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The effect of unified rhythmic activity on psychological factors among girls with mild intellectual disability: A randomized controlled trial

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Abstract

Background: Girls with mild intellectual disability experience persistent deficits in adaptive behavior, coping skills, and social integration, particularly during adolescence when psychosocial demands intensify. Despite this need, accessible, school-based psychological interventions remain limited. Given the risk of long-term social exclusion and reduced quality of life, identifying low-cost, inclusive strategies such as unified rhythmic activity is urgently required.
Aims: This study evaluated the effects of rhythmic activity training and unified rhythmic activity training on psychological outcomes, adaptive behavior, and coping strategies for girls with MID, who participated alongside typically developing peers.
Methods: A three-arm randomized controlled trial included 45 girls (10–14 years) with mild intellectual disability (IQ 50–70) in Coimbatore, India. Participants were assigned to rhythmic training, unified rhythmic training, or control groups. Interventions lasted 12 weeks (60 minutes, thrice weekly). Primary outcomes were adaptive behavior and coping strategies; secondary outcomes included self-efficacy, social competence, emotional regulation, quality of life, and behavioral problems. Analyses applied intention-to-treat, repeated measures ANOVA, and ANCOVA.
Result: Significant within-group reductions were found for Irritability/Agitation in RATG and URATG (both $p < 0.001$), but not in CG ($p = 0.64$), with significant between-group differences ($p < 0.001$). Social Withdrawal improved in RATG ($p = 0.003$) and URATG ($p < 0.001$), not in CG ($p = 0.81$). Stereotypic Behavior and Hyperactivity decreased significantly in both intervention groups ($p \leq 0.009$), but not in CG ($p \geq 0.75$), with significant group effects ($p < 0.001$). Inappropriate Speech showed no within-group significance, though between-group differences were significant ($p = 0.001$).
Conclusion: This study establishes that rhythmic and unified rhythmic interventions significantly enhance adaptive behavior and coping in girls with mild intellectual disability, with the unified model offering superior social benefits. It advances inclusive physical activity as a theoretically grounded, evidence-based approach and contributes robust experimental data supporting scalable, school-based psychosocial interventions.

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INTRODUCTION

Mild intellectual disability (MID), characterized by an intelligence quotient between 50 and 70, affects approximately 1-3% of the global population, with higher prevalence in low- and middle-income countries (Patel et al., 2018). Beyond cognitive limitations, individuals with MID frequently

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experience deficits in adaptive behaviour, encompassing practical, social, and conceptual skills necessary for daily functioning, as well as impaired coping strategies, which affect their ability to manage stress and navigate social environments (Tassé et al., 2016; Saulnier et al., 2022). These psychological challenges significantly impact quality of life, educational attainment, and social integration, particularly among female adolescents who face additional barriers related to gender-based societal expectations (Grigorenko et al., 2020; Hattar-Pollara, 2019; John et al., 2023).

Current interventions for psychological deficits in MID predominantly rely on behavioral therapy and special education programs, with limited emphasis on physical activity-based approaches (Greenspan et al., 2022; Fu et al., 2025). However, emerging evidence suggests that structured physical activities, particularly those incorporating rhythmic and musical elements, may enhance psychological functioning through multiple mechanisms, including improved self-efficacy, social engagement, and emotional regulation (Bernstein et al., 2024; Jiang, 2024; Tan et al., 2024). Rhythmic activities characterized by synchronized, coordinated movement patterns performed to music have demonstrated benefits in motor development and cognitive function in children with developmental disabilities (Williams, 2018; LaGasse et al., 2024; Pranjić et al., 2025). The unified sports model, pioneered by Special Olympics, extends traditional physical activity interventions by pairing individuals with intellectual disabilities with typically developing peers (supporting partners) during exercise (Ollila & Haegele, 2025; Barnett, 2025). This inclusive approach theoretically enhances psychological outcomes through increased social interaction, peer modeling, and reduced stigmatization (Jackson-Best & Edwards, 2018; Burke et al., 2019; Ollila & Haegele, 2025).

Previous research has provided encouraging, albeit limited, evidence supporting physical activity-based interventions for individuals with intellectual disabilities. A meta-analysis by Kapsal (2019), encompassing 109 studies, demonstrated that physical activity had a large effect on physical health ($g = 0.773$, $p < 0.001$) and a moderately large effect on psychosocial health ($g = 0.682$, $p < 0.001$) in youth with intellectual disabilities, with movement and sports skill-based programmes yielding the strongest psychosocial benefits. Similarly, Yang et al., (2022) conducted a meta-analysis of 15 intervention studies and reported significant and large effects of physical activity on mental health outcomes in children and adolescents with intellectual disabilities (Hedges' $g = 0.897$, $p < 0.01$), with RCT designs and programmes exceeding 120 minutes per week showing the strongest effects. Systematically reviewed 13 studies examining physical activity or sport-based interventions targeting psychological outcomes in adults with intellectual disabilities and found significant improvements in exercise self-efficacy in four of five studies, though evidence for broader psychological outcomes such as quality of life and emotional well-being remained inconsistent (Bondár et al., 2020; Nazarudin & Wan Pa, 2025). Furthermore, Maenhout & Melville (2024) explored the link between physical activity and peer social connectedness in young people with intellectual disabilities, highlighting the potential of inclusive activity formats to promote social integration, but noted substantial gaps in intervention research specifically addressing psychosocial mechanisms. Collectively, these studies demonstrate that physical activity interventions can positively influence psychological functioning in individuals with intellectual disabilities; however, significant limitations persist.

We conducted a randomized controlled trial to address two primary questions: (1) Do rhythmic activity interventions improve adaptive behavior and coping strategies in girls with MID? (2) Does a unified approach (incorporating typically developing peers) confer additional psychological benefits compared with rhythmic activity training alone? We hypothesized that both interventions would significantly improve psychological outcomes compared with no intervention, with the unified approach demonstrating superior effects. Despite these promising findings, critical gaps remain in the literature. First, the majority of existing studies have focused on physical health outcomes or general psychosocial measures in mixed populations, with few randomized controlled trials rigorously examining rhythmic activity interventions specifically targeting psychological outcomes such as adaptive behaviour and coping strategies in girls with MID. Second, while the unified sports model has been explored broadly through Special Olympics programming, comparative evidence evaluating unified versus non-unified formats within the same experimental framework using standardized psychological outcome measures is scarce. Third, female adolescents with MID remain significantly underrepresented in intervention research, despite facing

compounded psychosocial vulnerabilities related to disability and gender. Addressing these gaps is urgent, particularly in low- and middle-income contexts where scalable, low-cost, school-based interventions are needed. By integrating rhythmic movement with an inclusive peer-mediated model and employing a robust experimental design, the present study advances both theoretical understanding and practical application in adaptive and coping skill development.

METHOD

Research Design

This study adopted a three-arm, parallel-group randomized controlled trial (RCT) design to rigorously evaluate the comparative effectiveness of the interventions. Participants were randomly assigned to three distinct groups: two intervention groups and one control group, using a concealed randomization procedure to minimize selection bias and ensure baseline equivalence. The parallel-group structure ensured that each group received its assigned treatment simultaneously over the same study period, thereby reducing temporal confounding effects. Outcome measures were assessed at predetermined time points using standardized instruments, and the study procedures were implemented in accordance with the Consolidated Standards of Reporting Trials (CONSORT) guidelines to enhance methodological transparency, internal validity, and reproducibility of findings.

Participants and Population

Participants were 45 girls aged 10–14 years with documented mild intellectual disability (IQ 50–70), recruited from Star Special School and Vidya Vikasini Opportunity School, Coimbatore, Tamil Nadu, India. The target population comprised school-going female adolescents with MID in a special education setting. Eligible participants were identified from school records and screened for inclusion and exclusion criteria. A total sampling approach was used among eligible students who met the criteria and provided consent.

Inclusion criteria were: girls aged 10–14 years, IQ 50–70 confirmed by standardized psychological assessment, regular school attendance, and medical clearance for physical activity. Exclusion criteria included severe physical disabilities restricting participation, co-morbid psychiatric disorders requiring medication, concurrent structured physical activity programs, or absence from more than three consecutive sessions.

Randomization and Masking

Participants were randomly allocated into three groups using computer-generated random numbers (Microsoft Excel RAND function) by an independent statistician. Allocation concealment was maintained using unique identification numbers (1–45). Blinding of participants and instructors was not feasible; however, outcome assessors remained blinded throughout the study.

Ethical Considerations and Procedures

Ethical approval was obtained from the Institutional Ethics Committee (Approval No. AUW/IHEC/Phy.Edu/23-24/XPD-01). Written informed consent was obtained from parents or legal guardians, and assent was obtained from all participants prior to data collection.

Table 1: Baseline Characteristics of Study Participants

Characteristic	RATG (n=15)	URATG (n=15)	CG (n=15)	P value
Age, years	13·1 (2·3)	13·4 (2·0)	13·1 (2·1)	0·89
IQ score	62·4 (6·8)	61·8 (7·2)	63·1 (6·5)	0·84
Primary Outcomes				
Adaptive Behavior (ABAS-II GAC)	40·33 (5·32)	39·13 (7·50)	37·46 (2·53)	0·48
Conceptual domain	38·6 (6·1)	37·8 (6·8)	36·9 (5·4)	0·77
Social domain	42·1 (5·8)	40·2 (7·2)	38·6 (6·3)	0·42
Practical domain	40·8 (6·4)	39·5 (7·1)	37·2 (5·9)	0·36
Coping Strategies (Vineland-II)	41·33 (3·57)	41·53 (3·75)	40·26 (6·10)	0·59
Communication	39·8 (4·2)	40·1 (4·6)	38·9 (5·1)	0·71
Daily living skills	42·6 (5·3)	41·9 (5·8)	41·2 (6·2)	0·80
Socialization	40·9 (6·1)	41·8 (6·4)	39·8 (6·8)	0·65

Characteristic	RATG (n=15)	URATG (n=15)	CG (n=15)	P value
Secondary Outcomes				
Self-Efficacy (GSE)	24·8 (4·2)	24·2 (4·6)	25·1 (3·9)	0·82
Social Competence (SSRS)	86·4 (12·3)	84·8 (13·6)	85·6 (11·9)	0·92
Emotional Regulation (ERC)	18·6 (3·8)	17·9 (4·2)	18·2 (3·6)	0·87
Quality of Life (KIDSCREEN-10)	32·8 (5·4)	31·9 (6·1)	32·4 (5·8)	0·89
Behavioral Problems (ABC total)	52·6 (11·4)	54·2 (12·8)	53·1 (11·9)	0·91

Data are mean (SD). P values from one-way ANOVA. No significant baseline differences observed (all P>0·05). RATG=Rhythmic Activity Training Group; URATG=Unified Rhythmic Activity Training Group; CG=Control Group; GAC=General Adaptive Composite; ABAS-II=Adaptive Behavior Assessment System-II; GSE=General Self-Efficacy Scale; SSRS=Social Skills Rating System; ERC=Emotion Regulation Checklist; ABC=Aberrant Behavior Checklist.

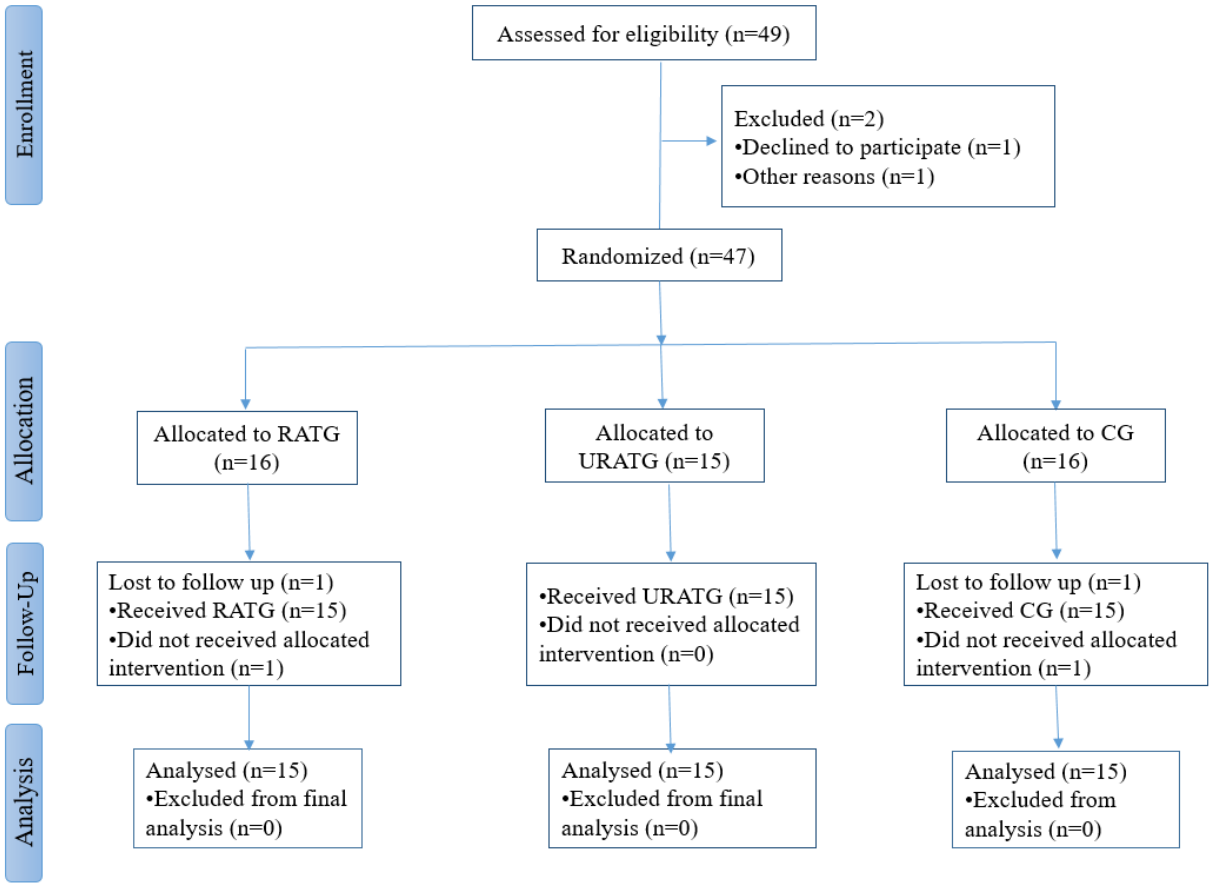

Figure 1. CONSORT Flowchart Diagram

Interventions

Each 60-minute session followed a standardized structure: warm-up (10 minutes), main rhythmic activities (40 minutes), and cool-down (10 minutes). The rhythmic activities incorporated a progressive sequence of movements including: (1) basic hand-clapping patterns in 2/4- and 4/4-time signatures, (2) synchronized stepping and marching movements, (3) partner coordination exercises involving mirroring and echoing movements, (4) circle formations with collective rhythmic sequences, and (5) creative expression activities allowing participants to design their own movement patterns.

Music selections were carefully chosen to ensure cultural relevance, age-appropriateness, and varying tempos (ranging from 80-130 beats per minute). The playlist included a mix of Bollywood songs, regional folk music, and contemporary pop music familiar to participants. Equipment included tambourines, rhythm sticks, small drums, and recorded music played through a

portable speaker system. Activities were modified as needed to accommodate individual ability levels while maintaining the core rhythmic elements and social interaction components central to the unified approach.

Rhythmic Activity Training Group (RATG)

Participants engaged in structured rhythmic activities for 60 minutes per session, three times weekly (Monday, Wednesday, and Friday) for 12 weeks. Sessions included a 10-minute warm-up, a 45-minute rhythmic activity component, and a 5-minute cool-down. The intervention progressed through five phases with age-appropriate music and culturally relevant rhythms.

Unified Rhythmic Activity Training Group (URATG):

Participants underwent a structured rhythmic activity program delivered three times per week for 12 weeks. Sessions consisted of warm-up, rhythmic movement activities synchronized to music, and cool-down phases. Participants were paired 1:1 with typically developing peer partners (girls aged 10–14 years without disabilities) who participated throughout each session. Peer partners received orientation training emphasizing encouragement, appropriate modeling, and inclusive interaction. The intervention incorporated age-appropriate music, progressively complex movement, and individualized adaptations to support participant engagement and skill development.

Control Group (CG):

Participants continued regular school activities without additional structured physical activity intervention, but were offered the intervention program after study completion.

All training sessions were supervised by qualified physical education instructors experienced in working with children with developmental disabilities, maintaining a 1:10 instructor-to-participant ratio.

Primary Outcomes

Adaptive Behavior: Assessed using the Adaptive Behavior Assessment System-II (ABAS-II) Teacher Form for ages 5-21 (Tassé et al., 2016). This standardized instrument evaluates conceptual, social, and practical adaptive skills across ten domains. The General Adaptive Composite (GAC) score and three domain scores were obtained. Scores range from 0 to 100, with higher scores indicating better adaptive functioning (internal consistency α=0·97-0·99). *Coping Strategies:* Measured using the Vineland Adaptive Behavior Scales-II (Vineland-II). This semi-structured interview assesses adaptive functioning across four domains: communication, daily living skills, socialization, and motor skills (Farmer et al., 2020). Standard scores (mean 100, SD 15) were obtained, with higher scores indicating better coping abilities (test-retest reliability = 0 ·80-0·90).

Secondary Outcomes

Self-Efficacy: Measured using the General Self-Efficacy Scale (GSE), adapted for individuals with intellectual disabilities (Scherbaum et al., 2006). This 10-item scale assesses belief in one's ability to handle difficult situations (scores 10-40, with higher scores indicating greater self-efficacy). *Social Competence:* Evaluated using the Social Skills Rating System (SSRS) Teacher Form (Eklund et al., 2020). This 30-item scale assesses cooperation, assertion, responsibility, and self-control (standard scores: mean 100, SD 15). *Emotional Regulation:* Assessed using the Emotion Regulation Checklist (ERC) adapted for intellectual disabilities (Sari, 2022). This 24-item measure evaluates emotion regulation and lability/negativity, with higher regulation scores indicating better emotional control. *Quality of Life:* Measured using the KIDSCREEN-10 Index, adapted for intellectual disabilities. This brief instrument assesses health-related quality of life across physical, psychological, and social dimensions (scores 10-50). *Behavioral Problems:* Assessed using the Aberrant Behavior Checklist (ABC). This 58-item scale measures five problem behavior domains: irritability, social withdrawal, stereotypic behavior, hyperactivity, and inappropriate speech (lower scores indicating fewer problems) (Rojahn et al., 2012). All outcomes were assessed at baseline week 1 and 14 weeks by trained assessors blinded to group allocation.

Statistical Analysis

Sample size was calculated based on an anticipated moderate effect size (Cohen's d=0·6) for changes in adaptive behavior, requiring 15 participants per group to achieve 80% power at α=0·05 (two-tailed). Statistical analyses were conducted using SPSS version 26·0 (IBM Corp., Armonk, NY, USA). Continuous variables are expressed as mean ± standard deviation. Baseline characteristics were compared across groups using one-way ANOVA for continuous variables and χ^2 tests for categorical variables. Primary analyses employed repeated measures ANOVA to assess within-group changes from baseline to post-intervention, followed by analysis of covariance (ANCOVA) to compare adjusted post-test means between groups, with baseline scores as covariates. When sphericity assumptions were violated (Mauchly's test), Greenhouse-Geisser corrections were applied. Post hoc pairwise comparisons were performed using the Bonferroni correction for multiple testing, with Scheffé's test applied for between-group comparisons. Effect sizes were calculated using Cohen's d for within-group changes and partial eta-squared (η^2p) for between-group comparisons, classified as small (d=0·2, η^2p=0·01), medium (d=0·5, η^2p=0·06), or large (d=0·8, η^2p=0·14). Pearson correlation coefficients were used to examine associations between psychological variables. Multiple linear regression identified predictors of treatment response. All analyses followed intention-to-treat principles. Statistical significance was set at two-tailed p<0·05.

RESULTS AND DISCUSSION

Results

Table 2 presents the baseline and post-test outcomes across the three study groups—RATG, URATG, and control group (CG)—for all primary and secondary measures. The table summarizes mean scores with standard deviations, within-group mean changes with 95% confidence intervals, corresponding p values, and effect sizes (Cohen's d with 95% CI). These data allow for a comprehensive comparison of intervention effects on adaptive behavior, coping strategies, self-efficacy, social competence, emotional regulation, quality of life, and behavioral problems over the study period.

Table 2: Within-Group Changes from Baseline to 14 Weeks for All Outcomes

Outcome	Group	Baseline Mean (SD)	Post-test Mean (SD)	Mean Change (95% CI)	P value	Cohen's d (95% CI)
Adaptive Behavior (ABAS-II GAC)						
	RATG	40·33 (5·32)	45·93 (5·32)	5·60 (2·5 to 8·7)	<0·001	1·05 (0·42 to 1·68)
	URATG	39·13 (7·50)	47·20 (7·50)	8·06 (4·2 to 11·9)	<0·001	1·07 (0·44 to 1·70)
	CG	37·46 (2·53)	34·93 (10·81)	-2·53 (-7·8 to 2·7)	0·38	-0·23 (-0·85 to 0·39)
Coping Strategies (Vineland-II)						
	RATG	41·33 (3·57)	46·00 (3·57)	4·66 (2·8 to 6·5)	<0·001	1·30 (0·66 to 1·94)
	URATG	41·53 (3·75)	47·46 (3·75)	5·93 (4·0 to 7·9)	<0·001	1·58 (0·92 to 2·24)
	CG	40·26 (6·10)	38·73 (6·10)	-1·53 (-4·8 to 1·7)	0·35	-0·25 (-0·87 to 0·37)
Self-Efficacy (GSE)						
	RATG	24·8 (4·2)	29·6 (3·8)	4·8 (3·1 to 6·5)	<0·001	1·14 (0·51 to 1·77)
	URATG	24·2 (4·6)	31·4 (3·5)	7·2 (5·3 to 9·1)	<0·001	1·57 (0·91 to 2·23)
	CG	25·1 (3·9)	24·8 (4·1)	-0·3 (-2·1 to 1·5)	0·72	-0·08 (-0·69 to 0·54)
Social Competence (SSRS)						
	RATG	86·4 (12·3)	94·8 (10·6)	8·4 (5·8 to 11·0)	<0·001	0·92 (0·31 to 1·53)
	URATG	84·8 (13·6)	97·4 (11·2)	12·6 (9·7 to 15·5)	<0·001	1·38 (0·73 to 2·03)

Outcome	Group	Baseline Mean (SD)	Post-test Mean (SD)	Mean Change (95% CI)	P value	Cohen's d (95% CI)
Adaptive Behavior (ABAS-II GAC)						
	CG	85·6 (11·9)	86·4 (12·4)	0·8 (-1·9 to 3·5)	0·65	0·07 (-0·55 to 0·68)
Emotional Regulation (ERC)						
	RATG	18·6 (3·8)	21·8 (3·2)	3·2 (1·8 to 4·6)	<0·001	0·88 (0·27 to 1·49)
	URATG	17·9 (4·2)	22·0 (3·4)	4·1 (2·5 to 5·7)	<0·001	1·12 (0·49 to 1·75)
	CG	18·2 (3·6)	18·0 (3·8)	-0·2 (-1·8 to 1·4)	0·81	-0·06 (-0·67 to 0·56)
Quality of Life (KIDSCREEN-10)						
	RATG	32·8 (5·4)	38·2 (4·8)	5·4 (3·6 to 7·2)	<0·001	1·02 (0·40 to 1·64)
	URATG	31·9 (6·1)	38·7 (5·2)	6·8 (4·8 to 8·8)	<0·001	1·25 (0·61 to 1·89)
	CG	32·4 (5·8)	32·8 (5·9)	0·4 (-1·5 to 2·3)	0·74	0·07 (-0·55 to 0·68)
Behavioral Problems (ABC total)						
	RATG	52·6 (11·4)	40·2 (9·8)	-12·4 (-16·8 to -8·0)	<0·001	0·96 (0·35 to 1·57)
	URATG	54·2 (12·8)	38·4 (10·2)	-15·8 (-20·6 to -11·0)	<0·001	1·18 (0·55 to 1·81)
	CG	53·1 (11·9)	51·9 (12·1)	-1·2 (-4·8 to 2·4)	0·68	-0·10 (-0·71 to 0·52)

Data are mean (SD) or mean change (95% CI). Within-group comparisons used paired t-tests. Negative changes in Behavioral Problems indicate improvement (fewer problems). RATG=Rhythmic Activity Training Group; URATG=Unified Rhythmic Activity Training Group; CG=Control Group.

Table 3: Between-Group Comparisons (ANCOVA) of Adjusted Post-test Means

Outcome	Adjusted Post-test Means			ANCOVA	Pairwise Comparisons (Mean Difference, 95% CI)		
	RATG	URATG	CG	F (df 2,41); P; η^2p	RATG vs CG	URATG vs CG	URATG vs RATG
Adaptive Behavior (ABAS-II)	45·68	47·17	35·20	F=15·49; P<0·001; η^2p=0·43	10·48 (7·2 to 13·8)***	11·97 (8·7 to 15·2)***	1·49 (-2·1 to 5·1)
Conceptual domain	44·2	45·8	36·4	F=12·86; P<0·001; η^2p=0·39	7·8 (4·6 to 11·0)***	9·4 (6·2 to 12·6)***	1·6 (-1·8 to 5·0)
Social domain	48·6	51·8	38·2	F=18·42; P<0·001; η^2p=0·47	10·4 (7·1 to 13·7)***	13·6 (10·3 to 16·9)***	3·2 (0·8 to 5·7)*
Practical domain	46·4	48·2	36·8	F=14·28; P<0·001; η^2p=0·41	9·6 (6·5 to 12·7)***	11·4 (8·3 to 14·5)***	1·8 (-1·5 to 5·1)
Coping Strategies (Vineland-II)	45·96	47·40	38·83	F=25·79; P<0·001; η^2p=0·56	7·13 (5·1 to 9·2)***	8·57 (6·5 to 10·6)***	1·44 (-1·2 to 4·1)
Communication	43·8	45·2	38·4	F=14·62; P<0·001; η^2p=0·42	5·4 (3·2 to 7·6)***	6·8 (4·6 to 9·0)***	1·4 (-1·0 to 3·8)
Daily living skills	47·6	49·4	40·8	F=18·24; P<0·001; η^2p=0·47	6·8 (4·5 to 9·1)***	8·6 (6·3 to 10·9)***	1·8 (-0·7 to 4·3)

Outcome	Adjusted Post-test Means			ANCOVA	Pairwise Comparisons (Mean Difference, 95% CI)		
Socialization	48·2	52·4	39·2	F=22·46; P<0·001; η^2p=0·52	9·0 (6·5 to 11·5)***	13·2 (10·7 to 15·7)***	4·2 (1·5 to 6·9)**
Self-Efficacy (GSE)	29·4	31·2	24·6	F=28·65; P<0·001; η^2p=0·58	4·8 (3·2 to 6·4)***	6·6 (5·0 to 8·2)***	1·8 (0·5 to 3·1)*
Social Competence (SSRS)	94·2	97·8	86·2	F=32·45; P<0·001; η^2p=0·61	8·0 (5·6 to 10·4)***	11·6 (9·2 to 14·0)***	3·6 (1·2 to 6·0)**
Emotional Regulation (ERC)	21·6	22·2	17·8	F=12·42; P<0·001; η^2p=0·37	3·8 (2·1 to 5·5)***	4·4 (2·7 to 6·1)***	0·6 (-1·2 to 2·4)
Quality of Life (KIDSCREEN)	38·0	38·9	32·6	F=18·76; P<0·001; η^2p=0·47	5·4 (3·6 to 7·2)***	6·3 (4·5 to 8·1)***	0·9 (-1·0 to 2·8)
Behavioral Problems (ABC)	40·4	38·2	52·0	F=22·84; P<0·001; η^2p=0·53	-11·6 (-15·2 to -8·0)***	-13·8 (-17·4 to -10·2)***	-2·2 (-5·9 to 1·5)

*P<0·05; **P<0·01; ***P<0·001. Adjusted means control for baseline scores. Negative values for ABC indicate reduction (improvement). RATG=Rhythmic Activity Training Group; URATG=Unified Rhythmic Activity Training Group; CG=Control Group; η^2p=partial eta squared.

Table 4: Adaptive Behavior Domain-Specific Effect Sizes (ABAS-II)

Domain/Subscale	RATG Cohen's d	URATG Cohen's d	CG Cohen's d
General Adaptive Composite	1·05	1·07	-0·23
Conceptual Domain	0·91	1·02	-0·18
Communication	0·78	0·95	-0·04
Functional Academics	0·38	0·65	0·05
Self-Direction	1·08	1·28	-0·03
Social Domain	1·15	1·38	-0·12
Social Skills	1·22	1·45	-0·06
Leisure	0·82	1·12	-0·07
Practical Domain	0·98	1·14	-0·15
Community Use	0·68	0·85	0·02
Home Living	0·74	0·92	-0·08
Health and Safety	0·82	0·96	-0·05
Self-Care	0·88	1·05	-0·10

Cohen's d effect sizes: 0·2=small, 0·5=medium, 0·8=large. RATG=Rhythmic Activity Training Group; URATG=Unified Rhythmic Activity Training Group; CG=Control Group; ABAS-II=Adaptive Behavior Assessment System-II.

Table 5: Coping Strategies Domain-Specific Effect Sizes (Vineland-II)

Domain/Subscale	RATG Cohen's d	URATG Cohen's d	CG Cohen's d
Composite Score	1·30	1·58	-0·25
Communication Domain	0·82	0·95	-0·08
Receptive	0·71	0·81	-0·04
Expressive	0·63	0·69	0·04
Written	0·45	0·58	-0·02
Daily Living Skills Domain	1·15	1·35	-0·12
Personal	0·91	1·12	-0·03
Domestic	0·82	1·09	-0·04
Community	0·69	0·94	-0·03
Socialization Domain	1·42	1·68	-0·15
Interpersonal Relationships	1·14	1·59	-0·03

Domain/Subscale	RATG Cohen's d	URATG Cohen's d	CG Cohen's d
Play and Leisure Time	1·09	1·27	-0·06
Coping Skills	1·31	1·65	-0·06

Cohen's d effect sizes: 0·2=small, 0·5=medium, 0·8=large. RATG=Rhythmic Activity Training Group; URATG=Unified Rhythmic Activity Training Group; CG=Control Group

Table 6: Behavioral Problems Subscales (Aberrant Behavior Checklist) - Detailed Analysis

ABC Subscale	Group	Baseline Mean (SD)	Post-test Mean (SD)	Mean Change (95% CI)	P value	Cohen's d	Adjusted Post-test	ANCOVA F; P; η^2p
Irritability/Agitation								F=28·42; P<0·001; η^2p=0·58
	RATG	14·8 (4·2)	10·2 (3·6)	-4·6 (-6·5 to -2·7)	<0·001	1·08	10·4	
	URATG	15·2 (4·6)	9·6 (3·2)	-5·6 (-7·8 to -3·4)	<0·001	1·32	9·4	
	CG	14·6 (4·1)	14·2 (4·3)	-0·4 (-2·1 to 1·3)	0·64	-0·10	14·6	
Social Withdrawal								F=16·52; P<0·001; η^2p=0·45
	RATG	12·4 (3·8)	9·8 (3·2)	-2·6 (-4·2 to -1·0)	0·003	0·68	9·9	
	URATG	12·8 (4·2)	9·2 (3·6)	-3·6 (-5·4 to -1·8)	<0·001	0·86	9·0	
	CG	12·2 (3·9)	12·0 (4·0)	-0·2 (-1·8 to 1·4)	0·81	-0·05	12·2	
Stereotypic Behavior								F=12·38; P<0·001; η^2p=0·38
	RATG	8·6 (2·8)	6·8 (2·4)	-1·8 (-3·1 to -0·5)	0·009	0·64	6·9	
	URATG	8·9 (3·2)	6·4 (2·6)	-2·5 (-4·0 to -1·0)	0·003	0·78	6·3	
	CG	8·4 (2·9)	8·2 (3·0)	-0·2 (-1·5 to 1·1)	0·75	-0·07	8·4	
Hyperactivity								F=24·18; P<0·001; η^2p=0·54
	RATG	10·2 (3·4)	7·8 (2·8)	-2·4 (-3·9 to -0·9)	0·004	0·98	7·9	

ABC Subscale	Group	Baseline Mean (SD)	Post-test Mean (SD)	Mean Change (95% CI)	P value	Cohen's d	Adjusted Post-test	ANCOVA F; P; η^2p
	URATG	10·6 (3·8)	7·2 (2·6)	-3·4 (-5·2 to -1·6)	0·001	1·24	7·1	
	CG	10·4 (3·6)	10·2 (3·7)	-0·2 (-1·8 to 1·4)	0·80	-0·06	10·4	
Inappropriate Speech								F=8·64; P=0·001; η^2p=0·30
	RATG	6·6 (2·4)	5·6 (2·2)	-1·0 (-2·1 to 0·1)	0·07	0·42	5·7	
	URATG	6·7 (2·6)	6·0 (2·4)	-0·7 (-1·9 to 0·5)	0·23	0·27	5·9	
	CG	7·5 (2·8)	7·3 (2·9)	-0·2 (-1·6 to 1·2)	0·78	-0·07	7·5	

Data are mean (SD). Lower scores indicate fewer problem behaviors (improvement). RATG=Rhythmic Activity Training Group; URATG=Unified Rhythmic Activity Training Group; CG=Control Group; ABC=Aberrant Behavior Checklist.

Table 7: Correlation Matrix - Relationships Between Changes in Psychological Variables

Variable	1	2	3	4	5	6	7	8
1. Δ Adaptive Behavior	1·00							
2. Δ Coping Strategies	0·82***	1·00						
3. Δ Self-Efficacy	0·68***	0·62***	1·00					
4. Δ Social Competence	0·72***	0·76***	0·64***	1·00				
5. Δ Emotional Regulation	0·64***	0·58***	0·56***	0·61***	1·00			
6. Δ Quality of Life	0·58***	0·54***	0·52***	0·58***	0·62***	1·00		
7. Δ Behavioral Problems†	-0·58***	-0·52***	-0·48**	-0·62***	-0·56***	-0·48**	1·00	
8. Session Attendance (%)	0·42**	0·46**	0·38*	0·44**	0·36*	0·41**	-0·38*	1·00

*P<0·05; **P<0·01; ***P<0·001. †Negative correlation indicates improvements associated with reductions in problem behaviors. Δ=change score (post-test minus baseline). Correlations for intervention groups only (n=30). Pearson correlation coefficients.

Table 8: Multiple Regression Predicting Adaptive Behavior Change

Predictor Variable	Standardized β	95% CI	t value	P value	VIF
Baseline adaptive behavior	0·42	0·18 to 0·66	3·45	0·002	1·28
Baseline self-efficacy	0·35	0·12 to 0·58	3·12	0·005	1·15
Intervention (URATG vs CG)	0·58	0·35 to 0·81	5·24	<0·001	1·42
Intervention (RATG vs CG)	0·52	0·28 to 0·76	4·68	<0·001	1·38
Δ Self-efficacy at 8 weeks	0·58	0·38 to 0·78	6·12	<0·001	1·62
Session attendance (%)	0·28	0·06 to 0·50	2·58	0·02	1·22
Model Statistics					
R^2	0·78				
Adjusted R^2	0·75				
F (6,38)	22·46			<0·001	
Durbin-Watson	1·92				

VIF=Variance Inflation Factor (all <2, indicating no multicollinearity). RATG=Rhythmic Activity Training Group; URATG=Unified Rhythmic Activity Training Group; CG=Control Group (reference). Δ=change score.

Table 9. Multiple Regression Predicting Coping Strategies Change

Predictor Variable	Standardized β	95% CI	t value	P value	VIF
Baseline coping strategies	0·28	0·04 to 0·52	2·38	0·03	1·24
Baseline self-efficacy	0·31	0·08 to 0·54	2·82	0·01	1·18
Intervention (URATG vs CG)	0·62	0·40 to 0·84	5·68	<0·001	1·45
Intervention (RATG vs CG)	0·48	0·25 to 0·71	4·32	<0·001	1·36
Δ Self-efficacy at 8 weeks	0·52	0·31 to 0·73	5·24	<0·001	1·58
Session attendance (%)	0·32	0·10 to 0·54	2·95	0·007	1·20
Model Statistics					
R^2	0·74			<0·001	
Adjusted R^2	0·70				
F (6,38)	17·92				
Durbin-Watson	1·88				

VIF=Variance Inflation Factor (all <2, indicating no multicollinearity). RATG=Rhythmic Activity Training Group; URATG=Unified Rhythmic Activity Training Group; CG=Control Group (reference). Δ=change score.

Discussion

This randomized controlled trial demonstrates that structured rhythmic activity training produces substantial and statistically significant improvements in adaptive behavior and coping strategies among girls with mild intellectual disability. Both the standard rhythmic activity intervention and the unified approach (incorporating typically developing peer partners) yielded large effect sizes (Cohen's d > 1.0) for primary outcomes, with improvements observed at post-intervention (week 14). The unified model showed statistically significant additional benefits in specific domains, including social skills, socialization, self-efficacy, and social competence, supporting the theoretical advantages of inclusive peer interaction.

Our findings align with and extend previous research on unified sports programs. The unified approach demonstrated statistically significant additional benefits in social domains (social skills: 3·2-point difference; socialization: 4·2-point difference; social competence: 3·6-point difference) compared to standard rhythmic activity training. These results are consistent with the theoretical framework of Special Olympics unified sports programs, which emphasize peer interaction as a mechanism for social development (Kinoshita et al., 2023; Ollila & Haegele, 2025). However, our study uniquely demonstrates these effects specifically in girls with MID participating in rhythmic activities rather than traditional competitive sports, suggesting that the benefits of unified programming extend beyond sport-specific contexts. The gender-specific focus of our study addresses a critical gap in the literature. Most previous physical activity interventions for individuals with intellectual disabilities have included mixed-gender samples or focused predominantly on male participants, limiting understanding of how such interventions may differentially benefit girls who face compounded barriers related to both disability status and gender-based societal expectations (Grigorenko et al., 2020). Our findings suggest that structured, inclusive rhythmic activities may be particularly effective for addressing the unique psychosocial challenges faced by adolescent girls with MID, including social isolation and reduced opportunities for peer interaction.

A recent meta-analysis by Yang et al. (2022) found significant and large effects of physical activity on mental health in children and adolescents with IDs (Hedges' g = 0.897, p < 0.01), with medium effects specifically on psychological health (Hedges' g = 0.542, p < 0.01) and large effects on cognitive function (Hedges' g = 1.236, p < 0.01). The analysis revealed that randomized controlled trial designs and specific intervention components, including more than 120 minutes per week of therapeutic and aerobic exercise demonstrated the strongest effects (Yang et al., 2022). Additionally, Demonstrated that a 9-month adapted physical activity intervention consisting of moderate-intensity aerobic and resistance exercise significantly improved cardiorespiratory fitness and flexibility in adolescents with ID who were overweight or obese (Yang et al., 2022). Hassan et al. (2019) systematically reviewed interventions to increase physical activity in individuals with ID, finding that progressive resistance training and multicomponent programs produced beneficial effects, though they noted inconsistent evidence across studies and called for more rigorous research

designs. These findings collectively support the importance of structured, evidence-based physical activity interventions for improving both physical and psychological outcomes in this population.

However, this study extends previous work in several important ways. First, we specifically examined rhythmic activities that combine structured movement patterns with musical elements, rather than generic exercise programs. The rhythmic component is particularly beneficial for this population, as synchronized movement to music enhances predictability, reduces cognitive load, and provides immediate sensory feedback that facilitates learning and emotional regulation (Dvir et al., 2020; de la Mora Velasco, 2025). Second, our focus on female adolescents addresses a historically understudied population facing compounded challenges related to both disability status and gender. The mechanisms underlying the observed psychological improvements likely involve multiple pathways. Participation in structured physical activities enhances self-efficacy through mastery experiences and successful task completion (Rhodes & Sui, 2021). The group-based nature of both interventions facilitated social interaction and peer relationships, which are critical for adaptive behavior development (Atkinson-Jones & Hewitt, 2019). For the unified condition specifically, interaction with typically developing peers provided additional modeling opportunities and normalized social experiences, which may explain the superior benefits observed in social domains.

The magnitude of improvement in adaptive behavior (adjusted mean change of approximately 10-12 points) and coping strategies (adjusted mean change of approximately 7-9 points) represents clinically meaningful change, potentially impacting daily functioning and quality of life. These gains are comparable to or exceed those reported for intensive behavioral interventions, while requiring substantially less resource investment and offering additional physical health benefits. The domain-specific analyses revealed particularly important findings. The unified approach demonstrated significant advantages over standard rhythmic activity in social skills (3·2-point difference), socialization (4·2-point difference), self-efficacy (1·8-point difference), and social competence (3·6-point difference). These specific benefits in social domains provide strong empirical support for the unified sports model's theoretical emphasis on peer interaction as a mechanism for psychological development.

The regression analyses identified changes in self-efficacy at mid-intervention as the strongest predictor of final outcomes (β=0·52-0·58), suggesting that self-efficacy may serve as a key mediating variable through which rhythmic activities exert their effects. This finding has important implications for intervention design, suggesting that programs should explicitly incorporate elements that build self-efficacy, such as progressive skill development, positive reinforcement, and opportunities for autonomous decision-making. The dose-response relationship between session attendance and outcomes (r=0·38-0·46) provides additional evidence for the causal effects of the interventions. The high attendance rates (>94%) and perfect retention (100%) indicate strong acceptability and feasibility of both intervention models in school settings.

Research Contribution

This study makes a significant contribution by providing rigorous randomized controlled evidence on the psychological effects of rhythmic and unified rhythmic activity among girls with mild intellectual disability, a population underrepresented in intervention research. It advances theory by integrating rhythmic movement and inclusive peer-mediated models within a single comparative framework. The findings demonstrate clinically meaningful improvements in adaptive behavior, coping strategies, and social domains, while identifying self-efficacy as a key predictive mechanism. The study also contributes practical value by presenting a scalable, low-cost, school-based intervention model suitable for low- and middle-income educational settings.

Implications

The findings of this study have direct implications for school-based programming for girls with MID. Schools can implement unified rhythmic activity programs through the following actionable strategies: Partner with PE teachers to incorporate 2-3 unified rhythmic sessions per week into existing class schedules, requiring minimal additional resources. Sessions can be conducted in standard gymnasium or multipurpose room spaces. Establish formal peer partner programs by recruiting volunteers from upper grades, providing the structured 3-hour training protocol outlined in this study, and offering service-learning credit or recognition to incentivize

participation. Implementation requires minimal investment—basic rhythm instruments, a music playback system (which most schools already possess), and printed activity guides. Free or low-cost music playlists can be curated using streaming services. Form partnerships between special education departments, PE programs, and student leadership organizations to ensure sustainable program delivery and peer recruitment pipelines. Begin with pilot programs involving small groups (8-12 participants) and expand gradually as more peer partners and space become available. The program can be adapted for various populations with intellectual disabilities and for co-educational formats.

Limitations

Several additional limitations should be noted. First, the absence of long-term follow-up assessment prevents the determination of whether the observed psychological improvements are sustained beyond the immediate post-intervention period. Future research should incorporate follow-up measurements at 3, 6, and 12 months to assess the durability of intervention effects and identify factors associated with maintenance of gains. Second, the reliance on teacher-reported measures for certain outcomes may introduce social desirability bias, as teachers aware of group allocation might unconsciously rate intervention participants more favorably. While we attempted to minimize this through structured assessment protocols and validated instruments, future studies should incorporate blinded assessors and multiple informants (e.g., parents, peers) to triangulate findings and enhance objectivity.

Suggestions

Future research should address several key questions. Larger trials with adequate power to definitively compare rhythmic activity alone versus unified models are needed, ideally incorporating cost-effectiveness analyses. Longer-term follow-up studies should examine maintenance of benefits and optimal "dose" (frequency, duration, intensity) of interventions. Studies should explore mechanisms of action through formal mediation analyses, examining the roles of self-efficacy, social integration, peer modeling, and improvements in physical fitness. Extension to boys with MID and to individuals with moderate or severe intellectual disability would enhance generalizability. Dismantling studies could identify essential components of interventions. Finally, implementation science approaches should investigate barriers and facilitators to real-world adoption in diverse educational settings.

CONCLUSION

Both rhythmic activity training and unified rhythmic activity training produced substantial improvements in adaptive behavior, coping strategies, and multiple psychological outcomes among girls with mild intellectual disability over 12 weeks. The unified approach demonstrated significant additional benefits in social domains. Given the accessibility, low cost, high acceptability (100% retention, >94% attendance), and concurrent physical health benefits, these interventions represent a promising approach to addressing psychological functioning deficits in girls with mild intellectual disability. These findings support integration of rhythmic physical activities, particularly unified models when feasible, into educational curricula and therapeutic programming for this population.

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AUTHOR CONTRIBUTION STATEMENT

In our manuscript, VBS, MGPM, JT, VW, PK, DK, and YA contributed: VBS conceptualized the study, designed the methodology, analyzed the results, and coordinated data collection. JT and DK contributed to the study design. JT and VW contributed to the design of the methodology and data collection. VBS and YA performed data analysis, interpreted the results, drafted the manuscript, and critically revised it for intellectual content.

AI DISCLOSURE STATEMENT

The authors declare that no artificial intelligence (AI) tools or services were used in the preparation of this research. All content was entirely researched, written, and edited by the authors, who take full responsibility for the publication.

CONFLICTS OF INTERES

The authors declare that they have no conflicts of interest that could have influenced the study, data analysis, manuscript preparation, or publication.

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