Effects of culturally embedded story-based movement training on physical preparedness in early childhood

Efectos del entrenamiento de movimiento basado en historias culturalmente arraigadas en la preparación física en la primera infancia

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Abstract

Introduction: physical preparedness in early childhood physical education includes reaction ability, locomotor coordination, and balance control that support adaptive movement. culturally embedded approaches may enhance these capacities through structured movement experiences.
Objective: this study aimed to examine the effectiveness of a culturally embedded story-based movement program in improving reaction ability, evacuation efficiency, and balance control as components of disaster-response physical preparedness among kindergarten children.
Methodology: a cluster quasi-experimental pretest–posttest control group design was conducted in 20 kindergartens across 2 provinces in indonesia. a total of 88 children were assigned to experimental and control groups at the school level. the intervention integrated gurindam and pantun as rhythmic cues within structured disaster-response activities during physical education sessions. reaction time, evacuation time, and balance errors were measured before and after the intervention.
Results: the experimental group showed significant improvements in reaction time (3.42 ± 0.65 to 2.58 ± 0.54 seconds, $p < .001$), evacuation time (8.76 ± 1.20 to 6.95 ± 1.05 seconds, $p < .001$), and balance errors (3.12 ± 1.04 to 1.54 ± 0.88, $p < .001$). the control group showed no significant changes ($p = .084$; $p = .072$; $p = .093$). posttest differences between groups were significant across all variables ($p < .001$).
Conclusions: culturally embedded story-based movement training provides an effective strategy for strengthening physical preparedness and early disaster readiness in kindergarten education.

Keywords

Disaster-response preparedness; early childhood Physical Education; fundamental movement skills; school-based intervention.

Resumen

Introducción: la preparación física en la educación física infantil incluye reacción, eficiencia locomotora y equilibrio para responder a situaciones adaptativas. los enfoques culturalmente integrados pueden fortalecer estas capacidades.
Objetivo: este estudio tuvo como objetivo analizar la efectividad de un programa de movimiento basado en historias culturalmente integradas para mejorar la capacidad de reacción, la eficiencia en evacuaciones y el equilibrio como componentes de la preparación física ante desastres en niños de educación infantil.
Metodología: se aplicó un diseño cuasi experimental por conglomerados con pretest–postest y grupo de control en 20 jardines de infancia de 2 provincias de indonesia. participaron 88 niños asignados a grupos experimental y de control. la intervención integró gurindam y pantun como señales rítmicas en actividades de respuesta ante desastres durante educación física. se evaluaron el tiempo de reacción, el tiempo de evacuación y los errores de equilibrio antes y después de la intervención.
Resultados: el grupo experimental mostró mejoras significativas en el tiempo de reacción (3.42 ± 0.65 a 2.58 ± 0.54 segundos, $p < .001$), el tiempo de evacuación (8.76 ± 1.20 a 6.95 ± 1.05 segundos, $p < .001$) y los errores de equilibrio (3.12 ± 1.04 a 1.54 ± 0.88, $p < .001$). el grupo de control no presentó cambios significativos ($p = .084$; $p = .072$; $p = .093$). las diferencias postest entre grupos fueron significativas ($p < .001$).
Conclusiones: el entrenamiento de movimiento culturalmente integrado constituye una estrategia eficaz para fortalecer la preparación física y la preparación temprana ante desastres en la educación infantil

Palabras clave

Educación Física infantil; habilidades motrices fundamentales; intervención escolar; preparación ante desastres.

Introduction

Physical preparedness in early childhood education constitutes a fundamental component of motor development within physical education contexts (Roscoe et al., 2024). Motor competence at an early age is associated with long-term physical activity participation, neuromuscular coordination, and health-related fitness (Park et al., 2024; Robinson et al., 2015a). Physical preparedness encompasses reaction speed, balance control, spatial orientation, and coordinated locomotor responses that enable children to respond effectively to environmental demands. Performance in these domains reflects the integration of sensory processing, motor planning, and execution mechanisms that develop rapidly during the preschool years (Ke et al., 2026). Fundamental movement skills represent the basic building blocks underlying more complex and context-specific motor performance. These skills include locomotor abilities such as running and directional change, stability skills such as balance control, and object-control skills that require coordination between perception and action (Logan et al., 2018; Yang et al., 2025). Development of fundamental movement skills during kindergarten years predicts later motor competence and adaptive physical functioning (Jiang et al., 2026). Structured learning environments provide repeated, guided practice that supports refinement of these foundational patterns.

School-based interventions play a critical role in ensuring systematic and equitable access to structured motor learning opportunities. Interventions implemented within regular physical education sessions demonstrate greater ecological validity and broader reach compared to extracurricular programs, and empirical evidence shows they can significantly improve fundamental movement skills (FMS) in children (Jiang et al., 2026; Yin et al., 2025). Recent research also highlights that characteristics of the school environment, including access to facilities, structured activity opportunities, and supportive physical education contexts, significantly influence children's physical fitness and movement development (Maia et al., 2025). School-based approaches allow integration of movement instruction with pedagogical objectives and contextual safety education. Programs designed within the school setting also facilitate consistent exposure, teacher supervision, and structured rehearsal of coordinated movement responses. Such structured exposure is particularly relevant during periods of rapid developmental change in early childhood, and targeted FMS interventions delivered by specialist PE staff have demonstrated significant gains in movement competence (Roscoe et al., 2024). The effectiveness of school-based programs depends on their alignment with children's neurological readiness and developmental characteristics. Understanding developmental maturation in kindergarten years provides a foundation for designing interventions that optimize motor learning outcomes.

Kindergarten children experience significant neurological and motor maturation that supports acquisition of structured movement patterns (Geirnaert et al., 2025). Physical education activities designed at this stage influence musculoskeletal development, executive functioning, and self-regulation capacities (Donnelly et al., 2016; Fuhrmann et al., 2019). Engaging and meaningful physical activity enhances attentional focus, motivation, and repetition of movement sequences, which strengthen neural pathways involved in motor execution. Structured interventions within school environments shape adaptive and timely movement responses, particularly when programs align with developmental readiness and mastery-oriented instructional climates (Palmer et al., 2022).

Story-based instructional approaches introduce narrative elements into movement learning and create symbolic frameworks that organize motor actions within meaningful scenarios. Research in embodied cognition indicates that narrative contexts support embodied simulation processes that link imagination with motor planning and execution (Castro-Alonso et al., 2024). Narrative cues stimulate imagination and embodied rehearsal, allowing children to anticipate movement sequences and coordinate responses according to contextual prompts. Studies on narrative-based physical activity interventions demonstrate increased engagement and sustained participation among young learners when movement tasks are embedded in story structures (Lu et al., 2019). External auditory cues improve timing accuracy, reaction performance, and synchronization through auditory–motor coupling processes that facilitate sensorimotor integration, as demonstrated in research on rhythmic entrainment in children (Pranjić et al., 2025a). Narrative-guided movement aligns cognitive processing with motor execution demands by organizing attention around meaningful sequences rather than isolated motor drills. Story structures provide predictable sequencing that supports memory encoding and procedural recall during repeated practice, consistent with findings from developmental motor learning research highlighting

the role of structured contextual cues in early childhood (Mariscal et al., 2022). Rhythmic verbal prompts embedded within stories reinforce temporal consistency and reduce cognitive overload during complex movement tasks. Contextualized scenarios enhance emotional engagement, which strengthens attentional regulation and self-directed participation in structured activities. Integration of rhythm and narrative within movement instruction therefore opens possibilities for incorporating culturally meaningful verbal traditions into physical education practice.

Culturally responsive pedagogy emphasizes integration of local linguistic and symbolic forms into educational practice to increase contextual relevance and intrinsic motivation, and contemporary research highlights that culturally grounded instruction strengthens engagement and identity affirmation in early learning environments (Aronson & Laughter, 2016). Gurindam and pantun constitute traditional Malay poetic forms characterized by rhythmic structure, repetition, and balanced phrasing. Studies in culturally sustaining pedagogy indicate that rhythmic oral traditions function as cognitive scaffolds that support attention and meaning-making in young children (Paris & Alim, 2017). Their phonological patterns provide natural temporal cues that regulate pacing, signal transitions, and guide coordinated group movement, consistent with evidence showing that rhythmic language enhances auditory–motor synchronization and temporal processing in early childhood (Luo & Lu, 2023; Pranjić et al., 2025a). Embedding gurindam and pantun within movement scenarios introduces culturally familiar auditory structures that enhance engagement while supporting timing precision and coordinated response. Research in developmental linguistics demonstrates that repetitive and rhyming structures strengthen phonological awareness, working memory, and anticipatory timing capacities in preschool-aged children (Milankov et al., 2021). Short, structured verses are easily memorized and reproduced, allowing children to internalize movement cues without excessive cognitive demand. Familiar cultural expressions foster emotional security and collective participation, factors that are associated with increased self-efficacy and sustained engagement in structured group activities (Thümmler et al., 2022). These dynamics position culturally embedded rhythmic language as a meaningful pedagogical mechanism within early childhood physical education contexts.

Empirical investigations examining culturally embedded story-based movement interventions within ecological kindergarten settings remain limited. Recent systematic reviews on school-based physical activity interventions report improvements in fundamental movement skills and fitness outcomes but rarely integrate culturally grounded narrative structures within structured pedagogical designs (Jiang et al., 2026; Yin et al., 2025). Most interventions emphasize physical performance indicators or isolated motor skill acquisition without incorporating safety-oriented simulations or context-specific responsiveness in early childhood physical education. Research on disaster education in early years highlights the importance of embodied rehearsal and scenario-based learning for strengthening adaptive response behaviors (Efastri et al., 2024; Sakurai et al., 2020), yet integration of these elements within movement-based physical education remains underexplored. Studies examining reaction time, evacuation-related locomotor efficiency, and balance control simultaneously within a cluster-based school design are scarce, particularly in culturally contextualized instructional frameworks. Examination of these dimensions within a culturally grounded pedagogical model therefore addresses a substantive empirical and methodological gap in early childhood physical education research.

The present study examines the effects of a culturally embedded story-based movement program implemented as a school-based intervention on physical preparedness in early childhood physical education. The program integrates gurindam and pantun as rhythmic verbal cues within structured scenarios designed to enhance fundamental movement skills, reaction time, evacuation efficiency, and balance control. This research determines whether children exposed to the intervention demonstrate greater improvements in physical preparedness outcomes compared to peers receiving routine instruction. The study contributes to advancing culturally contextualized school-based strategies that integrate motor development and early disaster readiness within kindergarten education.

Method

Research Design

This study employed a cluster quasi-experimental design with a pretest–posttest control group structure in which the unit of allocation was the school kindergarten in order to reduce contamination between children within the same setting and to preserve ecological validity in school-based physical education interventions, consistent with recommendations in cluster trial methodology (Campbell et al., 2012; Murray, 2007). Outcome data were collected at the individual child level while accounting for clustering effects at the school level during statistical analysis, following contemporary guidance on cluster-based educational research designs (Turner et al., 2017).

Participants

Participants were recruited from 20 kindergartens located in 2 Indonesian provinces, namely Riau Province and Riau Islands Province. 15 schools were situated in Riau Province and 5 schools in Riau Islands Province. From each participating school, 4 to 5 children were selected, resulting in a total sample of 88 children. The distribution of children reflected the distribution of schools, with 66 children from Riau Province and 22 children from Riau Islands Province. Selection of children within each school was conducted using a practical random selection procedure from eligible students who regularly attended physical education sessions and were physically able to participate in structured movement activities.

The study complied with ethical standards for research involving human participants. Ethical approval was granted by the institutional research ethics board under reference number Ref. EDU ERB 2025 041. Written informed consent was obtained from parents or legal guardians prior to participation, and all activities were conducted in a supervised school environment to ensure child safety and well-being throughout the intervention period.

Table 1. School and Participant Characteristics (n = 20 schools; N = 88 children)

Characteristic	Number of schools (n = 20)	%
Location (Province)	15	75.0
Riau Province Riau Islands Province	5	25.0
Group Allocation	10	50.0
Experimental group Control group	10	50.0
Children per Province (N = 88)	66	75.0
Riau Province Riau Islands Province	22	25.0
Children per Group (N = 88)	44	50.0
Experimental group Control group	44	50.0
Average children per school	4–5	—

Procedure

The study was conducted in three stages consisting of pretest, intervention, and posttest. All assessments were administered during regular physical education sessions under similar conditions across schools. At baseline, children completed structured movement performance tasks. Following the intervention period, the same tasks were re-administered to evaluate changes in physical preparedness.

The experimental schools implemented story-based movement training integrated into physical education classes, while control schools continued their regular physical education activities without structured safety-oriented movement scenarios.

Intervention Description

The intervention consisted of structured movement sessions guided by short story cues designed to simulate safety-related situations. Each session included warm-up activities followed by movement tasks targeting reaction ability, locomotor coordination, balance, and cooperative movement.

Four main activity components were implemented: signal-response movement toward a safe zone, route-following tasks with directional changes, balance and obstacle navigation, and small-group coordinated relocation. All activities were delivered using consistent instructional procedures across experimental schools.

Performance Assessment

Physical preparedness was evaluated using three performance-based movement tests. In the reaction test, children moved toward a safe zone immediately after an auditory signal, and response time and accuracy were recorded. In the evacuation route test, children followed a marked pathway toward a designated area, and completion time and route errors were noted. In the balance task, children crossed a simple obstacle pathway, and balance errors were recorded. All tasks were conducted at pretest and posttest using identical procedures.

Data Analysis

Data were analyzed using IBM SPSS Statistics version 26. Descriptive statistics were calculated to summarize performance scores. Paired-sample t-tests were conducted to examine pretest–posttest differences within each group, and independent-sample t-tests were used to compare posttest results between the experimental and control groups. The level of statistical significance was set at $p < .05$. Although the present analysis relied on t-test comparisons consistent with the study design, future research may employ analysis of covariance (ANCOVA) to further control for potential variability in pretest scores between groups.

Results

This study examined the effects of culturally embedded story-based movement training on children's physical preparedness within early childhood physical education. The intervention integrated short gurindam and pantun verses as rhythmic verbal cues to initiate and guide safety-related movement tasks. Descriptive and inferential analyses were conducted to examine changes in reaction time, evacuation movement performance, and balance control.

Within-Group Changes

Children in the experimental group, who participated in movement sessions guided by gurindam and pantun cues, demonstrated significant improvements across all measured variables. Reaction times decreased, evacuation movement became more efficient, and balance errors were reduced at posttest compared to pretest scores. In contrast, the control group, which continued routine physical education without culturally embedded rhythmic cues, showed no statistically significant changes. Table 2 presents the mean scores and standard deviations for both groups at pretest and posttest, along with the results of paired-sample t-tests.

Table 2. Pretest and posttest performance scores by group

Variable	Group	Pretest (M ± SD)	Posttest (M ± SD)	p-value
Reaction Time (s)	Experimental	3.42 ± 0.65	2.58 ± 0.54	< .001
	Control	3.39 ± 0.61	3.21 ± 0.59	.084
Evacuation Time (s)	Experimental	8.76 ± 1.20	6.95 ± 1.05	< .001
	Control	8.70 ± 1.18	8.22 ± 1.16	.072
Balance Errors (n)	Experimental	3.12 ± 1.04	1.54 ± 0.88	< .001
	Control	3.05 ± 1.01	2.78 ± 0.96	.093

As shown in Table 2, statistically significant improvements were observed only in the experimental group ($p < .001$), whereas changes in the control group did not reach statistical significance.

Between-Group Comparisons

To further examine the effectiveness of the intervention, posttest scores between the experimental and control groups were compared using independent-sample t-tests. Results indicated significant differences in all outcome variables in favor of the experimental group. Table 3 summarizes posttest comparisons between groups.

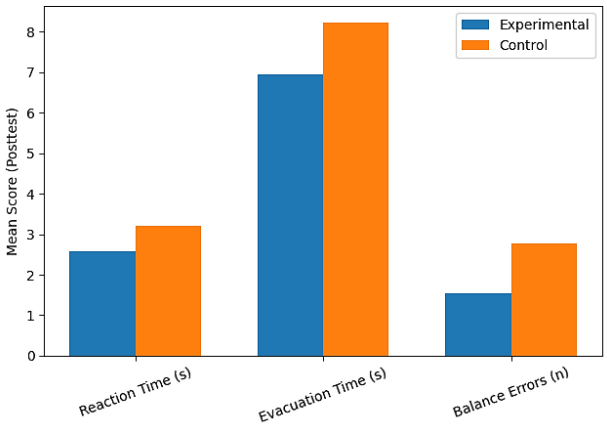
Table 3. Posttest comparison between experimental and control groups

Variable	Experimental (M ± SD)	Control (M ± SD)	p-value
Reaction Time (s)	2.58 ± 0.54	3.21 ± 0.59	< .001
Evacuation Time (s)	6.95 ± 1.05	8.22 ± 1.16	< .001
Balance Errors (n)	1.54 ± 0.88	2.78 ± 0.96	< .001

The effect size analysis indicates large intervention effects across all variables. Children who received movement instruction guided by gurindam and pantun cues demonstrated faster motor responses, more efficient route-following, and improved balance control compared to those receiving conventional physical education.

To complement the statistical findings, Figure 1 presents a visual comparison of posttest mean scores between the experimental and control groups. The figure demonstrates consistently better performance outcomes in the experimental group across all measured variables, supporting the statistical results reported in Table 3.

Figure 1. Posttest Comparison of Physical Preparedness Performance.



The results indicate that integrating gurindam and pantun as culturally embedded rhythmic prompts within physical education sessions is associated with measurable improvements in physical preparedness performance. Gains are observed consistently in reaction speed, locomotor efficiency, and balance stability.

Discussion

The findings demonstrate that culturally embedded story-based movement training enhances physical preparedness in early childhood physical education. The integration of gurindam and pantun as rhythmic instructional cues introduces structured auditory patterns that organize children's attention and movement timing. Traditional poetic forms characterized by rhythm, repetition, and predictable structure support memory encoding and attentional regulation in early learning contexts, consistent with recent findings on rhythmic language and early cognitive processing (Frischen et al., 2022; Williams et al., 2023). Research on auditory–motor synchronization shows that rhythmic verbal stimuli facilitate coordinated motor responses and temporal regulation in children (Pranjić et al., 2024), and Developmental evidence indicates that rhythmic entrainment enhances auditory–motor synchronization and temporal regulation during movement tasks in childhood (Tierney & Kraus, 2013). Rhythmic structure

provides external temporal cues that strengthen perception–action coupling, an essential component of motor coordination (Logan et al., 2012), with contemporary movement science emphasizing the role of temporally structured cues in optimizing motor initiation and sequencing during early development (Falk et al., 2014). When gurindam and pantun precede movement tasks, they function as temporal organizers that guide initiation and directional accuracy of movement.

Children who participate in sessions guided by gurindam and pantun demonstrate faster reaction responses, more efficient evacuation movement, and improved balance control than those receiving routine instruction. These findings are consistent with evidence indicating that structured, task-specific motor interventions enhance functional motor responsiveness in early childhood when compared to unstructured activity exposure (Palmer et al., 2022; Robinson et al., 2015b). These outcomes indicate that culturally resonant rhythmic cues strengthen functional motor responsiveness rather than merely increasing physical activity exposure. Research on motor learning emphasizes that temporal structuring and externally guided cueing improve initiation accuracy and movement efficiency beyond general activity participation alone (Dhawale et al., 2017; Schmidt & Lee, 2014). The results position traditional poetic forms as structured pedagogical tools capable of activating coordinated motor behavior within physical education settings, particularly when rhythm is embedded within meaningful instructional contexts that align perception and action processes.

Improvements in reaction performance reflect strengthened perception–action coupling and enhanced temporal coordination between auditory input and motor execution. Reaction-based tasks require rapid detection of external signals, immediate interpretation, and organized motor initiation, processes that depend on efficient sensorimotor integration during early development (Warren, 1990). Structured motor practice improves neuromotor coordination and response efficiency in early childhood by reinforcing the integration of sensory processing and goal-directed movement (Logan et al., 2018), and contemporary motor development research further indicates that repeated temporally organized practice enhances anticipatory control mechanisms in young children (Dapp et al., 2021; Hadders-Algra, 2018). The present findings demonstrate that culturally embedded rhythmic cues intensify this integration process. Children respond not only to a signal but to patterned verbal structures that prepare the body for movement through anticipatory timing and attentional focus, consistent with evidence that predictive auditory structures facilitate preparatory motor activation (Morillon & Baillet, 2017). Gurindam and pantun introduce predictable rhythmic patterns characterized by repetition, cadence, and structured phrasing. These elements function as temporal scaffolds that regulate movement onset and sequencing. Perception–action theory explains that effective motor behavior emerges from continuous interaction between environmental information and bodily movement (Gibson, 2014; Seifert et al., 2022), and ecological dynamics research has extended this perspective by emphasizing the role of structured environmental cues in shaping coordinated action during childhood (Renshaw et al., 2022). Rhythmic poetic cues provide structured environmental information that carries both semantic meaning and temporal guidance. The patterned cadence narrows attentional dispersion, stabilizes response timing, and aligns auditory perception with motor preparation. This alignment reduces reaction latency and enhances directional precision during task execution. Research on rhythmic entrainment shows that patterned auditory stimuli enhance synchronization and temporal accuracy in coordinated movement (Carrillo et al., 2024; Repp & Su, 2013), with subsequent developmental studies demonstrating that rhythmic cueing improves movement timing consistency in children (Cirelli et al., 2016). The present findings extend this evidence by demonstrating that traditional poetic forms operate as culturally grounded motor regulators within physical education contexts. Gurindam and pantun function simultaneously as narrative carriers and timing mechanisms that organize motor initiation. Improved reaction performance therefore represents a culturally mediated enhancement of neuromotor efficiency rather than a simple repetition effect. The results position rhythmic cultural language as an embodied pedagogical tool capable of optimizing stimulus–response alignment during early developmental stages.

Locomotor efficiency gains observed in evacuation tasks reflect strengthened spatial organization, anticipatory control, and directional precision. Efficient route-following requires continuous adjustment of stride length, modulation of speed, and regulation of body alignment relative to environmental markers, processes that depend on adaptive locomotor control in dynamic environments (Sui et al., 2025). Fundamental movement skill research establishes that structured locomotor practice enhances movement fluency and controlled directional change in early childhood. and more recent evidence indicates

that targeted locomotor interventions improve spatial coordination and agility performance in preschool populations (M. Bloch et al., 2025; Kanzari et al., 2025). The present findings indicate that children exposed to culturally embedded story-based movement training demonstrate more organized locomotor execution during evacuation simulations, suggesting improved integration of spatial awareness and motor planning.

Evacuation performance depends on anticipatory motor control, which involves prediction of subsequent movement phases and preparation of coordinated transitions. Contemporary motor learning research indicates that repeated exposure to task-specific locomotor challenges strengthens feedforward control and sequencing accuracy in early childhood (Johnson et al., 2023). The reduced evacuation time observed in this study indicates improved efficiency in anticipatory adjustments during route navigation. Performance gains represent enhanced organization of locomotor sequences rather than simple acceleration, as improved execution is accompanied by reduced hesitation and more stable directional transitions.

Pantun recited during flood simulations functions as a rhythmic pacing mechanism that structures movement timing. Patterned verbal cadence provides temporal anchors that regulate stride rhythm and transition intervals. Research on auditory–motor coupling demonstrates that rhythmic auditory cues enhance synchronization and stabilize locomotor timing in children (Kanzari et al., 2025). The structured repetition inherent in pantun narrows attentional variability and aligns motor output with external temporal patterns. Locomotor fluency therefore reflects coordinated entrainment between rhythmic language and body movement. Existing research establishes that structured motor interventions improve locomotor competence and directional control in early childhood (Kanzari et al., 2025; Luo & Lu, 2023; Pranjić et al., 2025). Evidence primarily focuses on task repetition, physical practice intensity, and environmental structuring as mechanisms for motor development. The present findings expand this framework by demonstrating that culturally embedded rhythmic language operates as a functional regulator of locomotor organization within situational movement contexts. Pantun does not merely accompany movement instruction; it structures timing, stabilizes pacing, and reinforces anticipatory sequencing during evacuation tasks. Locomotor efficiency improvements therefore reflect an integrated linguistic–motor mechanism in which rhythmic cultural forms actively shape spatial control and directional execution. This integration positions culturally embedded poetic structures as operative components of motor pedagogy rather than peripheral narrative elements.

Improvements in balance performance indicate strengthened postural stability, trunk control, and coordinated weight transfer during transitional movements. Balance represents a core component of motor competence and underpins controlled locomotion, directional change, and safe body positioning in dynamic environments (Schmutz et al., 2020). Dynamic balance requires integration of vestibular input, proprioceptive feedback, and visual information to regulate body alignment relative to gravity and movement demands. The reduction in balance errors observed in the present findings reflects enhanced neuromotor regulation during obstacle navigation tasks that require continuous postural adjustment. Balance control in early childhood develops through repeated exposure to structured tasks that challenge body alignment under varying spatial constraints. Motor development research demonstrates that structured balance activities strengthen anticipatory postural adjustments and improve stability during movement transitions (M. Bloch et al., 2025; Kanzari et al., 2025; Luo & Lu, 2023). Obstacle-based simulations implemented in this study require children to modulate center-of-mass displacement, regulate trunk flexion, and stabilize lower-limb positioning while responding to situational cues. The observed performance gains indicate improved coordination between postural control mechanisms and locomotor execution. Gurindam recited during earthquake and fire simulations provides rhythmic sequencing that organizes the order of protective movements, including crouching, shielding, and controlled relocation. Rhythmic auditory patterns serve as external timing regulators that stabilize motor output and reduce variability in body positioning. Evidence from auditory–motor entrainment research shows that patterned rhythmic cues enhance stability and synchronization in coordinated movement tasks (Li et al., 2025). The structured cadence embedded in gurindam supports smoother transitions between upright and protective postures, reinforcing dynamic balance during rapid adjustment phases. Existing literature on balance training primarily emphasizes repetitive physical drills and environmental manipulation as mechanisms for improving postural stability (Hänisch et al., 2026). The present findings extend this understanding by demonstrating that culturally embedded rhythmic language operates as a functional regulator of postural organization during situational movement tasks. Gurindam functions

not only as narrative guidance but as a structured temporal scaffold that reinforces trunk stabilization and controlled weight transfer. Balance improvements therefore reflect an integrated linguistic–motor regulation process in which cultural rhythmic forms actively support dynamic stability within physical education contexts.

The integration of disaster-response scenarios illustrates how culturally embedded instruction supports functional movement readiness across diverse contexts. Flood simulations require relocation toward elevated safe zones while maintaining directional accuracy. Fire-response tasks involve crouching locomotion and controlled evacuation sequencing. Earthquake drills require rapid posture adjustment through "drop–cover–protect" actions, combining trunk stability with spatial relocation. Gurindam verses recited during these activities provide structured verbal sequencing that organizes the order and timing of movements. Rhythmic phrasing functions as an auditory–motor regulator that supports coordinated transitions between postural states.

Research on rhythmic entrainment demonstrates that patterned auditory cues enhance synchronization and temporal regulation of motor responses (Pereira et al., 2019). Narrative-based physical activity also increases engagement and sustained participation among young learners (Lolowang et al., 2025). These findings are consistent with recent developments in physical education pedagogy, where innovative instructional approaches and gamified learning experiences are reported to enhance student motivation and social interaction, thereby supporting more effective learning environments (Saavedra et al., 2024). Within this perspective, physical literacy theory emphasizes meaningful and contextually grounded movement experiences as foundations for confident and purposeful engagement in physical activity (Carl et al., 2022). The present findings align with these perspectives by demonstrating that culturally resonant rhythmic cues simultaneously enhance attentional focus, engagement, and motor execution.

The study extends existing knowledge by positioning physical preparedness as an embodied outcome of culturally embedded movement instruction within early childhood physical education. Physical preparedness emerges not only as a function of repeated motor practice but as the result of structured interaction between rhythmic language, attentional regulation, and coordinated motor execution. Culturally grounded poetic forms such as gurindam operate as temporal and organizational scaffolds that shape spatial control, postural regulation, and sequential movement accuracy. Physical education therefore functions as an integrated pedagogical space in which cultural literacy and motor competence converge to strengthen functional readiness across diverse situational demands. The consistent pattern of large effect sizes across performance indicators confirms the practical relevance of culturally embedded story-based movement training. The findings support the integration of rhythmic cultural cues within structured physical education sessions as an effective approach to strengthening reaction capacity, locomotor efficiency, and balance stability during early developmental stages.

A limitation of the present study relates to the cultural specificity of the rhythmic narrative structures used in the intervention. The movement sessions incorporated *gurindam* and *pantun*, traditional Malay–Indonesian poetic forms that are culturally familiar to children in the study context. Their rhythmic cadence and repetitive structure may have enhanced attentional engagement and anticipatory motor timing partly because these linguistic patterns are recognizable within the children's cultural environment. Consequently, the effectiveness of the intervention may be influenced by participants' prior familiarity with culturally meaningful rhythmic language. However, the core pedagogical mechanism of the program lies not in the specific poetic forms themselves but in the use of culturally relevant rhythmic narrative cues that structure attention, timing, and coordinated motor responses during movement tasks. From this perspective, the model may be adapted to other educational and cultural contexts by incorporating locally meaningful rhythmic or narrative traditions, such as nursery rhymes, chants, rhythmic storytelling, or culturally familiar verbal prompts used in early childhood education, consistent with principles of culturally sustaining pedagogy (Paris & Alim, 2017). Future studies should further examine how culturally grounded rhythmic language functions as a pedagogical scaffold for motor coordination across diverse cultural settings and evaluate the transferability of this approach in different educational environments.

Conclusions

The study demonstrated that culturally embedded story-based movement training improved physical preparedness in early childhood physical education. Children who participated in sessions integrating gurindam and pantun showed enhanced reaction performance, greater locomotor efficiency during evacuation tasks, and improved dynamic balance control compared to routine instruction. The findings indicated that rhythmic cultural language structured attentional regulation, temporal organization, and coordinated motor execution during disaster-response simulations involving flood, fire, and earthquake contexts. The work contributed to the field by evidencing that culturally grounded poetic forms functioned as operative pedagogical mechanisms within structured motor training, expanding the instructional repertoire of physical education while maintaining measurable performance gains. Future research may examine long-term retention, transferability to real emergency contexts, and adaptation of culturally embedded rhythmic movement training across diverse educational and cultural settings.

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Conflict of interest

The author has no conflict of interest regarding the author or results of other studies.

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