t tests were applied, and effect sizes were calculated.
Results: The experimental group showed significant improvements in all variables (all $p < 0.001$), whereas the control group showed no significant changes. Posttest comparisons favored the experimental group (all $p < 0.01$), with moderate-to-large effect sizes (Cohen's $d = 0.72–0.85$). Positive correlations were also found among the three variables.
Discussion: TPSR-based martial arts instruction appears to support physical, psychological, and safety-related development in adolescent athletes.
Conclusions: An eight-week TPSR-based intervention improved movement competency, mental toughness, and injury-prevention behavior, supporting its integration into school-based martial arts programs.

Keywords

Injury prevention; martial arts; mental toughness; movement competency; personal and social responsibility.

Resumen

Introducción: La competencia motriz, la dureza mental y las conductas de prevención de lesiones son importantes para el rendimiento y bienestar de atletas adolescentes de artes marciales, aunque la evidencia escolar aún es limitada.
Objetivo: Evaluar los efectos de una intervención de artes marciales de ocho semanas basada en la Enseñanza de la Responsabilidad Personal y Social (TPSR) sobre esas variables en atletas de secundaria de Aceh, Indonesia.
Metodología: Se utilizó un diseño experimental pretest-postest con grupo control en 50 atletas de 15 a 17 años, asignados aleatoriamente a un grupo experimental (n = 25) y a un grupo control (n = 25). El grupo experimental recibió un programa de artes marciales con TPSR durante ocho semanas; el control continuó con el entrenamiento convencional. Se aplicaron el Movement Competency Screen, el Sports Mental Toughness Questionnaire y un cuestionario de prevención de lesiones. Se realizaron pruebas t y se calcularon tamaños del efecto.
Resultados: El grupo experimental mejoró significativamente en todas las variables ($p < 0.001$), mientras que el grupo control no mostró cambios significativos. Las comparaciones postest favorecieron al grupo experimental ($p < 0.01$), con tamaños del efecto moderados a grandes ($d = 0.72–0.85$). También hubo correlaciones positivas entre las variables.
Discusión: El enfoque TPSR puede fortalecer el desarrollo físico, psicológico y la seguridad deportiva.
Conclusiones: La intervención mejoró la competencia motriz, la dureza mental y las conductas de prevención de lesiones, respaldando su incorporación en programas escolares de artes marciales.

Palabras clave

Prevención de lesiones; artes marciales; dureza mental; competencia motriz; responsabilidad personal y social.

Introduction

Education in physical culture is not limited to improving physical performance; it also seeks to cultivate self-discipline, resilience, and moral strength through purposeful movement experiences (Hulteen et al., 2018; Kraus et al., 2014a). In martial arts pedagogy, these educational dimensions are expressed through the integration of movement competency, injury-prevention awareness, and mental toughness, which together form a holistic framework of psychophysical development (Read et al., 2016). Martial arts emphasize harmony between body and mind, discipline, respect, self-regulation, and character formation, which align closely with the broader goals of physical culture education (Aguilar et al., 2023; Bennett et al., 2022; Kraus, 2018).

Movement competency refers to the ability to perform fundamental movement patterns with stability, control, and efficiency (Jimenez-Garcia et al., 2023; Prieske et al., 2016). It is closely linked to physical literacy and motor learning and is associated with reduced injury risk when movement quality is adequate (Kraus et al., 2014b; Read et al., 2016). Conversely, poor movement patterns—such as asymmetrical squats, unstable lunges, or limited shoulder mobility—can increase biomechanical stress and elevate the likelihood of injury (Turner & Comfort, 2022). For this reason, systematic movement screening and corrective training are increasingly viewed as essential components of safe and effective athlete development (Bennett et al., 2022; Turner & Comfort, 2022).

Mental toughness describes an individual's capacity to sustain focus, motivation, and emotional control under physical and psychological pressure (Akbar et al., 2024; Moore et al., 2019; Mulyana & Lutan, 2020). In martial arts, where training frequently involves discomfort, fatigue, and competitive demands, mental toughness is a key determinant of performance consistency and sustained participation (Moore et al., 2019). It commonly includes self-belief, commitment to goals, and the ability to recover from setbacks—qualities that are central to both sporting success and educational outcomes in physical culture (Jimenez-Garcia et al., 2023; Tropin et al., 2023).

Many school-based martial arts programs remain strongly oriented toward technical performance and competition outcomes, whereas recent evidence suggests that martial arts instruction can also support psychosocial development, resilience, physical fitness, and responsible participation when delivered through structured educational approaches (Moore et al., 2021; Prieske et al., 2016). Experimental evidence from school-based martial arts interventions indicates that martial arts training can contribute to resilience, psychosocial functioning, and mental health-related outcomes among school-aged participants (Moore et al., 2019, 2021; Pinto-Escalona et al., 2021), which provides limited evidence about instructional approaches capable of simultaneously improving movement quality, mental toughness, and injury-prevention behavior. Experimental research that integrates movement screening with responsibility-centered pedagogy in Indonesian adolescent martial arts settings therefore remains scarce.

To address this gap, the present study applies an experimental pedagogical intervention that integrates the Movement Competency Screen framework with mental skills education informed by martial arts practice. The program combines corrective movement tasks with structured reflection, breathing control, and goal-setting activities to strengthen both physical control and psychological readiness for safe participation. This integrated approach positions movement quality not only as a physical outcome, but also as a teachable responsibility linked to self-regulation and injury-prevention behavior.

Previous international research has shown that movement-oriented and psychosocially structured sport programs can improve functional movement quality, self-regulation, and health-related behaviors in young athletes; however, these outcomes are often examined separately rather than within a single integrated pedagogical framework. In martial arts settings, the combination of technical discipline, reflective practice, and responsibility-based learning provides a strong foundation for simultaneously developing movement competency, mental toughness, and safer participation habits. Nevertheless, experimental evidence testing these dimensions together in adolescent school-based martial arts remains limited, especially in contexts where instructional practice is still primarily performance-oriented.

Accordingly, this study aimed to evaluate the effects of an eight-week Teaching Personal and Social Responsibility (TPSR)-based martial arts intervention on movement competency, mental toughness, and injury-prevention behavior among high school martial arts athletes in Aceh, Indonesia. By integrating motor learning, psychosocial development, and safety-oriented practice within a single instructional

model, the study sought to support a more holistic and educationally grounded approach to adolescent martial arts training.

Based on the theoretical rationale and prior evidence, this study hypothesized that athletes who participated in the eight-week TPSR-based martial arts intervention would demonstrate greater post-intervention gains in movement competency, mental toughness, and injury-prevention behavior than those who received conventional training. In addition, positive associations were expected among movement competency, mental toughness, and injury-prevention behavior.

Method

Participants

The study was conducted with 50 adolescent martial arts athletes aged 15–17 years (M = 16.2, SD = 0.7) from SMA Keberbakatan Olahraga Negeri Aceh, Indonesia. All participants were enrolled in the school martial arts program and had at least one year of formal training experience. Participants were randomly allocated into an experimental group (n = 25) and a control group (n = 25). The experimental group consisted of 9 males and 16 females, whereas the control group consisted of 18 males and 7 females. The experimental group received an eight-week pedagogical intervention integrating movement competency education, injury-prevention training, and mental toughness development within martial arts practice, whereas the control group continued conventional training focused on technical drills, sparring, and physical conditioning without structured pedagogical reflection or guided psychological skills activities.

Sample size was determined a priori using G*Power 3.1.9.7 for a repeated-measures design (medium effect size f = 0.25, α = 0.05, power = 0.80). The analysis indicated that at least 24 participants per group were required, supporting the adequacy of the final sample. All participants were reported as injury-free during the intervention period. Written informed consent was obtained from all students and their parents or legal guardians prior to data collection. Ethical approval for this study was granted by the relevant institutional review body (No. 010/LPPM/UN.II.05/2025). Written informed consent was obtained from all students and their parents or legal guardians prior to data collection. The study was conducted in accordance with accepted ethical standards for research involving human participants, including the protection of participant confidentiality and identity, voluntary informed consent, the minimization of physical and psychological risk, and the principles of justice, beneficence, and scientific integrity.

Procedure

Instrument

A quantitative experimental approach with a pretest–posttest control group design was employed (Alessandri et al., 2017; Creswell & Creswell, 2018). Three instruments were used to assess the study outcomes. First, movement competency was measured using the Movement Competency Screen (MCS), which evaluates the quality of fundamental movement patterns relevant to athletic performance and safe participation. The screen included tasks assessing squat, lunge, push-up, pull, brace, and single-leg stability patterns. Each movement task was scored according to execution quality, control, alignment, and stability, with higher scores indicating better movement competency. In the present study, the internal consistency of the MCS was acceptable (Cronbach's α = 0.87).

Second, mental toughness was assessed using the Sports Mental Toughness Questionnaire (SMTQ), which is commonly used to evaluate psychological resilience in sport settings. The SMTQ measures key dimensions of mental toughness, including confidence, constancy, and control. Participants responded to each item using a Likert-type response format, with higher total scores reflecting greater mental toughness. In this study, the SMTQ demonstrated acceptable reliability (Cronbach's α = 0.83).

Third, injury-prevention behavior was measured using a self-report injury-prevention behavior questionnaire designed to assess athletes' adherence to safe training practices. The questionnaire covered behaviors such as performing warm-up routines, applying safe movement technique, monitoring phys-

ical discomfort, reporting pain or minor injuries, and following recovery-related recommendations. Responses were scored on a Likert-type scale, with higher scores indicating stronger adherence to injury-prevention practices. The questionnaire showed acceptable internal consistency in the present sample (Cronbach's α = 0.81).

Before data collection, all instruments were administered in the same order during the pretest and posttest sessions under the supervision of the research team. Instructions were standardized to ensure consistent understanding across participants.

Intervention Program

The intervention was guided by the Teaching Personal and Social Responsibility (TPSR) model and was implemented over eight weeks, with two sessions per week, resulting in a total of 16 instructional sessions. Each session lasted 60 minutes and followed a standardized structure consisting of: (1) introduction and responsibility-based goal setting (10 minutes), (2) movement competency training (25 minutes), (3) injury-prevention exercises (15 minutes), and (4) mental toughness activities with guided reflection (10 minutes).

In the movement competency phase, athletes performed fundamental movement tasks involving squat, lunge, push, pull, rotation, landing, and single-leg stability patterns. These exercises were generally completed in 2–3 sets of 8–12 repetitions, depending on the type and complexity of the movement, with 30–45 seconds of rest between sets. Coaches provided corrective verbal cues emphasizing posture, balance, joint alignment, controlled tempo, and movement symmetry. Exercise difficulty was progressively increased throughout the intervention by increasing repetition volume, reducing base of support, introducing unilateral variations, and adding coordination demands.

The injury-prevention component included balance drills, proprioceptive tasks, controlled landing practice, deceleration technique, and partner-based stability exercises. These activities were typically performed in 2 sets of 6–10 repetitions or 20–30-second holds, depending on task demands. Intensity was maintained at a moderate level to prioritize technical quality, safe execution, and neuromuscular control rather than fatigue.

The mental toughness component consisted of breathing control, short visualization exercises, self-talk prompts, and guided reflection related to perseverance, emotional regulation, responsibility, and attentional focus during training. At the end of each session, students were invited to reflect briefly on how they responded to physical difficulty, corrected movement errors, supported peers, and maintained self-control during practice. These activities were intended to strengthen self-regulation, confidence, and commitment within the martial arts learning process.

TPSR principles were embedded throughout the intervention by emphasizing respect, effort, self-direction, and helping others. Athletes were encouraged not only to complete the drills correctly but also to take responsibility for movement quality, safe participation, and cooperative behavior during training. To ensure implementation consistency, instructors received pre-intervention orientation and were provided with a session guide describing the objectives, activities, and teaching points for each phase. Intervention fidelity was monitored using periodic observation checklists completed by the research team to verify adherence to the planned session structure and TPSR-based instructional approach.

Data analysis

Data were analyzed using SPSS. Assumptions were examined using the Shapiro–Wilk test for normality and Levene's test for homogeneity of variance. Within-group changes from pretest to posttest were tested using paired-samples t tests, and between-group differences at posttest were examined using independent-samples t tests. A Bonferroni adjustment was applied to reduce Type I error due to multiple comparisons. Effect sizes were calculated using Cohen's d (0.2 = small, 0.5 = medium, ≥ 0.8 = large). Statistical significance was set at α = 0.05.

Results

The study involves 50 martial arts athletes aged 15–17 years (M = 16.4, SD = 0.9) from SMA Keberbakatan Olahraga Negeri Aceh, Indonesia. At baseline, the experimental and control groups show comparable levels of movement competency, mental toughness, and injury-prevention behavior. Table 2 presents the mean, standard deviation, and score ranges for each variable at pretest and posttest. The baseline Movement Competency Screen score indicates generally satisfactory fundamental movement patterns, with stronger performance in squat and lunge tasks, while single-leg balance and bend-and-pull actions show weaker control in some athletes. The baseline Sports Mental Toughness Questionnaire score reflects a generally robust psychological profile, with relatively lower ratings observed for emotional control under pressure. Injury-prevention behavior scores indicate good adherence to safety practices, although some athletes report inconsistent injury reporting and recovery monitoring. Assumption testing indicates that the data meet normality requirements ($p > 0.05$), supporting the use of parametric comparisons.

Table 1. Descriptive statistics of movement competency, mental toughness, and injury-prevention behavior (n = 50)

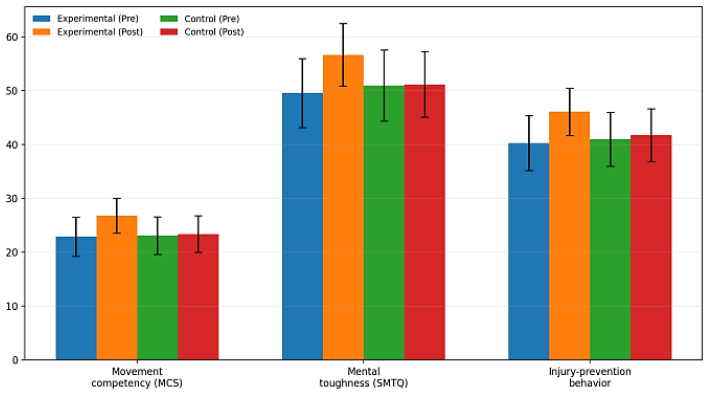
Variable	Group	Time	Mean	SD	Min	Max
Movement Competency (MCS)	Experimental	Pre	22.9	3.6	17	29
		Post	26.8	3.2	20	30
	Control	Pre	23.1	3.5	18	30
		Post	23.4	3.4	18	31
Mental Toughness (SMTQ)	Experimental	Pre	49.6	6.4	38	63
		Post	56.7	5.8	42	65
	Control	Pre	51.0	6.6	39	64
		Post	51.2	6.1	40	63
Injury-Prevention Behavior	Experimental	Pre	40.3	5.1	29	49
		Post	46.1	4.4	33	50
	Control	Pre	41.0	5.0	30	51
		Post	41.8	4.9	31	52

Paired-samples t tests show significant improvements from pretest to posttest in the experimental group across movement competency, mental toughness, and injury-prevention behavior (all $p < 0.001$). In contrast, the control group shows no significant changes across the same outcomes ($p > 0.05$). Table 2 reports the within-group pretest–posttest comparisons, and Figure 1 visually summarizes the pretest–posttest patterns by group across the three outcomes.

Table 2. Paired-samples t test results for pretest–posttest changes

Variable	Group	Pretest (M ± SD)	Posttest (M ± SD)	t	p
Movement Competency (MCS)	Experimental	22.9 ± 3.6	26.8 ± 3.2	7.42	< 0.001
	Control	23.1 ± 3.5	23.4 ± 3.4	0.64	0.525
Mental Toughness (SMTQ)	Experimental	49.6 ± 6.4	56.7 ± 5.8	6.93	< 0.001
	Control	51.0 ± 6.6	51.2 ± 6.1	0.28	0.780
Injury-Prevention Behavior	Experimental	40.3 ± 5.1	46.1 ± 4.4	5.85	< 0.001
	Control	41.0 ± 5.0	41.8 ± 4.9	0.92	0.362

Figure 1. Pretest and posttest outcomes (mean ± SD) for movement competency, mental toughness, and injury-prevention behavior by group.



Source: authors' own elaboration.

Independent-samples t tests on posttest scores indicate significant differences between groups in all outcomes, with the experimental group outperforming the control group (p = 0.001–0.005). Effect sizes indicate moderate-to-large practical significance (Cohen's d = 0.72–0.85). Table 3 reports the posttest comparisons.

Table 3. Posttest independent-samples t test results

Variable	Experimental (M ± SD)	Control (M ± SD)	t	p	Cohen's d
Movement Competency	26.8 ± 3.2	23.1 ± 3.5	3.74	0.001	0.85
Mental Toughness	56.7 ± 5.8	51.2 ± 6.1	2.96	0.005	0.72
Injury Prevention	46.1 ± 4.4	41.8 ± 4.9	3.25	0.002	0.79

Spearman correlation analysis using posttest data shows positive associations among the three constructs. Movement competency correlates strongly with injury-prevention behavior (r = 0.71, p < 0.001), and movement competency correlates moderately with mental toughness (r = 0.56, p < 0.001). Mental toughness also correlates strongly with injury-prevention behavior (r = 0.63, p < 0.001). Table 4 presents the correlation matrix.

Table 4. Correlation matrix among key study variables (posttest)

Variable correlation	r	p	Interpretation
MCS ↔ Injury Prevention	0.71	< 0.001	Strong positive
MCS ↔ Mental Toughness	0.56	< 0.001	Moderate positive
SMTQ ↔ Injury Prevention	0.63	< 0.001	Strong positive

Discussion

This study examines the effects of a Teaching Personal and Social Responsibility (TPSR)-based martial arts intervention on movement competency, mental toughness, and injury-prevention behavior in adolescent athletes. The findings indicate that integrating responsibility-centered pedagogy into school-based martial arts training strengthens physical performance indicators, psychosocial capacities, and safety-related behaviors simultaneously. This integrated pattern supports TPSR as a holistic instructional framework that connects motor learning with self-regulation and responsible participation in sport.

Structured movement screening, corrective feedback, and repeated practice may help young athletes improve movement quality, body control, and functional movement proficiency, which are important for both performance development and injury-risk reduction (Fitton Davies et al., 2022). In martial arts contexts, where technique precision and body alignment are central, responsibility-based learning may strengthen athletes' capacity to monitor and adjust movement patterns, thereby improving functional movement outcomes.

The gains in mental toughness reinforce the psychological value of TPSR-oriented instruction. The intervention appears to strengthen athletes' persistence, confidence, and emotional regulation under demanding training conditions. Responsibility-centered learning is known to support autonomy and self-efficacy in youth physical education settings (Escartí et al., 2018), and these mechanisms are consistent with the current results. The recurring cycle of goal setting, guided reflection, and self-directed practice provides structured opportunities for athletes to develop coping strategies and regulate effort and emotions, which are core elements of mental toughness in performance environments. This interpretation is also consistent with sport psychology perspectives emphasizing that mental toughness involves confidence, control, and sustained commitment in demanding athletic environments (Akbar et al., 2024).

Injury-prevention behavior also improves in the experimental group, indicating that the program influences safety-related habits in addition to physical and psychological outcomes. TPSR emphasizes personal and social responsibility, and this orientation may translate into stronger adherence to warm-up routines, safer technique execution, recovery monitoring, and mutual responsibility for training partners' safety. This finding is consistent with previous research showing that educational and behavior-

focused interventions contribute to reductions in youth sport injury risk (Emery et al., 2015). The present results therefore suggest that responsibility-centered pedagogy does not only shape attitudes but also supports practical behavioral routines that improve safe sport participation.

In addition to statistical significance, the posttest effect sizes indicated moderate-to-large practical effects across the three outcomes (Cohen's d = 0.72–0.85). This pattern suggests that the intervention was not only statistically effective but also educationally meaningful in a school-based martial arts context. The magnitude of these effects supports the practical value of integrating responsibility-centered pedagogy with movement competency training, particularly when the aim is to improve physical, psychological, and safety-related outcomes simultaneously.

The correlational findings further support an interconnected model of development, in which motor, psychological, and behavioral domains reinforce one another during adolescent sport participation. The strong positive association between movement competency and injury-prevention behavior suggests that athletes with better control, stability, and movement awareness may also be more likely to adopt safer training habits. Likewise, the positive relationship between mental toughness and injury-prevention behavior indicates that athletes with stronger self-regulation, commitment, and emotional control may be more consistent in following preventive routines. The moderate association between movement competency and mental toughness also suggests that physical control and psychological resilience may develop in parallel within structured and reflective training environments. These findings should be interpreted as relational rather than causal; however, they are consistent with the view that holistic pedagogical models can simultaneously support movement quality, psychological readiness, and responsible sport behavior.

This practical implication aligns with TPSR-based physical education literature, which positions responsibility-centered instruction as a pedagogical approach for promoting personal responsibility, social responsibility, motivation, and positive youth development through structured physical activity contexts (Pozo et al., 2018). This practical implication is also in line with previous educational perspectives that position combat sports and martial arts as meaningful contexts for responsibility, discipline, and character development (Aguilar et al., 2023).

A notable strength of this study is its integration of movement competency, mental toughness, and injury-prevention behavior within a single instructional intervention, rather than examining these outcomes in isolation. Another strength is the use of an experimental pretest–posttest control group design, which provided stronger evidence of intervention-related change than descriptive or correlational approaches alone. In addition, the study contributes context-specific evidence from adolescent martial arts athletes in Indonesia, a population that remains underrepresented in intervention-based sport pedagogy research.

Several limitations should be considered when interpreting these findings. The sample was drawn from a single school-based martial arts context, which may limit broader generalizability. The intervention duration was restricted to eight weeks, so the long-term maintenance of gains remains unclear. In addition, injury-prevention behavior was assessed through self-report, which may be influenced by response bias. Future studies should include larger multi-site samples, longer follow-up periods, and more objective indicators such as observational measures of preventive behavior or actual injury incidence.

Conclusions

This study showed that an eight-week TPSR-based martial arts intervention significantly improved movement competency, mental toughness, and injury-prevention behavior among high school athletes in Aceh, Indonesia, whereas the control group showed no meaningful changes. Posttest comparisons also demonstrated better outcomes in the intervention group, with moderate-to-large practical effects. In addition, positive associations were found among movement competency, mental toughness, and injury-prevention behavior, indicating that these physical, psychological, and behavioral domains may develop in a complementary manner within responsibility-centered training.

These findings suggest that integrating TPSR principles with movement competency and safety-oriented practice can support more holistic athlete development in school-based martial arts. In practical

terms, this approach may help coaches and physical education teachers improve movement quality, strengthen psychological readiness, and promote safer sport participation simultaneously. Future research should examine the long-term sustainability of these gains, involve larger multi-site samples, and include more objective indicators such as observed preventive behavior or injury incidence.

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