

Integrating music–movement pedagogy into inclusive physical education for children with intellectual disabilities

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Abstract

Background and Study Aim In inclusive education, traditional play is often used to help children with intellectual disabilities (ID) improve motor skills. However, these activities may lack structured sensory input. This study evaluates the effects of structured music-movement activities and traditional play on motor skills in children with mild to moderate ID.

Material and Methods Sixty children (ages 8 to 14; IQ 50-70) with intellectual disabilities (ID) participated in a quasi-experimental study. They were randomly assigned to either the control group (CON, n=30), which engaged in traditional school-based play, or the intervention group (INT, n=30). For eight weeks, the INT group participated in three sessions of progressive music-movement activities (orientation, coordination, interaction, and generalization), lasting forty-five minutes each. The activities included rhythmic scaffolding, sensory aids (textured balls), and environmental modifications. The CON group practiced regular school-based play—sensorimotor, constructive, social, and role-playing. The Movement Assessment Battery for Children-2 (MABC-2), modified for ID populations (reliability $\alpha=0.91$), was used to evaluate motor skills before and after the intervention. Data were analyzed using clinical classification, t-tests, and effect sizes (Cohen's d).

Results The INT group significantly improved total MABC-2 scores ($\Delta=2.00\pm 2.32$) compared to the CON group ($\Delta=0.86\pm 1.38$; $p=0.025$, $d=0.60$). This represents a moderate effect size, indicating meaningful functional improvement attributable to the intervention. Subdomain analyses showed that INT significantly improved aiming and catching ($\Delta=0.50\pm 1.11$, $p=0.019$) and balance ($\Delta=0.80\pm 1.24$, $p=0.001$). The proportion of children with significant motor impairments decreased from 33.3% to 26.7%. However, 70% remained borderline, suggesting that while the intervention was beneficial, many children still required sustained support to achieve functional motor proficiency.

Conclusions For children with ID, structured music-movement pedagogy significantly outperforms traditional play in enhancing motor skills, especially bilateral coordination and dynamic balance. Its multisensory, phased approach addresses key temporal and sensory integration issues associated with ID. However, persistent borderline impairments underscore the necessity for hybrid or extended interventions. Incorporating this approach into inclusive physical education curricula is strongly recommended to optimize functional outcomes.

Keywords: motor skills, intellectual disability, music-movement pedagogy, inclusive education, children

Introduction

Inclusive Physical Education (PE) provides equal opportunities to promote physical development for children with intellectual disabilities (ID). Traditional play-based activities are widely used in these settings to develop motor skills. However, these activities often lack the structured sensory input needed to achieve maximum developmental outcomes.

Every child, including those with intellectual disabilities (ID), has the equal right to develop academically, socially, and physically as much as possible, according to inclusive education [1]. Children with ID frequently experience developmental delays, including in motor skills, and inclusive education aims to address their needs [1]. For instance, below-average intelligence and trouble adapting are traits of children with ID that may impact their motor development [1]. Effective pedagogical interventions that improve gross motor skills are essential in the context of inclusion because they are one of the key pillars for students

with ID to become independent and participate in everyday activities [2].

Children with special needs have had their motor skills stimulated using various conventional and adaptive methods. According to some research, children with disabilities can significantly enhance their gross motor skills by participating in adaptive sports or traditional games [3]. Additionally, Mulya discovered that using traditional games improved the gross motor development of students with special needs [4]. Similarly, circuit games and traditional sports significantly improved the basic locomotor movements of deaf and mute students [1]. Using the concepts of sports science, this game-based sports intervention has demonstrated its ability to help children with ID develop their functional skills and improve their muscle strength and balance [1, 5]. However, some of these activities are static and don't consider children's multisensory or imaginative abilities.

The movement-music pedagogy approach is becoming more popular in inclusive and general education as a creative substitute [6]. This method creates engaging and meaningful learning experiences using rhythm, music, and body movement. Ulfah demonstrated how the ATIK (Observe-Imitate-Improvise-Create) learning model, combined with movement-song demonstrations, gradually enhances early childhood gross motor skills, significantly improving balance control and movement coordination [7]. According to other studies, integrating rhythmic movements into educational activities can enhance kids' self-expression and creativity while enhancing their motor coordination and efficiency [8]. Kanzari et al. found that an integrated intervention centred on play, music, and physical activity significantly improved children's motor skills and social motivation with autism spectrum disorders [9]. These findings align with a recent systematic review that found rhythmic movement exercises improve children's expressive skills and body awareness in special education [8].

Del Barrio and Arús stressed the importance of an additional classification and noted the lack of research combining music and movement in elementary education [8]. However, few studies have examined the sustainability and practical implementation of these interventions [10, 11]. Motor skills and physical activity interventions have been shown to improve motor development in children with Autism Spectrum Disorder (ASD), with lasting effects observed throughout the duration of the interventions [12].

Analysis of the research results revealed that motor skills and physical activity interventions significantly contribute to the development of motor abilities in children with intellectual disabilities. The authors emphasize the importance

of integrating music and movement into inclusive education, noting its potential to enhance motor development. However, despite the promising findings, there remains a need for further research in this area. This gap highlights the necessity for more comprehensive studies that combine sports science with music-movement pedagogy to fully understand the long-term impact of these interventions on children's development.

This study evaluates the effects of structured music-movement activities and traditional play on motor skills in children with mild to moderate ID.

Materials and Methods

Participants

This study followed the CONSORT 2010 guidelines for non-equivalent studies, using a quasi-experimental design with pretest and posttest measures and a different control group [13]. The study recruited 60 students aged 8–14 with mild-to-moderate intellectual disabilities (IQ 50–70) from grades 2–6 SDLB, employing the selective learning model from two schools: SLBN Bekasi Jaya (n=30) and SLB ABC Citra Mandala (n=30) [14]. Exclusion criteria included severe motor disorders (GMFCS Level IV-V), total sensory deficits, and uncontrolled comorbid psychosis or epilepsy. Inclusion criteria involved children with mild to moderate intellectual disabilities (IQ 50-70) who did not have severe physical conditions preventing participation, as confirmed by a psychologist, and with parental informed consent.

This study used a stratified random assignment design to ensure that the experimental (INT) and control (CON) groups had an equal mix of important characteristics. Participants were first categorized by school (SLB Citra Mandala and SLBN Bekasi Jaya), gender (M/F), academic class (2-3/4-6), and degree of intellectual disability (mild/moderate). The block randomization method, which places participants into groups of four, was then used to randomly assign each category to either the intervention or control group in equal numbers. This resulted in 30 students in each group: 15 from the intervention group and 15 from the control group at SLB Citra Mandala, and 15 from the intervention group and 15 from the control group at SLBN Bekasi Jaya. SLB Citra Mandala contributed 15 intervention students and 15 controls, while SLBN Bekasi Jaya contributed 15 intervention students and 15 controls.

Age ($p=0.312$), gender ($p=0.621$), the level of intellectual disability ($p=0.605$), motor function (GMFCS Level, $p=0.588$), and IQ score ($p=0.195$) showed no significant differences between groups, based on the baseline balance analysis. The assignment protocol followed a partially-blind approach, meaning neither the measurement assessor nor the teacher implementing the

intervention knew the group assignments or the study's objectives. Ethical considerations were addressed by offering the intervention program to the control group after the study ended and providing individual reports to parents [15]. To prevent contamination, intervention and control activities took place in separate rooms with different schedules.

Research Design

A quasi-experimental pretest-posttest design with stratified random allocation was used, comparing an 8-week structured music-movement intervention to traditional play activities. The stages began in November and December 2024 with administrative and ethical preparations. A sensory corner and a visual partition were added to the intervention room, and the measuring tool was validated by three experienced SLB teachers and tested on ten non-participant students. In the first week of January 2025, starting points were measured in three separate sessions: (1) Two independent assessors evaluated motor skills using the MABC-2 Checkpoint, and they agreed on their findings; (2) physiological responses were monitored with Shimmer3 GSR+ for 15 minutes during a neutral activity. Each measurement followed specific guidelines for people with intellectual disabilities, which involve using rewards based on their preferences, visual instructions such as pictures, and keeping each session to a maximum of 30 minutes with two scheduled breaks.

Three weekly sessions of 45 minutes each were held during the 8-week intervention implementation period (weeks 2–9). Four progressive phases comprised the structured song-movement intervention given to the experimental group: (1) orientation (song introductions with isolation movements); (2) coordination (bilateral movements with physical scaffolding); (3) interaction (turn-based pair activities); and (4) generalisation (song-

movement combinations in novel contexts). The therapist's daily logbooks and video recordings of 20% of the sessions, evaluated using the Motor Performance Analysis Tool-ID (MPAT-ID), were used to track the intervention's fidelity. According to the school curriculum, the CON group engaged in traditional play activities. The entire baseline process was repeated in the final measurement at week 10 under strict, partially blind conditions: an independent assessor from outside the institution evaluated the video recordings, and the assessor was unaware of the group allocation.

Table 1 shows the structured music-movement teaching method used by the experimental group (INT) over 8 weeks. The program was built up over four important stages: (1) Orientation (a slow song introduction with isolation movements at 60-70 BPM), (2) Coordination (bilateral movements using textured balls), (3) Interaction (turn-based partner activities), and (4) Generalization (song-movement combinations in new settings). Each phase included a set of core activities, scaffolding strategies based on evidence (such as visual instructions, partial physical support, and sensory aids), and specific goals for developing motor skills (such as single limb coordination, bilateral integration, and contextual transfer). The protocol addressed the needs of children with intellectual disabilities by adjusting the length of sessions (maximum 45 minutes), implementing a reward system based on individual preferences, and modifying the environment (including visual partitions and sensory zones).

The protocol for the traditional play activities given to the control group (CON) as a comparison and conducted simultaneously over eight weeks according to the school curriculum is detailed in Table 2. Four types of play were included: (a) sensorimotor (bead stringing, coin insertion activities), (b) constructive (puzzles, building block towers), (c) social (unplanned ball throwing and

Table 1. Music-movement intervention protocol (INT group)

Phase	Week	Core Activity	Scaffolding	Motor Targets
Orientation	1-2	Slow song introduction (60-70 BPM) with isolation movements (raise one hand, tap shoulder)	- Visual instructions (movement pictures) - Child's preference rewards	Single limb coordination
Coordination	3-4	Bilateral movements: clapping while jumping, throwing and catching textured balls	- Partial physical support (elbow guidance) - Assistive devices: bean bag ball	Bilateral integration
Interaction	5-6	Pair activities: «Turn Song» (throw the ball to the rhythm to the partner)	- Visual turn cards - 2-minute timer	Eye-hand and social coordination
Generalisation	7-8	Combination of song-movement in a new environment (school field)	- Reduction of physical scaffolding - Modification of floor texture	Contextual skill transfer

catching), and (d) role play (selling and buying role play). Each category involved specific toys (such as plastic balls, piggy banks, and toy store equipment) and essential operational details, like the absence of structured musical elements and verbal instructions. The activity design followed a traditional approach, without individual response-based adjustments, environmental modifications, or gradual scaffolding, which are standard practices in inclusive educational settings.

Data collection procedures adhered to the International Test Commission (2020) and APA Standards for Educational Testing guidelines. Standardized instruments validated for populations with intellectual disabilities were used to gather data. The Movement Assessment Battery for Children-2 (MABC-2) Checkpoint, made for people with intellectual disabilities, assessed motor perception by (1) not having time limits for tasks, (2) offering three types of help (verbal, gestural, and partial physical), and (3) using textured balls and bean bags instead of tactile stimuli [16]. Hadwin et al. confirmed that the instrument is valid because it has a high reliability score of $\alpha = 0.91$ and can accurately identify 85% of bilateral coordination disorders [17]. Two MABC-2 certified assessors evaluated three domains: manual dexterity, aiming and catching, and static-dynamic balance, in 30-minute sessions

within a controlled environment (temperature 24-26°C, low lighting).

Table 3 displays the motor skills of participants with mild intellectual disability (IQ 50–70), including their raw scores, scaled scores, and explanations in three key areas: manual dexterity, aiming and catching, and static-dynamic balance, all based on standard assessment guidelines. This section illustrates how the modified MABC-2 instrument is applied to the population with intellectual disabilities.

The MABC-2-based criteria for classifying motor impairment used in this study are outlined in Table 4. These criteria define three clinical severity categories: (1) Significant Impairment (\leq 5th percentile), (2) Borderline Risk (6th-15th percentile), and (3) Normal Range (\geq 16th percentile). The main findings of the study are explained using this standard classification, which makes it easier to compare the different categories before and after the test to see how participants' functional status changed across groups.

On Wednesday, January 1, 2025, the baseline (pre-intervention) phase was carried out in five distinct sessions: motor measures (MABC-2 Checkpoint) on Days 1-2, and physiological monitoring (GSR+) on Day 5. All of these sessions took place between 8:00 and 10:00 a.m., which is when students are most

Table 2. Traditional play protocol (CON group)

Activity Type	Week	Activity	Tools	Notes
Sensorimotor Play	1-2	- Putting coins in a piggy bank - Stringing beads	Piggy bank, large beads	No structured musical elements
Constructive Play	3-4	- Building a block tower - Simple puzzle	Wooden blocks, 6-piece puzzle	Minimal verbal instructions
Social Play	5-6	- Throw and catch the ball with friends	Plastic balls	Spontaneous interaction without turns
Role Play	7-8	- Play the role of seller/buyer	Toy shop equipment	Teacher-led

Table 3. Individual performance score of a child with mild intellectual disability on the MABC-2 (Band 2)

Motor Domain	Task	Raw Score	Scaled Score (0–19)
Manual Dexterity	Posting Coins seconds	
	Threading Lace seconds	
	Drawing Trail errors	
	Subdomain Total		
Aiming & Catching	Catching Beanbag (out of 10) successful catches	
	Aiming at Target (out of 10) accurate throws	
	Subdomain Total		
Balance	One-Leg Balance seconds	
	Walking Heels Raised steps correct	
	Jumping in Squares correct positions	
	Subdomain Total		
Total Scaled Score	–	– (Max = 152)

Table 4. MABC-2 total score classification criteria

Category	Percentile Rank	Description
Significant Motor Impairment	≤ 5th percentile	Motor impairment is highly likely
Borderline (At Risk)	6th–15th percentile	Motor impairment is likely, monitoring is required
Within Normal Range	≥ 16th percentile	No significant motor impairment

alert according to circadian studies on intellectual disabilities [18]. The task sequencing began with the student’s favorite activity, and sessions were spaced at least 48 hours apart to prevent fatigue. The mid-intervention monitoring phase, which took place at the end of Week 5, included the MABC-2 dynamic balance subtest (15 minutes per student) and monitoring skin conductance level (SCL) in 20% of randomly chosen sessions. This information was used to identify learning plateaus and modify scaffolding in real time.

The entire baseline process was repeated in the post-intervention phase (Week 10) under the following strict conditions: (1) it had to occur on the same day and at the same time as the pre-test (Tuesday at 8:00); (2) the temperature and humidity had to remain within $\pm 1^\circ\text{C}$; and (3) an additional generalisation test was conducted using a movement-song activity in a different setting (such as a school ceremony).

Statistical Analysis

IBM SPSS Statistics version 27 was used for all statistical analyses. The Shapiro-Wilk test was conducted to assess whether data were normally distributed before hypothesis testing, and results indicated that all variables followed a normal distribution ($p > 0.05$). Descriptive statistics are presented as means and standard deviations (mean \pm SD) for each motor domain. The intervention group (INT) and the control group (CON) underwent separate paired-sample t-tests to evaluate within-group effects of the interventions. Effect sizes were calculated using Cohen’s *d* and interpreted using standard thresholds: small (0.2), medium (0.5), and large (0.8). Independent-sample t-tests were used to examine differences between groups in pre-post change scores. Shifts in motor impairment levels were descriptively analyzed using MABC-2 percentile categories (significant impairment, borderline, within normal range) to observe how clinical classifications changed. This categorical analysis allowed for the functional interpretation of the intervention effects.

Results

In this quasi-experimental study, 60 children with mild-to-moderate intellectual disabilities (ages 8–14) were randomized into either traditional play activities (CON, $n=30$) or music-movement pedagogy (INT, $n=30$) to assess their motor skill outcomes. Baseline characteristics, including age, gender,

school, and motor function classification, were well balanced between groups ($p > 0.05$; Table 5).

After the 8-week intervention, the INT group’s total MABC-2 scores improved significantly more than the controls ($\Delta = 2.00 \pm 2.32$ vs. 0.86 ± 1.38 ; $p = 0.025$, Cohen’s *d* = 0.60). Additionally, there were clinically significant changes in the categories of motor impairment: the percentage of INT participants classified as having significant motor impairment decreased from 33.3% to 26.7%. In comparison, the percentage of CON participants classified as having significant motor impairment remained constant at both time points, at 36.7%.

The results of the Shapiro-Wilk test indicate that the data are normally distributed with a *p*-value of 0.200 across all variable groups. Additionally, a paired t-test was performed to assess the treatment effects on both the INT and CON groups. The findings are presented in Table 6.

The study compared motor domain scores before and after the intervention using MABC-2 assessments. The INT group showed significant improvements across all motor domains, especially in balance and aiming/catching, compared to the control group (Table 6). All improvements reached statistical significance ($p < 0.05$), with small-to-moderate effect sizes.

Based on MABC-2 percentile thresholds, Table 7 shows the categorical distribution of motor impairment severity levels (significant impairment, borderline, and within normal range) to contextualize these quantitative improvements for clinical relevance.

Clinically, the proportion of children with significant motor impairment in the INT group declined from 33.3% to 26.7%, although 70% remained in the borderline category, indicating an ongoing need for support (see Table 7). However, the share of participants within the normal range remained unchanged, suggesting that most were still at risk and required continuous support. The control group showed no change in the proportion of participants in each category, indicating that unstructured traditional play has a limited impact on motor function classifications.

Next, researchers conducted an independent sample t-test to determine the difference in results between the INT and the CON groups. Table 8 presents the significantly different test results.

Between-group analysis confirmed that motor gains were significantly greater in the INT group

Table 5. Demographic and clinical profiles of the study

Characteristic	Total Sample (n=60)	Intervention Group (n=30)	Control Group (n=30)	p-value
Age (years), mean ± SD	10.8 ± 1.9	10.6 ± 2.0	11.0 ± 1.8	0.312
Gender, n (%)				0.621
- Male	34 (56.7)	17 (56.7)	17 (56.7)	
- Female	26 (43.3)	13 (43.3)	13 (43.3)	
School, n (%)				-
- SLBN Bekasi Jaya	30 (50.0)	15 (50.0)	15 (50.0)	
- SLB ABC Citra Mandala	30 (50.0)	15 (50.0)	15 (50.0)	
Academic Class, n (%)				-
- Grades 2-3	24 (40.0)	12 (40.0)	12 (40.0)	
- Grades 4-6	36 (60.0)	18 (60.0)	18 (60.0)	
IQ Score, mean ± SD	62.3 ± 5.4	63.1 ± 5.1	61.5 ± 5.6	0.195
ID Severity, n (%)				0.605
- Mild (IQ 55-70)	38 (63.3)	20 (66.7)	18 (60.0)	
- Moderate (IQ 50-54)	22 (36.7)	10 (33.3)	12 (40.0)	
GMFCS Level, n (%)				0.588
- Level I	20 (33.3)	11 (36.7)	9 (30.0)	
- Level II	28 (46.7)	13 (43.3)	15 (50.0)	
- Level III	12 (20.0)	6 (20.0)	6 (20.0)	
MABC-2 Scores, n (%)				
- Within Normal Range	2 (3.33)	1 (3.33)	1 (3.33)	
- Borderline	37 (61.67)	19 (63.33)	18 (60.0)	
- Significant Difficulty	21 (35.0)	10 (33.33)	11 (36.67)	

Table 6. Pre-Post within-group changes in MABC-2 motor domain scores

Group	Motor Domain	Mean±SD			P(sig)	Effect Size Cohen's D
		Pre	Post	Δpost-pre		
INT	Manual Dexterity	16.00±3.49	16.70±3.42	0.70±1.37	0.009*	-0.203
	Aiming and Catching	9.17±2.74	9.67±2.49	0.50±1.11	0.019*	-0.190
	Balance	16.10±4.81	16.90±4.20	0.80±1.24	0.001*	-0.177
	Domain total	41.27±7.19	43.27±6.87	2.00±2.32	0.000*	-0.284
CON	Manual Dexterity	16.97±4.38	17.20±4.06	0.23±0.86	0.147	-0.054
	Aiming and Catching	8.00±3.81	8.47±3.56	0.47±0.86	0.006*	-0.127
	Balance	16.73±3.25	16.90±3.06	0.17±0.69	0.202	-0.053
	Domain total	41.7±6.53	42.57±6.45	0.86±1.38	0.002*	-0.134

*Significant difference with $p < 0.05$

than in the control group ($p = 0.025$; $d = 0.60$), representing a moderate effect (see Table 8). These findings support the idea that structured music-movement interventions are more effective than traditional play-based activities in helping children with intellectual disabilities develop their motor skills. Given the observed moderate effect size, this approach may hold value for incorporation into therapeutic or adapted physical education programs, particularly in inclusive settings.

Discussion

This study evaluates the effects of structured music-movement activities and traditional play on motor skills in children with mild to moderate intellectual disabilities (ID). The findings suggest that structured music-movement pedagogy may enhance motor skills in children with intellectual disabilities. A moderate improvement in motor function was observed in the intervention group, reflected in the decrease of severe motor difficulties

Table 7. Distribution of Motor Impairment Severity Categories Based on MABC-2 Total Scores

Total Scale Score (8 tasks)	Percentile Range	Category	INT Group (n(%))	CON Group (n(%))
> 56	≥ 16th percentile	Within Normal Range	1 (3.33%)	1 (3.33%)
41–55	6th–15th percentile	Borderline	19 (63.33%)	18 (60%)
≤ 40	≤ 5th percentile	Significant Difficulty	10 (33.33%)	11 (36.67%)

Table 8. Between-Group Differences in MABC-2 Total Score Changes Post-Intervention

Group	Mean±SD			P(sig)	Effect Size Cohen's D
	Pre	Post	Δpost-pre		
INT	41.27±7.19	43.27±6.87	2.00±2.32	0.025*	0.597
CON	41.7±6.53	42.57±6.45	0.86±1.38		

*Significant difference with $p < 0.05$

and a Cohen's d of 0.60. These findings align with existing theories suggesting that rhythmic music may facilitate motor planning and execution by supporting movement-related neural processes [19, 20]. For children with ID who struggle with executive function and anticipatory control, the temporal structure of music offers predictive cues that scaffold movement sequencing [21, 22]. Through the song, students develop the ability to analyze and distinguish musical sounds and rhythmic-melodic structures with greater precision by actively and deliberately engaging in their interpretation. Simultaneously, cognitive development occurs in environments where music provides a framework that is both enjoyable and conducive to its activities [23].

A phase-based scaffolding approach (orientation → coordination → interaction → generalisation) was particularly important. Mukhtarkyzy et al. suggest "woven motor learning" for the ID population, which is reflected in progressively complex sensory support (textured balls, visual cues) [24]. The systematic fading of support needed to close skill gaps is missing from traditional unstructured play formats [25]. Since rhythmic bilateral tasks enhance interhemispheric communication, a known deficit area in ID, our intervention's focus on bilateral integration activities (Phase 2) likely explains the significant improvements in aiming/catching ($d = 0.19$) and balance ($d = 0.18$).

The control group's modest increase in manual dexterity ($\Delta = 0.23$; $d = 0.05$) raises questions about the effectiveness of traditional play. Without rhythmic structuring, sensorimotor play (such as bead-stringing) cannot address the temporal coordination deficiencies that are a hallmark of intellectual disabilities (ID) [26]. Thus, our findings corroborate those of Downs et al., who contend that unstructured play fails to adequately address the specific motor control deficits in this population [27].

However, the fact that 70% of the intervention group still had borderline motor impairment

after treatment points to an important drawback: even though music-movement pedagogy is more effective than conventional approaches, the majority of children still require continuous assistance. This finding aligns with global data indicating that motor impairments in individuals with intellectual disabilities rarely return to normal without consistent intervention [28, 29]. Future research should explore combined or longitudinal approaches (such as incorporating assistive technology) to enhance these effects.

Music-movement pedagogical approaches, such as Dalcroze Eurhythmics and the Orff method, effectively promote children's motor development. Early exposure to joyful music can improve coordination, spatial orientation, and overall motor efficiency [8]. The integration of music and movement supports physical, cognitive, and emotional development, making it suitable for all learners, including those with special needs [8]. Experiential learning stimulates enthusiasm and creativity, which are important aspects of learning for children with intellectual disabilities [30]. Recent experimental studies support the effectiveness of music-movement interventions for children with special needs. For instance, a rhythmic music program for children with Down syndrome significantly improved their functional motor skills compared to a control group without music. Neurologic Music Therapy (NMT) sessions via telehealth led to a significant increase in BOT-2 scores in autistic children, indicating a real improvement in motor skills [31]. Pediatric music therapy consistently improves motor function and emotional well-being [32]. Combining music training with motor play results in greater improvements in coordination than either method alone [33].

From the perspective of exercise science, music-movement interventions can be seen as a type of organized physical activity that incorporates the three pillars of motor learning: task variation, repetition, and a gradual increase in

intensity. Focused exercise training programs have significantly improved the gross and fine motor skills of children with intellectual disabilities, according to a recent meta-analysis [34]. For instance, the total motor score increased with an effect size of 1.28. Similar outcomes have been observed with music interventions, especially those involving active participation (e.g., playing rhythmic instruments or engaging in structured singing). A systematic review found that music has moderate to high effects on enhancing children's motor recovery, with active music activities (instruments, singing, rhythmic movements) outperforming passive music exposure [35]. In other words, incorporating music training into physical activities engages children's emotional and cognitive motivation, which helps them remember motor skills by encouraging repeated practice of body movements and maintaining emotional and cognitive involvement. Future research should explore longitudinal effects, hybrid interventions, assistive technology, and culturally appropriate musical content to maximize accessibility and long-term gains.

Limitations of the study

Several limitations of this study warrant consideration. First, the sample included only two special-needs schools in Indonesia, significantly limiting the generalizability of the findings to other cultures and educational settings. Results cannot be extended to children with severe intellectual disabilities, younger populations, or those with comorbid conditions (e.g., autism spectrum disorder) because the participants were exclusively children with mild-to-moderate intellectual disabilities (IQ 50–70). Although the intervention showed notable short-term motor improvements, the 8-week duration was insufficient to address long-term borderline impairments, highlighting the need for longitudinal studies to evaluate sustainability. Third, the absence of an active alternative intervention, such as standard physiotherapy, limits the comparison of pedagogical approaches, even though

the control group participated in traditional play activities. Methodologically, due to known ceiling effects in aiming and catching tasks, the MABC-2 may not detect subtle motor improvements, even with adaptations for ID populations. Additionally, while assessors remained blinded, participants and activity facilitators could not be fully blinded due to logistical constraints. Finally, conducting the study in controlled settings somewhat reduces ecological validity; further research is required to verify practical applicability in diverse inclusive classrooms.

Conclusions

Structured music-movement pedagogy significantly improves motor competence in children with intellectual disabilities (ID), outperforming traditional play-based activities. Participants showed improvements in manual dexterity, aiming, catching, and balance over the 8-week intervention. The proportion of children with significant motor impairment decreased from 33.3% to 26.7%, with a moderate effect size. The findings suggest that rhythmic, sensory-integrated pedagogy is effective in scaffolding motor learning. However, 70% of the intervention group experienced borderline impairment, indicating that they require sustained multimodal support. These findings have implications for inclusive education and therapeutic programming, suggesting that integrating music-movement interventions into adapted physical education and inclusive learning plans is essential.

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Conflict of Interest

The authors declare that they have no conflict of interest regarding the publication of this study.

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