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Constraints-led traditional game-based adaptive physical education for fundamental movement skills in children with mild intellectual disabilities

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ABSTRACT

Children with intellectual disabilities (ID) commonly experience delays in fundamental movement skills (FMS), while evidence on culturally grounded adaptive physical education in Indonesian special schools remains limited. This study examined the effects of a Central Sulawesi traditional-games programme, guided by Newell's constraints model, on FMS in children with mild ID. A pre-experimental, single-group pretest-posttest design involved 23 children aged 7–10 years at SLB ABCD Muhammadiyah Palu, selected through total sampling. Participants completed 10 adaptive physical education sessions using mongalas, nobangan, and hadang, with modified rules, distances, equipment, and playing areas. FMS were assessed using the Test of Gross Motor Development-2 (TGMD-2), and data were analysed using a paired t-test supported by a Wilcoxon signed-rank test. Mean FMS scores increased from 42.35 (SD = 8.43) to 58.35 (SD = 10.02), representing a mean gain of 16.00 points (95% CI [15.23, 16.77]). The improvement was statistically significant, $t(22) = 43.02$, $p < 0.001$, with a large effect size (Cohen's $d_{av} = 1.73$), and all participants improved. These findings provide preliminary evidence that culturally relevant traditional games may support FMS development in children with mild ID and offer a practical application of Newell's constraints model in adaptive physical education. However, the absence of a control group limits causal inference, and controlled studies are needed to establish programme effectiveness.



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Introduction

Fundamental movement skills (FMS), comprising locomotor skills such as running, hopping and jumping and object-control skills such as throwing, catching and kicking, are regarded as the building blocks of more complex movements and of lifelong physical activity (Stodden et al., 2008). Children with intellectual disabilities (ID) consistently demonstrate lower FMS proficiency and developmental delays compared with typically developing peers (Mañano et al., 2019), as well as poorer postural and balance control (Adamović & Stošljević, 2013; Klavina et al., 2017; Li et al., 2025). These limitations are not explained by reduced activity alone. Children with mild ID process information more slowly and show weaker executive functioning, both of which are associated with poorer motor performance (Hartman et al., 2010; Vuijk et al., 2010), and their low FMS

proficiency in turn restricts participation in sport and active play (Westendorp et al., 2011). The result is a self-reinforcing cycle in which limited competence reduces practice opportunities and limited practice keeps competence low, so the critical question for physical education is not whether these children need more movement, but how practice conditions can be designed to break this cycle. Physical education is therefore one of the few structured, school-based opportunities through which these children can acquire FMS, provided that the learning experience is adapted to their characteristics and needs (Martin Ginis et al., 2021).

In this study, intellectual disability is understood as a condition characterised by significant limitations in both intellectual functioning and adaptive behaviour that originates during the developmental period (Schalock et al., 2021). Mild ID corresponds to an IQ range of approximately 50–69 in the ICD-10 classification (World Health Organization, 1992). Adaptive physical education refers to physical education in which the content, rules, equipment, space and instruction are modified so that learners with disabilities can participate safely and successfully (Ben Rakaa et al., 2025; O'Neil & Olson, 2021). Fundamental movement development is operationally defined as the raw score obtained on the 12 locomotor and object-control skills of the Test of Gross Motor Development-2 (TGMD-2) (Ulrich, 2000).

The study is grounded in Newell's (1986) constraints model, which views movement as emerging from the interaction of individual constraints (e.g., cognitive and motor capacities), task constraints (e.g., rules, goals and equipment) and environmental constraints (e.g., the physical and socio-cultural setting). From this perspective, adaptive physical education is essentially the purposeful manipulation of task and environmental constraints—simplifying rules, reducing distances, modifying equipment and providing play-based goals—so that children with ID can explore and stabilise functional movement solutions. The constraints model was preferred to information-processing accounts, which locate learning difficulties mainly in the learner's limited capacity to attend to, store and use instructions and feedback, and therefore tend to prescribe verbally loaded, drill-based teaching that places heavy demands on exactly the capacities that are reduced in mild ID. The constraints-led perspective, in contrast, shifts the focus from what the child lacks to what the teacher can change: when individual constraints cannot be altered quickly, task and environmental constraints can be designed so that functional movement solutions emerge through exploration and repetition in meaningful activity (Chow et al., 2007; Renshaw et al., 2010). Traditional games offer a natural vehicle for such manipulation because they are rich in running, dodging, jumping, throwing and catching, are easily modified, and are culturally familiar, which may increase motivation and engagement. The developmental model proposed by Stodden et al. (2008) further suggests that improved FMS competence can initiate a positive spiral of perceived competence, physical fitness and physical activity participation.

Recent empirical studies support the value of adapted physical activity for children with ID. Structured programmes have improved motor proficiency and adaptive development in youths with mild ID (Hsu et al., 2021; Karakaş et al., 2025), motor and social development (Kashi et al., 2023), motor skills and quality of life (Özkan & Kale, 2023), and motor coordination through technology-assisted exercise (Park et al., 2022), while ICF-based adapted physical activity programmes have been proposed to address the broader functioning of adolescents with ID (Shen et al., 2024). Meta-analytic evidence shows that sports games improve children's FMS, although the pooled effect in typically developing children is modest ($SMD = 0.30$; Sun & Chen, 2024), and that exercise interventions improve balance in children and adolescents with ID (Gao et al., 2025). In Indonesia, traditional game-based instruction has been shown to improve the FMS of typically developing kindergarten and primary school children (Festiawan, 2020; Irawan et al., 2021; Suherman et al., 2019; Supriadi, 2019).

Nevertheless, three gaps remain. First, most traditional-game studies in Indonesia have involved typically developing children, and evidence for children with ID in special schools (SLB) is limited. Second, the traditional games of Central Sulawesi (monggalas, nobangan and hadang) have not been systematically adapted and tested as a physical education medium for this population. Third, and most importantly from a theoretical standpoint, it remains unresolved how task and environmental constraints should be designed to compensate for the individual constraints that characterise mild ID. Constraints-led and nonlinear pedagogy have been developed mainly with typically developing learners and sport performers (Chow et al., 2007; Renshaw et al., 2010), whereas intervention studies in ID populations have usually relied on structured exercise or sport-specific programmes without specifying which constraints were manipulated (Hsu et al., 2021; Kashi et al., 2023; Aksović et al., 2023), and their benefits may fade when the programmes stop (Karakaş et al., 2025). It is therefore unknown whether the rules, space and social setting of culturally familiar games can function as a task-environment design that elicits FMS in learners with limited cognitive resources, and few studies in this field have reported effect sizes that allow comparison with international evidence. Accurate FMS assessment is also a recognised challenge in adapted physical education (Kwon & Maeng, 2022), underlining the need for a standardised instrument such as the TGMD-2.

From the experience of the Special Learning Needs (SLB) schools in Palu City, teachers have found that using games as a means of learning really suits the kids and it can be the best way to improve the basic skills in movement through play. Traditional games like mongalas, nobangan and hadang, are indigenous and have deep roots in Central Sulawesi. They are seen to be very good examples for developing the fundamentals of movement that children with mild intellectual disabilities will need as they contain skills like running, jumping, throwing, and catching, which match the level of the children. Accordingly, the novelty of this study lies in (a) the adaptation of three indigenous Central Sulawesi games as the content of adaptive physical education for children with mild ID, and (b) the interpretation of the intervention through the constraints-led perspective. The research question was: does a 10-session traditional game-based adaptive physical education programme improve the TGMD-2 gross motor raw scores of children aged 7–10 years with mild ID? It was hypothesised (H1) that the mean posttest TGMD-2 score would be significantly higher than the mean pretest score ($\alpha = 0.05$). Because all eligible children at the school formed a single accessible population, and withholding the programme from some of them was considered neither practical nor ethically desirable, a single-group pretest–posttest design was adopted as an initial, exploratory test of the programme prior to a controlled trial.

Method

Design. This study used a quantitative, pre-experimental single-group pretest–posttest design (O1 – X – O2). This label is used deliberately instead of "quasi-experimental" because no comparison group was involved; the design therefore allows the change within the group to be estimated, but it cannot isolate the effect of the programme from maturation, testing or regression to the mean, which are addressed in the Discussion. A controlled alternative was considered but judged unfeasible at this stage: splitting the 23 eligible children of a single school into intervention and waiting-list groups would have produced groups of only 11–12 children with a high risk of contamination, because the children share the same school environment and physical education lessons, while a multiple-baseline design would have required repeated TGMD-2 administrations before the intervention, which was considered too burdensome for children with ID and would itself have increased testing effects. The single-group design was therefore used as an exploratory step to establish feasibility and the likely magnitude of change for planning a controlled trial (see Conclusions).

Participants. The accessible population comprised all children with mild ID aged 7–10 years enrolled at SLB ABCD Muhammadiyah, Palu City, and all 23 children were included (total sampling). Inclusion criteria were: (a) classification as having mild ID in the school's assessment records; (b) age 7–10 years; (c) no physical disability or medical condition contraindicating physical activity; and (d) written parental consent. Children who missed the pretest or posttest, or who attended fewer than [...] of the 10 sessions, were to be excluded. The sample consisted of [...] boys and [...] girls (mean age = [...] $\pm$ [...] years). A sensitivity power analysis (G*Power 3.1; Faul et al., 2007) showed that, with $n = 23$, a one-tailed paired t-test at $\alpha = 0.05$ and power = 0.80 can detect a minimum effect of $d_z = 0.54$, whereas 12 participants would be sufficient to detect a large effect ($d_z = 0.80$). The sample was therefore adequate for detecting a moderate-to-large within-group change, although its size and single-site origin limit generalisability. The study was approved by [name of ethics committee/institution, approval number], and written informed consent was obtained from the parents or guardians.

Intervention. The programme comprised 12 consecutive meetings: a pretest, 10 intervention sessions and a posttest. Sessions were held [...] times per week for [...] minutes each (total intervention time $\pm$ [...] minutes over [...] weeks) and were delivered by [the physical education teacher/researcher], who had been briefed on the protocol. Each session consisted of a warm-up ([...] minutes), the main traditional game activity ([...] minutes) and a cool-down with reflection ([...] minutes). Before the pretest, participants were allowed to play the traditional games briefly to become familiar with them. Three games that are well known and widely played in Central Sulawesi were used: mongalas ([brief description of rules and dominant movements]), nobangan ([brief description of rules and dominant movements]) and hadang (a team game in which players try to cross lines guarded by opponents, emphasising running, dodging, sliding and agility). In line with the constraints-led principle, the games were adapted by modifying task and environmental constraints: shortening distances and reducing the playing area, simplifying rules, using softer and larger balls, providing demonstrations and visual cues, reducing team size, and progressively increasing difficulty as the children mastered each level. The study procedure and participant flow are summarised in Figure 1.

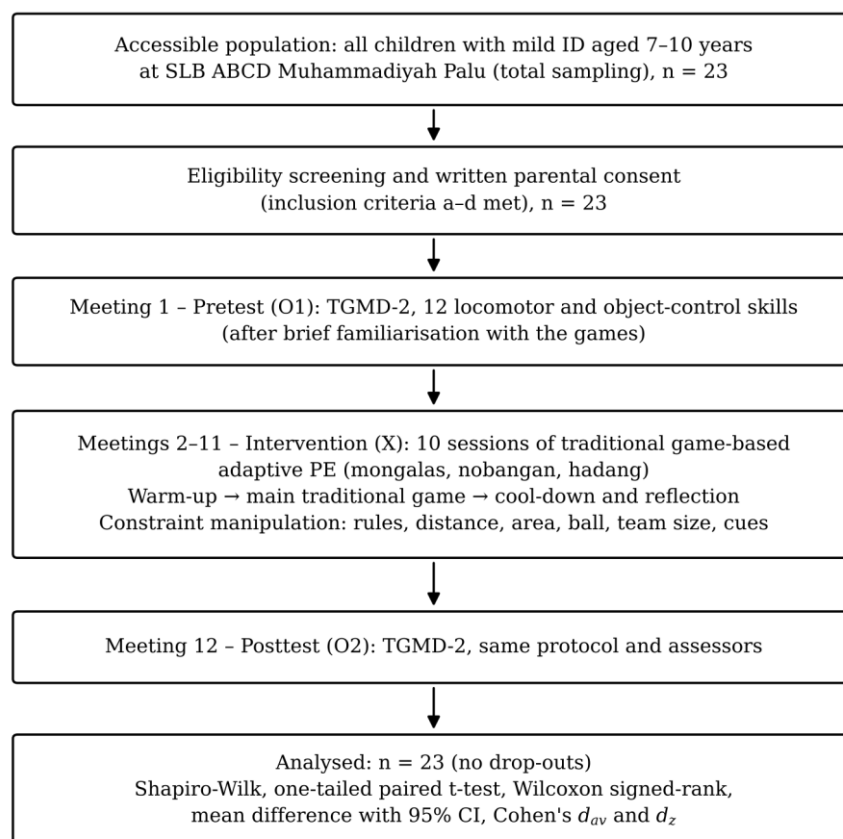


Figure 1. Participant flow and study procedure

Instrument. FMS were measured with the TGMD-2 (Ulrich, 2000), which assesses six locomotor skills (run, gallop, hop, leap, horizontal jump and slide) and six object-control skills (striking a stationary ball, stationary dribble, catch, kick, overhand throw and underhand roll). Each skill is scored on three to five performance criteria (1 = present, 0 = absent) over two trials, yielding raw scores of 0–48 for each subtest and 0–96 in total. The equipment used included a softball, cones, a tape measure, a stopwatch and a soccer ball. The TGMD-2 has shown good validity and reliability in its normative sample (Ulrich, 2000), acceptable construct validity (KMO = 0.837) and reliability (Cronbach's $\alpha = 0.743$) in Indonesian children aged 7–10 years (Ismaryati et al., 2023), and satisfactory validity and reliability in children with ID (Capio et al., 2016; Simons et al., 2008). It was also chosen because it is a process-oriented, criterion-referenced test whose items correspond to the skills practised in the games. Raw scores rather than standard scores were used as the dependent variable because the TGMD-2 standard scores are referenced to a normative sample of typically developing children, in which children with ID may cluster near the floor of the scale, whereas raw scores retain sensitivity to within-child change across the 12 skills. Performances were scored by [two] trained assessors [who were not involved in delivering the intervention]; inter-rater reliability was [ICC = ..]. The assessors were not blinded to the testing occasion, which is acknowledged as a limitation.

Data analysis. The normality of the pretest and posttest scores was examined with the Shapiro-Wilk test, which has greater power than the Kolmogorov-Smirnov test for small samples ($n < 50$); the Kolmogorov-Smirnov (Lilliefors) result is reported for completeness, and scores were considered normally distributed when $p > 0.05$, and H_1 was tested with a one-tailed paired-samples t-test ($\alpha = 0.05$). Because the paired t-test strictly assumes normality of the difference scores, the Wilcoxon signed-rank test was computed as a robustness check. In addition to statistical significance, the mean difference with its 95% confidence interval and two effect sizes were reported: Cohen's d_z (the mean difference divided by the standard deviation of the differences) and Cohen's d_{av} (the mean difference divided by the average standard deviation of the pretest and posttest), interpreted as small (0.2), medium (0.5) and large (0.8) (Lakens, 2013; Sullivan & Feinn, 2012). The percentage gain relative to the pretest mean was also calculated. A 95% confidence interval for d_{av} was obtained with a percentile bootstrap (20,000 resamples), and the correlation between pretest scores and individual gains was examined to check for a regression-to-the-mean pattern (Barnett et al., 2005).

Results and Discussions

This research was carried out in 12 consecutive meetings which included a pretest, adaptive P.E. treatment for 10 sessions, and a posttest to examine the extent to which the learning method of adapting physical education had changed the development of gross-motor skills in students through a pre-post design. The effectiveness of the implementation of such a learning method was assessed by examining the changes in pre-test and post-test results after the study was completed. SLB ABCD Muhammadiyah Palu is the institution that was used to conduct research on the effects of the changes to physical development of intellectual handicapped students through the use of learning physical education in an adaptive mode.

Normality and the hypothesis were tested through data analysis (t-test). The results of the normality test and the t-test are shown below.

Normality Test

Before the hypothesis was tested, the distribution of the pretest and posttest scores was checked using the criteria described in the Method. The results are presented in Table 1.

Table 1. Tests of Normality

Variable	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	0.132	23	0.200*	0.946	23	0.242
Posttest	0.128	23	0.200*	0.942	23	0.201

Drawing from the SPSS outputs shown, the levels of significance for the pretest and posttest are both higher than 0.05. Therefore, this is an indication that the data sets are normally distributed and hence, it is safe to assume normality of the data. The value 0.200* in the Kolmogorov-Smirnov (Lilliefors-corrected) columns does not contradict the Shapiro-Wilk result: SPSS reports 0.200 as the lower bound of the true significance whenever the exact p-value exceeds this limit, so both tests consistently indicate normality (Shapiro-Wilk $p = 0.242$ for the pretest and $p = 0.201$ for the posttest).

Hypothesis Test (t-test)

After the normality of the data is checked, a t-test is performed to test the hypothesis. Table 2 below gives descriptive statistics of the pretest and posttest results.

Table 2. Descriptive Statistics of Pretest and Posttest

Subject	Pretest (X1)	Posttest (X2)	D (X2-X1)	d (D-MD)	d ²
CT	42	58	16	0	0
GFH	37	51	14	-2	4
AG	48	66	18	2	4
BR	29	42	13	-3	9
WHY	54	70	16	0	0
TH	38	52	14	-2	4
JR	46	62	16	0	0
DP	32	45	13	-3	9
BK	50	68	18	2	4
MG	36	51	15	-1	1
KS	44	60	16	0	0
GT	30	43	13	-3	9
HST	52	70	18	2	4
IS	40	56	16	0	0
YP	56	74	18	2	4
CK	34	49	15	-1	1
AA	46	64	18	2	4
TAS	38	54	16	0	0
ASB	54	72	18	2	4
RS	32	47	15	-1	1
MS	48	66	18	2	4
KBL	52	70	18	2	4
AB	36	52	16	0	0
	974	1342	368	0	70

From the data table provided, it seems that the overall pretest result was $\Sigma X1 = 974$ whereas the overall posttest result was $\Sigma X2 = 1342$. The difference of the pretest and posttest values amounts to $\Sigma D = 368$, and the sum of squared deviations is $\Sigma d^2 = 70$. After that, we carried out a t-test.

To calculate the t-value, the following formula was used:

$$\begin{aligned} t &= MD \div \sqrt{(\Sigma d^2 \div [N(N-1)])} \\ t &= 16 \div \sqrt{(70 \div [23 \times 22])} \\ t &= 16 \div \sqrt{(70 \div 506)} \\ t &= 16 \div \sqrt{0.1383} \\ t &= 16 \div 0.3719 \\ t &= 43.02 \end{aligned}$$

Based on the results of the above analysis by the t-test, the calculated t-value turned out higher than the table t-value, to wit: $t(22) = 43.02 > t\text{-table} = 1.717$ ($df = 22$, one-tailed $\alpha = 0.05$; $p < 0.001$). Given the results of these tests, the conclusion is that an impact of physical education on fundamental movements development in children with intellectual disabilities in a special school is evident, and $H1$ is accepted.

Descriptively, the mean TGMD-2 raw score increased from 42.35 ($SD = 8.43$) at pretest to 58.35 ($SD = 10.02$) at posttest, a mean gain of 16.00 points ($SD = 1.78$; 95% CI [15.23, 16.77]), equivalent to a 37.8% improvement. All 23 children improved, with individual gains ranging from 13 to 18 points. The standardised effect size was very large ($d_{av} = 1.73$, 95% bootstrap CI [1.49, 2.23]). The within-subject effect size was $d_z = 8.97$; this exceptionally high value reflects the very small variability of individual gains and should not be compared directly with between-group effect sizes reported in controlled studies. The post hoc statistical power for the observed effect approached 1.00. The Wilcoxon signed-rank test led to the same conclusion (all 23 differences positive; $z = -4.23$, $p < 0.001$), so the result does not depend on the normality assumption. The gains were also strongly and positively correlated with the pretest scores ($r = 0.87$, $p < 0.001$): the children with the highest pretest scores gained 18 points, whereas those with the lowest pretest scores gained 13 points, which is the opposite of the pattern expected if regression to the mean were the main source of change. Taken together, these results answer the research question affirmatively for this sample: TGMD-2 gross motor raw scores were higher after the 10-session programme than before it.

The findings show that, after the 10-session traditional game-based adaptive physical education programme, the TGMD-2 scores of children with mild ID increased substantially and consistently (mean gain = 16.00 points; $d_{av} = 1.73$). Interpreted through Newell's (1986) constraints model, the improvement may be attributed to the systematic modification of task constraints (simplified rules, reduced distances and adapted equipment) and environmental constraints (a familiar, culturally meaningful play setting), which allowed the children to practise running, sliding, jumping, throwing and catching repeatedly at an appropriate level of challenge. Because no control group was included, however, this interpretation remains tentative.

The programme elements can be mapped explicitly onto the three constraint domains. Individual (organismic) constraints—limited attention span and working memory, slower information processing, lower postural control and weaker muscular strength, which are typical of mild ID (Hartman et al., 2010; Vuijk et al., 2010; Li et al., 2025)—cannot be changed within a few weeks, so the programme was designed to accommodate them: instructions were reduced to short demonstrations and visual cues instead of lengthy verbal explanation, rules were simplified so that each game had one clear goal, and difficulty was increased only after a child had mastered the current level. Task constraints were then manipulated to channel the children toward the target skills: *hadang*, in which players cross lines guarded by opponents, demanded running, dodging, sliding and rapid changes of direction, while *mongalas* and *nobangan* supplied the jumping, throwing and catching demands of the programme; distances, ball size and team size were scaled so that every child could succeed. Environmental constraints were manipulated through smaller playing areas and, importantly, through the socio-cultural familiarity of the games, which reduces the novelty of the learning setting and may sustain the motivation needed for the large number of repetitions that skill stabilisation requires (Renshaw et al., 2010). In this sense, traditional games did not merely make practice enjoyable; they altered the interaction among the three constraint domains so that functional movement solutions became attainable for children whose individual constraints limit learning from conventional instruction (Chow et al., 2007).

Two strands of earlier research converge with this interpretation, although each covers only part of it. The first strand concerns adapted physical activity for children with ID: programmes based on movement and song (Sumaryanti et al., 2024), competition-based adaptive sport (Wahid et al., 2026), floor hockey (Hsu et al., 2021),

basketball and futsal (Aksović et al., 2023) and structured exercise packages (Kashi et al., 2023) have all improved gross motor outcomes in this population. Their common element is not a particular content but frequent, success-oriented practice in a modified task, which is consistent with the constraints-led explanation; however, these studies rarely specify which constraints were changed, and most relied on sport- or exercise-based content rather than culturally embedded play. The second strand concerns traditional games in typically developing children. Studies in Indonesia (Festiawan, 2020; Irawan et al., 2021; Suherman et al., 2019; Supriadi, 2019) and a controlled trial in Iran (Akbari et al., 2009) found that traditional-game programmes improved FMS, in several cases more than conventional instruction or ordinary daily activity, suggesting that the variability, unpredictability and intrinsic goals of such games provide rich opportunities to explore movement solutions. The strands diverge in their populations: none of the traditional-game studies involved children with ID, and none of the ID studies used indigenous games. The present study lies at the intersection of the two, and its results suggest that the mechanism identified in typically developing children—learning through modified, meaningful play—may also operate when the learners' individual constraints are more pronounced.

A critical comparison, however, shows that the magnitude of change in this study ($d_{av} = 1.73$) is considerably larger than the pooled effect of sports-game interventions on FMS ($SMD = 0.30$; Sun & Chen, 2024). Several methodological differences may explain this discrepancy. Sun and Chen (2024) pooled randomised controlled trials that compared intervention and control groups, whereas the present effect is a within-group pre-post change that also contains maturation, practice and test familiarity. Likewise, Irawan et al. (2021) and Supriadi (2019) compared experimental and control groups of typically developing children, while Festiawan (2020) and Suherman et al. (2019) worked with typically developing children rather than children with ID. In addition, the participants in this study started from a low baseline, typical of children with ID (Maïano et al., 2019), which leaves more room for improvement, and the TGMD-2 items overlap closely with the skills practised in the games. The consistent direction of findings across these studies strengthens confidence that adapted, play-based activity benefits motor skills, but the magnitude found here should be regarded as an upper-bound estimate.

The plausibility of the main alternative explanations can be judged, at least partly, from the data. Regression to the mean would predict the largest gains among the lowest-scoring children, yet the opposite was observed ($r = 0.87$ between pretest score and gain; Barnett et al., 2005). Maturation is unlikely to account for most of the change, because FMS develop gradually over years rather than weeks and are markedly delayed in children with ID (Maïano et al., 2019; Vuijk et al., 2010); nevertheless, without a control group the maturational gain expected over the intervention period cannot be quantified for this population. Testing effects are the most serious remaining threat: the TGMD-2 was administered twice by the same assessors, and the games rehearsed movements that the test assesses, so part of the gain may reflect familiarity with the test tasks rather than generalised skill improvement. Meta-analytic evidence that motor skill interventions are effective but produce considerably smaller effects when compared with control groups (Logan et al., 2012; Sun & Chen, 2024) indicates that only a controlled comparison can separate these sources of change.

International studies of children with ID point in the same direction, although none of them used traditional games. Adapted physical activity also gives these children a means of social inclusion that allows them to participate actively in school life (O'Neil & Olson, 2021). Hsu et al. (2021) showed that a structured floor hockey intervention improved motor proficiency, physical fitness and adaptive development in youths with mild intellectual disabilities. Meanwhile, the systematic review by Ben Rakaa et al. (2025) emphasises that adapted pedagogical strategies are central to the successful inclusion of students with special educational needs in physical education. Özkan and Kale (2023) in their empirical study showed that physical education activities can have positive effects on children with intellectual disabilities not only regarding the motor skills but as well the quality of the lives; and this conclusion is in accordance to what Karakaş, Eroğlu Kolayış, and Bayazıt (2025) report, namely that prolonged engagement in adaptive physical activity consistently results in better motor proficiency of children with mild intellectual disabilities, although without continuous program implementation these positive impacts may fade away. Another research done by Kashi, Dawes, Mansoubi, and Sarlak (2023) confirms the above-mentioned facts by showing that structured exercise package can lead to motor proficiency as well as social development among students with intellectual disabilities.

Regarding posture and movement coordination, this study's findings align with those of systematic reviews by Balayi and colleagues (2022) and Gao et al., (2025). Those studies concluded that children with intellectual disabilities who undergo a planned physical activity regimen experience significant enhancement of their postural control and balance. A systematic review, a meta-analysis, and the research by Li, Zhou, and Xu (2025) also support that the movement of children and the adolescents of intellectual disability are more limited in terms of balance control compared to those of the same age with normal development. Thus, a movement intervention focusing on this aspect, through games, would really help to improve this condition. This has been further validated by Klavina, Zusa-Rodke, and Galeja (2017) who demonstrated that children diagnosed with

intellectual disabilities have static control of their balance at a lower level than children without such difficulties, which shows the necessity of balance through the movement which is planned. In fact, Sun and Chen's (2024) meta-analysis has verified once again that game-based or sport-based approaches are much more effective than learning without a game element in improving children's fundamental movement skills.

From the perspective of participation and social inclusion, Martin Ginis along with his coauthors (Van Der Ploeg, Foster, Lai, McBride, & Ng, 2021) maintain that the right and fundamental need of disability-affected people worldwide is the physical activity. The article points out that besides disability, one of the main factors for physical education to be accessible is the use of inclusive pedagogical methods adapted to different needs. O'Neil and Olson (2021) support the claim of the importance of social acceptance and integration in the learning of physical education for the success of adapted programs. These ideas are also in line with evidence on adapted pedagogy for learners with other types of disability (Greve & Süßenbach, 2022; Kohut et al., 2021; Rufino et al., 2021). Mazzoli et al. (2021) found that brief classroom physical activities positively affect the intellectual disability in children by improving both cognition and on-task behavior. Barring the fact that children and teenagers with intellectual disabilities have a major risk of being overweight if they do not have enough regular physical activity, Maiano et al. (2016) stress that physical activity is essential. Wang, Lee, Zhang, Svendsen, Li, and Li (2023) also acknowledge this and their study showed that individuals with intellectual disabilities were at higher risk of cardiovascular disorders; thus, introducing physical activity as a routine during childhood through the adapted physical education is of preventive nature. In line with these studies, physical adaptation in the case of sports can be considered not only a matter of body mechanics but also brainpower, society and healthy lifestyle.

Theoretically, these results support the application of the constraints-led perspective to adaptive physical education for children with ID: rather than teaching isolated technical skills, teachers can design culturally familiar games whose rules, space and equipment are manipulated to elicit target movement patterns. The findings are also consistent with the developmental model of Stodden et al. (2008), in which improved FMS competence is expected to support later physical activity participation—an assumption that still needs to be tested longitudinally in this population. At the same time, the observation by Karakaş et al. (2025) that the benefits of adapted physical activity may fade when programmes are discontinued suggests that the gains reported here cannot be assumed to be permanent. The specific theoretical contribution of this study is therefore to show how culturally embedded games can serve as the design of task and environmental constraints for learners whose individual constraints are atypical, extending a framework developed largely with typically developing learners (Renshaw et al., 2010) to adaptive physical education in special schools.

This study has several limitations. First, the single-group pretest–posttest design without a control group cannot rule out alternative explanations for the improvement, including maturation during the intervention period, testing (practice) effects from repeated administration of the TGMD-2, regression to the mean, and novelty or attention effects. Although the short intervention period makes maturation an unlikely sole explanation for a 16-point gain, it cannot be excluded. Second, the sample was small ($n = 23$) and drawn from a single special school in Palu, which limits generalisability to children with moderate or severe ID, to other age groups and to other regions. Third, the assessors were not blinded to the testing occasion, and intervention fidelity was not formally measured. Fourth, only gross motor outcomes were measured immediately after the programme, so the retention of the gains and their transfer to daily activities are unknown. Future research should therefore use randomised or matched controlled designs involving comparable SLB institutions, blinded assessment with reported inter-rater reliability, fidelity monitoring, follow-up measurements and larger multi-site samples.

Overall, the direction of the present results is consistent with previous research and suggests that traditional-game-based adaptive PE may support the motor development of children with mild intellectual disabilities and may offer a holistic approach to promoting their cognitive, social and emotional development, although these latter outcomes were not measured in this study. Adaptive physical education programs can help children develop their motor skills at both inclusive and special schools when they are continuously provided. Continuous provision may allow steady improvement and help maintain the motor benefits over time. Research in the future might design variants of adaptive physical education games, music-based, and technology-assisted activities to enhance the level of motivation among children with intellectual disabilities in physical education classes. It is suggested that future work should incorporate not only gross motor indicators but also elements related to fine motor skills, endurance, and other physiological responses such as respiration and flexibility. Teachers working in adaptive physical education need to collaborate with other specialists such as a psychologist, a physiotherapist, and a parent to develop a program which will not be just a list of motor activities but will be addressing the children's real needs. Longitudinal studies are also needed to assess the long-term effects of

adaptive physical education on the motor development and quality of life of children with mild intellectual disabilities.

Conclusions

This exploratory study suggests that the constraints-led perspective can be translated into everyday adaptive physical education through culturally familiar games. By modifying the rules, space and equipment of mongalas, nobangan and hadang, teachers created practice conditions in which children with mild intellectual disability repeatedly performed the locomotor and object-control skills assessed by the TGMD-2, and the scores of all 23 participants were higher after 10 sessions. The main contribution is therefore pedagogical and methodological rather than proof of efficacy: indigenous games can be systematically adapted as task and environmental constraints for learners whose individual constraints limit the usefulness of verbally loaded, drill-based instruction. Because the single-group pretest–posttest design cannot exclude maturation, testing effects or regression to the mean, and because the sample came from a single school, the size of the change should not be interpreted as a causal effect or as evidence of superiority over other approaches. Future studies should randomise children or classes to the programme or to usual physical education; with $\alpha = 0.05$ and power = 0.80, about 64 children per group would be needed to detect a moderate between-group effect ($d = 0.50$), and more if whole classes are randomised. They should also use assessors blinded to group and testing occasion, report attendance and fidelity, examine locomotor and object-control subscores separately, and include a follow-up of at least 8–12 weeks after the programme ends to establish whether the gains are retained.

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