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Effect of Baduanjin on physical functioning and balance in adults with mild-to-moderate intellectual disabilities: A comparative study

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Abstract

Background: Adults with intellectual disabilities often experience mobility limitations. Baduanjin, a mindfulness-based exercise intervention, can exert positive effects on functional mobility and balance. This study examined the impact of Baduanjin on physical functioning and balance of adults with intellectual disabilities.

Method: Twenty-nine adults with intellectual disabilities participated in the study. Eighteen received a Baduanjin intervention for 9-months; 11 participants did not receive any intervention (comparison group). Physical functioning and balance were assessed using the short physical performance battery (SPPB) and stabilometry.

Results: Participants in the Baduanjin group experienced significant changes in the SPPB walking test ($p = .042$), chair stand test ($p = .015$), and SPPB summary score ($p = .010$). No significant changes between groups were observed in any of the variables assessed at the end of the intervention.

Conclusions: Baduanjin practice may cause significant, albeit small, improvements in physical functioning of adults with intellectual disabilities.

KEYWORDS
Baduanjin, disability, physical functioning, short physical performance battery, stabilometry

1 | INTRODUCTION

Adults with intellectual disabilities experience mobility limitations due to balance impairment and gait disturbances (Enkelaar et al., 2012; Oppewal et al., 2018). These balance and gait problems lead to a high risk of falling and to a less efficient walk (Almuhtaseb et al., 2014), which in turn may increase sedentary lifestyle and the risk for negative health outcomes associated with physical inactivity such as higher incidence of obesity or increased prevalence of cardiovascular disease (Oppewal et al., 2018; Perez-Cruzado et al., 2021). Mobility limitations also affect negatively basic activities of daily living and functional level (Oppewal et al., 2014) which are basic to ensure independent live and social participation (Hästbacka et al., 2016). Thus, interventions improving balance and gait may offer a promising strategy to improve physical functioning and health among adults with intellectual disabilities.

Several investigations proposed exercise programs as an intervention for improving balance and gait in people with intellectual disabilities. While there is a considerable body of research conducted with young people with intellectual disabilities (age range 8–25 years old) (Maïano et al., 2019), there is a paucity of research evaluating the effects of exercise interventions on balance and physical functioning in adults. The available research suggests that exercise interventions such as balance (Kovačič et al., 2020), strength training (Martínez Aldao et al., 2020) or combined training programs (Oviedo et al., 2014) improve static and dynamic balance, gait and physical functioning in adults with intellectual disabilities. However, the small number of studies indicates the need for further research.

One interesting area for such research encompasses mindfulness-based interventions, which seem to be well accepted by people with intellectual disabilities (Singh & Hwang, 2020). For instance, preliminary evidence showed that Tai Chi is an effective mindfulness rehabilitation strategy for improving balance among young people with intellectual disabilities (Collier, 2019; Kong et al., 2019), and can reduce fall risk among adults with intellectual disabilities (Nissim et al., 2019). However, Tai Chi can be complex to understand and lengthy for some individuals (Yuen et al., 2021). Baduanjin, a form of traditional Qigong, is considered easier to learn because it comprises eight simple movements, known as eight-section brocades (Zou et al., 2017). This makes this form of Qigong less physically and cognitively demanding and easier to practice. Moreover, Baduanjin is an adaptable exercise that can be practiced in any place and requires no special equipment. Therefore, Baduanjin may be a more approachable intervention than other mindful movement-based practices for people with intellectual disabilities.

Like other mind–body interventions, Baduanjin is characterised by coordination of mind and body with low exercise intensity. Baduanjin involves maintaining balance with weight shifting or moving the arms, legs, and torso to change the centre of gravity while emphasising mental practice, breathing techniques, and musculoskeletal relaxation (Zou et al., 2018). Baduanjin movements requires the individual to reach beyond the base of support or change the base of support between bilateral and unilateral stance while moving head and neck (Yuen et al., 2021; Zou et al., 2017). These movements enhance the integration of sensory information required for effective balance control. Besides, most of the manoeuvres are performed in a semi-squatting position so muscle strength is required to execute movements successfully. Thus, it seems that Baduanjin is a potentially useful strategy for improving balance and muscle strength (Yuen et al., 2021). This may in turn confer benefits on physical functioning and mobility. In accordance with this line of reasoning, previous studies performed in people with different health conditions indicated that Baduanjin has a positive effect on balance (Liu et al., 2016), gait and functional mobility (Xiao & Zhuang, 2016), and can improve the ability to perform activities of daily living (Li et al., 2019; Liu et al., 2016; Zou et al., 2018).

To the best of the authors' knowledge, no study has sought to evaluate the effects of delivering a Baduanjin intervention to adults with intellectual disabilities. Therefore, the aim of this study was to identify the impact of a Baduanjin intervention on the physical functioning and balance levels of a group of adults with intellectual disabilities.

2 | METHOD

2.1 | Participants

Participants were recruited from Lantegi Batuak, a company that provides supported employment to people with intellectual disabilities. Eligible participants were employees who participated in the company's Active Aging Program. The aim of this program is to adapt the workplace environments of people with intellectual disabilities so that they can remain active while carrying out an occupational activity. Study inclusion criteria were (a) age ≥40 years, (b) diagnosed with mild or moderate intellectual disabilities according to the American Association on Intellectual and Developmental Disabilities criteria (Schalock et al., 2021), (c) ambulatory autonomy, (d) medically cleared to perform exercise, (e) able to follow an exercise intervention and (f) able to participate in activities in groups of 10 people. Participants were excluded from the study if they were (a) diagnosed with severe intellectual disability, (b) require one-to-one support and (c) participated in other movement-based activities.

Recruitment took place through social workers at Lantegi Batuak. Individuals who met inclusion criteria were invited to join the study after their parents or legal guardians were given detailed information about the research. The Ethics Committee for Research on Human Subjects of the University of the Basque Country approved this study, which was performed in accordance with the principles of the Declaration of Helsinki (World Medical Association, Helsinki, 2013).

After obtaining participant and parent or legal guardian written informed consent (as appropriate), participants who wanted to attend Baduanjin sessions were allocated to the intervention group. The rest of the participants were allocated to the comparison group (Figure 1). Because of the nature of the intervention, it was not possible to disguise assignments for participants or the Baduanjin instructor. However, group allocations were disguised to the research staff responsible for the outcome assessments and statistical analyses.

2.2 | Intervention

2.2.1 | Baduanjin

One-hour group Baduanjin sessions were conducted once a week for nine-months (a total of 35 sessions) at the company's facilities and were led by a certified instructor with 12 years of experience. The intervention included 5–10 min warm-up exercises, 40–50 min of Baduanjin exercises, and 5–10 min of cool-down exercises. The warm-up included deep breathing and simple movements of trunk rotation and arm swinging. Core Baduanjin movements, which consist of 10 postures (including the beginning and ending postures), were conducted according to the standards of the Health Qigong Management Center of General Administration of Sport in China (2003) (Figure 2). Deep breathing, meditation, and patting the body were included in the cool-down. Any unexpected adverse event during the intervention (e.g., scrapes or falls) was collected on a daily basis by the instructor and then reported to the research staff. Participants did not receive additional exercise intervention during the study. Comparison group participants continued with their daily activity pattern and did not receive any other movement-based therapy. Participants, their families and the social workers of the centre were urged to inform the

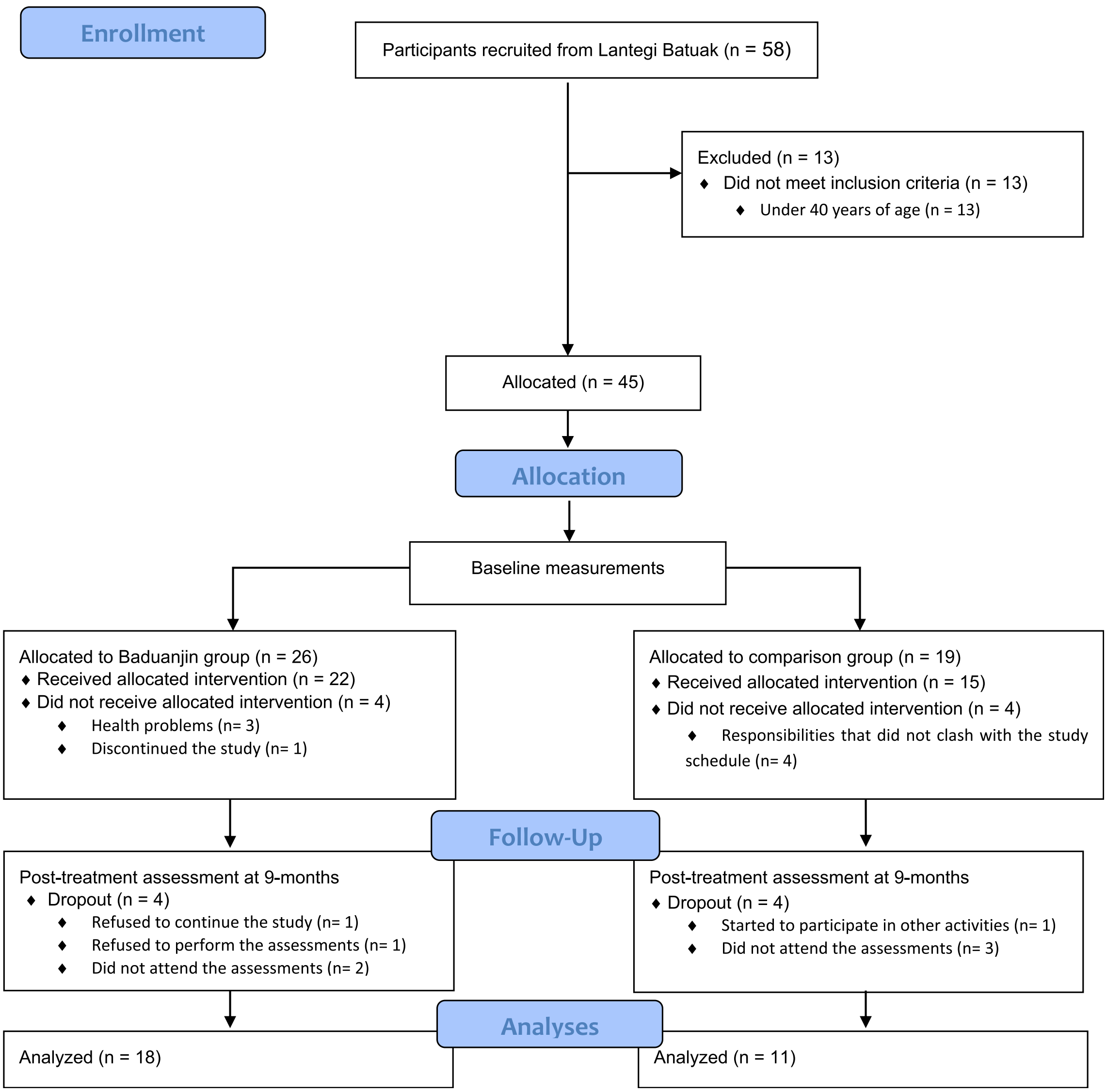

FIGURE 1 Study flow diagram

research staff in case any of the participants were taking part in any movement-based therapy.

2.3 | Outcome measures

Participant demographics, intellectual disability severity, and institutionalisation status were obtained from the company database. Baduanjin session attendance and compliance information were collected by the social workers of the company.

2.3.1 | Anthropometric measurements

Height was measured to the nearest 0.1 cm with a portable stadiometer (Asimed T226). Weight was measured to the nearest 0.1 kg on a digital scale (Seca Model 869) with the participant wearing lightweight clothing and no shoes. Body mass index was calculated as weight in kilograms divided by height in meters squared (kg/m^2).

2.3.2 | Short physical performance battery

The Short Physical Performance Battery (SPPB) provides functional status information through lower-body muscular performance assessments. The SPPB consists of three tests: standing balance, walking speed, and a chair-stand test. The score for each test is given in a categorical modality (0–4) based on run intervals, with higher values representing the best performance. The total score ranges from 0 (worst) to 12 points (best) (Guralnik et al., 1994). To measure standing balance, the ability to stand for up to 10 s with feet positioned in three different positions (side-by-side, semi-tandem, and full tandem) was scored. Participants scored 1 if they could hold a side-by-side standing position for 10 s but were unable to hold a semi-tandem

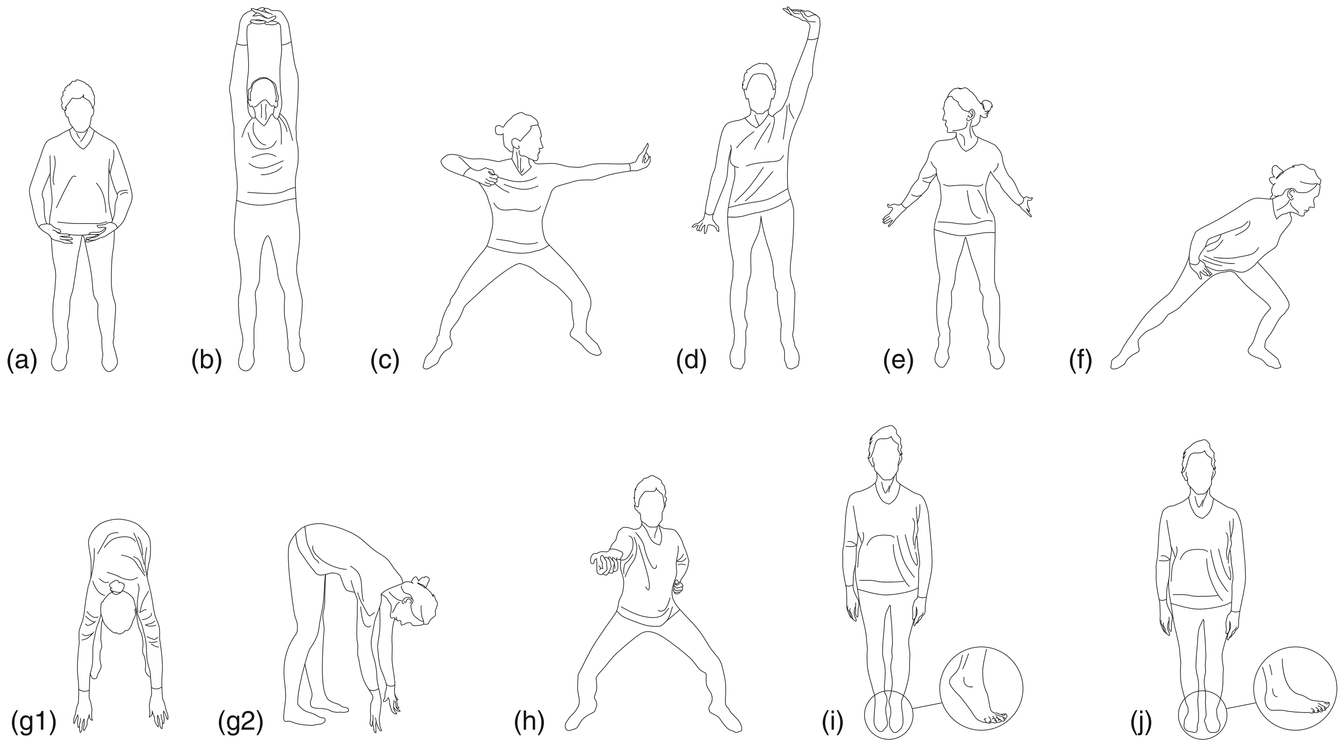

FIGURE 2 The postures of Baduanjin. (a) Preparation posture; (b) Hands up to heaven; (c) Hawk shooting with a bow; (d) Separating heaven and earth; (e) Head turning left and right; (f) Trunk leaning from side to side; (g) Trunk forward bending with hands sliding slowly from chest to knee; (h) Arm punch left and right; (i) Heels up and down; (j) Ending posture

position for 10 s, a score of 2 if they could hold a semi-tandem position for 10 s but were unable to hold a full tandem position for more than 2 s, a score of 3 if they could stand in the full tandem position for 3–9 s, and a score of 4 if they could stand in the full tandem position for 10 s. Walking speed was measured using two photocells (Seiko, S23751J, JP) connected with a recording chronometer. Photocells were placed at the beginning and end of the 4 m course. Participants were instructed to stand with both feet touching the starting line and to begin walking at their usual pace after a verbal command. The time between activation of the first and second photocells was recorded. The time of the faster of the two walks was used for scoring. Participants were scored according to cut-off points (Guralnik et al., 1994). For the chair-stand test, a pre-test was performed in which participants were asked to fold their arms across their chest and stand up from a seated position. If the pre-test was successful, participants were then asked to perform five chair stands as quickly as possible. The test was performed once and the time to complete five chair rises was recorded. Predefined cut-off points for time required to perform the test were used for scoring (Guralnik et al., 1994).

The SPPB has been previously used to analyse the effects of exercise on physical functioning and balance in people with intellectual disabilities (Torres-Unda et al., 2017) and its feasibility with adults with intellectual disabilities has been positively informed (Oppewal et al., 2018; Oppewal & Hilgenkamp, 2020).

2.3.3 | Static balance

Static balance was assessed with a stabilometric platform (Winposture, Medicapteurs, FR) at an acquisition frequency of 40 Hz (Normes 85; Association Française de Posturologie, 1985). Participants were instructed to stand barefoot as still as possible on the platform for 60 s (Ruhe et al., 2010). A plastic form was used to ensure the same foot position for all participants. Participants were instructed to look straight ahead at a mark placed on the wall 2 m away at eye level with arms at their sides. Data were collected after participants adopted the required posture on the platform, stabilised their postural sway, and signalled one of the assessors that they were ready to begin. For safety reasons, an assessor remained near the participant without touching them or providing additional instructions during the test. Displacements of the centre of pressure (COP) were expressed in terms of sway area (mm^2) and path length (mm).

Stabilometry is a postural control assessment that has been widely used for clinical populations (Qiu & Xiong, 2015; Terra et al., 2020) and the reliability of COP measures in static bipedal stance in adults with intellectual disabilities has been previously reported (Suomi & Koceja, 1994). In addition, previous studies with people with intellectual disabilities used stabilometry to evaluate changes in static balance after exercise interventions (Torres-Unda et al., 2017).

TABLE 1 Baseline characteristics of the sample

Variable	All sample ($n = 29$)	Comparison group ($n = 11$)	Baduanjin group ($n = 18$)	p
Age (years)	51.52 (7.45)	50.00 (6.45)	52.44 (8.03)	
Weight (kg)	81.41 (23.53)	77.56 (19.47)	83.77 (25.95)	.501
Stature (cm)	165.66 (12.61)	162.29 (13.44)	167.72 (12.00)	.471
BMI (kg/m^2)	29.69 (8.48)	29.17 (5.69)	30.01 (9.96)	.268
Sex				
Men	21 (72.4)	7 (63.6)	14 (77.8)	.408
Women	8 (27.6)	4 (36.4)	4 (22.2)	
Intellectual disability level				
Mild	19 (65.5)	7 (63.6)	12 (66.7)	.868
Moderate	10 (34.5)	4 (36.4)	6 (33.3)	
Living in nursing home	6 (20.7)	2 (18.2)	4 (22.2)	.736

Note: Variables are expressed in mean (SD) or in number (%) as appropriate.

2.4 | Assessments

Participants received instructions about the experimental procedures and tests and performed three familiarisation sessions before the study. In these sessions participants repeated the tests until the researcher group observed that the participants were confident and able to perform the assessments correctly. Assessments were conducted at the company's facilities by research staff with no knowledge of group allocation on two occasions: before the program onset and just after its finalisation. Anthropometric measurements were taken at baseline. Next, static balance and SPPB tests were individually explained and then performed by research staff. Right after the explanation, participants were allowed to attempt each test. The same research staff, who had experience working with people with intellectual disabilities, were in charge of all assessments.

2.5 | Statistical analyses

Descriptive statistics of quantitative variables are represented as mean (standard deviation) and qualitative variables as n (%). Data were checked for normality of distribution using the Shapiro–Wilk test. Descriptive statistics were computed and baseline differences were assessed using a Student's t-test or a Chi-squared test for quantitative and qualitative variables, respectively. A two-way mixed analysis of variance was conducted to determine between (comparison and Baduanjin) and within (baseline and nine-month) effects. Significant between-group differences at each level were examined using Student's-t test or Mann–Whitney U-test. Within-group differences were assessed by paired t-tests or Wilcoxon test. Time-by-group interaction was calculated to analyse differences in evolution of the 2 groups. Partial η^2 was calculated to estimate the effect size; η^2 values of .01 to .059, .06 to .137, and .138 or greater were considered small, medium, and large, respectively (Cohen, 1988). Significance for all variables was set at a p-value of <.05. IBM SPSS Statistics 25 software (SPSS, Inc.) was used to analyse the data.

3 | RESULTS

Of the 58 participants interested in taking part in the study, 45 met the inclusion criteria and performed baseline tests. Four participants in each group did not receive their allocated intervention (one participant discontinued the study, three participants had health problems and four participants had responsibilities that did not clash with the study schedule). Therefore, a total of 37 participants were allocated to comparison or Baduanjin groups. Four participants dropped out of the study in each group (one participant started to participate in another movement-based activity, others refused to continue in the study or refused to perform the assessments). A total of 29 participants completed the study (Figure 1).

The characteristics of the sample are shown in (Table 1). The mean age of the sample was 51.52 years and 67.72% were men. Nineteen (61.3%) and 10 (32.3%) participants were diagnosed with mild and moderate intellectual disability, respectively. Six participants lived in a nursing home. No statistically significant differences were found between both groups in any of the variables assessed at baseline.

No adverse events were reported during the Baduanjin intervention. Overall session attendance was 85.7%, ranging from 30 to 35 sessions. Lack of attendance was generally due to participants' personal issues and other commitments not related to the study.

The statistical analysis of the Wilcoxon test indicated the existence of significant pre-post changes in the SPPB walking test score [pre: 3.67 (.59); post: 3.89 (.32); $p < .042$], chair-stand test [pre: 3.17 (1.09); post: 3.67 (.76); $p < .015$] and SPPB summary score [pre: 9.83 (2.06); post: 10.78 (1.73); $p < .010$] in the Baduanjin group. No significant pre-post changes were found in standing or static balance in either group. Time-by-group interactions were not observed in any of the analysed variables (Table 2).

4 | DISCUSSION

This study analysed the impact of Baduanjin as a therapeutic strategy for improving balance and physical functioning in adults with

TABLE 2 Short Physical Performance Battery and static balance at Baseline and after a 9-month intervention in comparison and Baduanjin groups

	Comparison group ($n = 11$)			Baduanjin group ($n = 18$)				
	Baseline	9-month	*p*	Baseline	9-month	*p*	Time · group interaction	η^2
	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)			
SPPB								
Balance standing test (score)	3.63 (0.67)	3.45 (1.03)	.617	3.00 (0.97)	3.22 (1.11)	.361	.331	.035
Side-by-side stand (score)	1.00 (0.00)	1.00 (0.00)	–	1.00 (0.00)	1.00 (0.00)			
Semi-tandem stand (score)	0.91 (0.30)	0.91 (0.30)	1.000	0.78 (0.42)	0.89 (0.32)	.163	.444	0022
Full tandem stand (score)	1.73 (0.64)	1.55 (0.82)	.553	1.22 (0.73)	1.33 (0.90)	.579	.398	.027
Walking test (score)	3.73 (0.46)	4.00 (0.00)	.082	3.67 (0.59)	3.89 (0.32)*	.042	.768	.003
Chair stand test (score)	3.45 (0.82)	3.73 (0.90)	.277	3.17 (1.09)	3.67 (0.76)*	.015	.456	.021
SPPB summary (score)	10.82 (1.40)	11.18 (1.83)	.476	9.83 (2.06)	10.78 (1.73)*	.010	.316	.037
Stabilometry								
Sway area (mm^2)	184.01 (88.90)	197.92 (226.67)	.811	283.86 (170.83)	242.30 (143.05)	.178	.348	.033
Path length (mm)	737.21 (807.29)	741.38 (544.68)	.967	721.96 (309.89)	651.84 (229.13)	.272	.507	.016

*$p < .05$: statistically significant versus Baseline. A Wilcoxon test was performed.Abbreviations: SD, standard deviation; SPPB, short physical performance battery.

intellectual disability. The present findings may be of interest for rehabilitation professionals working in the field of intellectual disability, since they offer original information on the efficacy of this novel approach.

The obtained results indicate that Baduanjin led to significant improvements in physical functioning of the participants. Nevertheless, this positive effect was mainly due to improved performance on the chair-stand and walking tests of the SPPB, while standing balance seemed not to be affected. Similar results were obtained by Torres-Unda et al. (2017) after a long exercise intervention based on administration of the Feldenkrais method, a movement-awareness therapy, to a group of adults with intellectual disability. The observed improvements in the chair-stand test could be attributed to Baduanjin exercises that require performing upper limb movements while maintaining a semi-squat position, which may have increased lower-limb muscular strength (Fang et al., 2021). Walking performance could have also improved through acquisition of a better gait pattern. Indeed, previous research has shown that Baduanjin can increase gait-related spatiotemporal parameters such as cadence, step and stride length (Ye et al., 2022).

It is important to note that at baseline the showed functioning levels similar to those observed in adults aged 80 years or older, while after the intervention the SPPB total score was close to that of adults aged 70–74 years (Bergland & Strand, 2019). Notably, the intervention led to clinically meaningful changes in physical functioning only in the Baduanjin group (0.95 points in the SPPB summary score) (Kwon et al., 2009). This improvement was also similar to the minimal detectable change range reported in older people (0.8–1 points) (Olsen & Bergland, 2017; Perera et al., 2006). This results talks in favour of the utility of Baduanjin as a therapy for people with intellectual disabilities. However, it is worth mentioning the lack of significant differences found between groups once the program ended. Therefore, the impact of Baduanjin might not be as high as initially expected. According to a present review about clinical studies on Baduanjin, the average duration of the programs was 18 weeks with sessions 1 or 2 times a day, 3–5 days per week (Zhou et al., 2020). Although the duration of the present Baduajin intervention was long enough (nine-months), sessions were only held once per week. This exercise schedule might help to explain the low magnitude of the observed changes and may suggest the need for greater weekly exercise frequency in this population.

Results from the stabilometric tests reinforce the idea that Baduanjiin performance may not have a significant impact on static balance. This was an unexpected result, as mind–body interventions stimulate cognitive components such as heightened body awareness, focused mental attention, proprioception, neuromuscular coordination and executive function (Song et al., 2017), that are related to balance performance. In addition, the execution of slow and rhythmic movements in which the body weight is shifted from one leg to the other, challenges the balance control system to keep its centre within a changing base of support (Wu et al., 2018). Specifically, Baduanjin routines require practitioners to sustainably maintain the balance with weight-shifting movement or moving their arms, legs, and torso to change the centre of gravity. This sequence of movements in turn can lead to a better postural control (Zou et al., 2018). Indeed, previous studies have confirmed the efficacy of Baduanjin for improving balance. Nevertheless, it should be noted that scientific evidence in this regard comes from healthy samples (Zou et al., 2017), or from stroke survivors (Zou et al., 2018).

The effects of exercise interventions on balance in individuals with intellectual disabilities remain inconclusive (Suárez-Iglesias et al., 2021). The underlying mechanisms contributing to balance impairment in this population are multifactorial and involve premature aging, obesity, physical inactivity, neurological disturbances, altered executive function, and peripheral sensory deficits (Leyssens et al., 2022). Thus, it is plausible that a multidisciplinary approach could be a more accurate strategy for achieving balance improvements in adults with intellectual disabilities (Kovačič et al., 2020).

This study shows novel preliminary scientific evidence of the effects of Baduanjin on physical functioning and balance in adults with intellectual disability. A comparison group was included, the intervention was lengthy, and widely used measurement tools that have been proved to be feasible with people with intellectual disabilities were used to assess its effects. However, there are certain methodological weaknesses that limit the strength of the results obtained. In the first place, the lack of allocated randomization together with the fact that participants were not equally distributed, could affect the comparability between groups at baseline. Secondly, the sample size was small and the study only included people over the age of 40 which makes it difficult to extrapolate the data to the entire population with intellectual disabilities. Finally, participants in the Baduanjin group were willing to exercise, while those who did not wish to do so formed the comparison group. This unbalanced distribution does not allow to confirm whether the practice of Baduanjin would be positively accepted by the whole spectrum of people with intellectual disabilities. In any case, this investigation sets the basis for further randomised controlled trials on the efficacy of Baduanjin in this population.

5 | CONCLUSION

A nine-month Baduanjin intervention led to significant improvements in physical functioning in a group of adults with intellectual disabilities, albeit of low magnitude. No significant effects on static balance were observed. Future randomised controlled trials with larger samples are needed to expand the scientific evidence on the impact of Baduanjin on this population.

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CONFLICT OF INTEREST STATEMENT

All authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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