INPLASY

The Impact of Physical Activity on the Balance Ability of Children and Adolescents with Intellectual Disabilities: A Systematic Review and Meta-Analysis

INPLASY202550025
doi: 10.37766/inplasy2025.5.0025
Received: 12 May 2025
Published: 12 May 2025

Li, DD; Hu, JP.

Corresponding author:
Dandan Li

18763873907@163.com

Author Affiliation:
University of Jinan.

ADMINISTRATIVE INFORMATION

Support - None.

Review Stage at time of this submission - Data analysis.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202550025

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 12 May 2025 and was last updated on 12 May 2025.

INTRODUCTION

Review question / Objective This systematic review and meta-analysis aim to investigate the impact of physical activity on the balance ability of children and adolescents with intellectual disabilities and to explore the dose-response relationship of physical activity in improving their balance ability. This study provides an objective reference for future relevant practices.

Rationale In recent years, physical activity has been widely recognized as an effective intervention for improving individuals' balance abilities. Studies indicate that consistent and regular physical activity can enhance the coordination between nerves and muscles in the general population, optimize proprioceptive abilities, and effectively reduce the risk of falls. For specific groups, such as the elderly and children with cerebral palsy, targeted systematic training programs have also demonstrated significant improvements in balance. Additionally, research on children and adolescents with intellectual disabilities is increasing, showing that appropriate exercise interventions can enhance their motor skills, postural stability, and significantly reduce fall frequency.

The mechanisms by which physical activity improves balance primarily include central nervous system regulation, enhanced proprioception, and increased core strength. First, regular physical activity is believed to promote functional integration between the cerebral cortex and motor-related areas, thereby improving neural mechanisms associated with motor control and coordination. Research suggests that sensorimotor training can activate neural plasticity, enhance functional activity in the cerebral cortex, and improve motor coordination in children with intellectual disabilities. This strengthening of neural mechanisms provides a crucial physiological foundation for balance improvement. Second, physical activity can also enhance balance control by improving proprioception, which is the ability to perceive the body's position and movement in space and is essential for maintaining balance. Exercise interventions stimulate neuromuscular

feedback pathways, increasing sensitivity and responsiveness to postural changes in children with intellectual disabilities. Finally, increased core strength is another key mechanism by which physical activity improves balance. Core muscles play a vital role in maintaining postural stability and dynamic balance. Targeted training, such as jumping and gait exercises, enhances the strength and endurance of core muscles, improving postural control in children with intellectual disabilities and effectively reducing fall risks. Notably, while physical activity is beneficial for improving balance in children and adolescents with intellectual disabilities, the optimal dose-response relationship remains unclear and requires further exploration and validation.

Condition being studied (1) Participants must be children and adolescents under 18 years old diagnosed with intellectual disability based on established criteria. (2) Studies focusing solely on specific intellectual disabilities (e.g., Down syndrome, autism spectrum disorder, Williams syndrome, cerebral palsy, etc.) are excluded. This exclusion criterion aims to enhance the homogeneity of the study population regarding the primary factors affecting balance ability. These specific conditions often involve unique motor (e.g., hypotonia in Down syndrome, spasticity in cerebral palsy), sensory, or neurological impairments, which may act as significant confounding factors that obscure the specific effects of general physical activity on balance ability related to intellectual disability itself. (3) Participants should not have other acute or chronic physical or medical conditions that may independently affect balance or participation in physical activity.

METHODS

Search strategy Six electronic databases, including Web of Science, Cochrane Library, PubMed, CNKI, Wanfang, and VIP, were selected to retrieve randomized controlled trials (RCTs) on the effects of physical activity (exercise intervention) on balance ability in children and adolescents with intellectual disabilities. The search period ranged from the establishment of each database to June 25, 2024. The search strategy primarily combined subject headings and free-text terms. The English search strategy was as follows: ("intellectual" OR "mental retard" OR "developmental" OR "intellectual disability") AND ("child" OR "adolescences" OR "students" OR "youth") AND ("balance" OR "posture control" OR "postural adaptation" OR "postural performance").The search terms in Chinese are roughly as follows: SU = ("intellectual disability" + "developmental delay") AND SU = ("children" + "adolescents") AND SU = ("physical activity" + "exercise intervention") AND SU = ("balance ability" + "postural control").

Participant or population Participant or Patient: (1) Participants must be children and adolescents under 18 years of age diagnosed with intellectual disabilities according to established criteria. (2) Studies focusing solely on specific intellectual disabilities (e.g., Down syndrome, autism spectrum disorder, Williams syndrome, cerebral palsy, etc.) are excluded. This exclusion criterion is set to enhance the homogeneity of the study population regarding the primary factors affecting balance ability. These specific conditions often involve unique motor (e.g., hypotonia in Down syndrome, spasticity in cerebral palsy), sensory, or neurological impairments, which may act as significant confounders and obscure the specific effects of general physical activity on balance ability related to intellectual disabilities themselves. (3) Participants should not have other acute or chronic physical or medical conditions that may independently affect balance or participation in physical activity.

Intervention Intervention: The intervention must be a well-designed, planned physical activity aimed at improving individual balance ability. Examples include core strength training, hippotherapy, Tai Chi, Wii Fit balance training, and other exercise modalities.

Comparator Comparison: (1) There should be no significant differences in baseline indicators between the experimental and control groups before the intervention, ensuring comparability. (2) The control group must maintain normal daily routines or participate in regular school physical education classes without receiving other specialized exercise interventions.

Study designs to be included Published randomized controlled trials (RCTs) are eligible for inclusion, while non-randomized studies are excluded.The primary outcome measure is the score assessing balance ability. Secondary outcome measures include the duration of a single intervention session, intervention frequency, intervention period, etc.

Eligibility criteria All criteria other than the PICOS inclusion criteria were listed as exclusion criteria.

Information sources Six electronic databases—Web of Science, Cochrane Library, PubMed, CNKI,

Wanfang, and VIP—were searched for randomized controlled trials (RCTs) examining the effects of physical activity (exercise intervention) on balance ability in children and adolescents with intellectual disabilities. The search period spanned from the inception of each database to June 25, 2024. A combination of subject headings and free-text terms was primarily used to construct the search strategy. The search identified 2,289 relevant articles. After removing 1,383 duplicate records, 906 articles remained. Subsequently, 890 articles were excluded based on title, abstract, and adherence to inclusion/exclusion criteria. Ultimately, 16 articles (21 studies) were included in the meta-analysis.Six electronic databases—Web of Science, Cochrane Library, PubMed, CNKI, Wanfang, and VIP—were searched for randomized controlled trials (RCTs) examining the effects of physical activity (exercise intervention) on balance ability in children and adolescents with intellectual disabilities. The search period spanned from the inception of each database to June 25, 2024. A combination of subject headings and free-text terms was primarily used to construct the search strategy. The search identified 2,289 relevant articles. After removing 1,383 duplicate records, 906 articles remained. Subsequently, 890 articles were excluded based on title, abstract, and adherence to inclusion/exclusion criteria. Ultimately, 16 articles (21 studies) were included in the meta-analysis.Six electronic databases—Web of Science, Cochrane Library, PubMed, CNKI, Wanfang, and VIP—were searched for randomized controlled trials (RCTs) examining the effects of physical activity (exercise intervention) on balance ability in children and adolescents with intellectual disabilities. The search period spanned from the inception of each database to June 25, 2024. A combination of subject headings and free-text terms was primarily used to construct the search strategy. The search identified 2,289 relevant articles. After removing 1,383 duplicate records, 906 articles remained. Subsequently, 890 articles were excluded based on title, abstract, and adherence to inclusion/exclusion criteria. Ultimately, 16 articles (21 studies) were included in the meta-analysis.

Main outcome(s) A total of 16 articles (21 studies) involving 554 participants (281 in the intervention group and 273 in the control group) were included. (1) Physical activity had a positive effect on the balance ability of children and adolescents with intellectual disabilities (SMD=1.19, 95% CI [0.87, 1.51], $p < 0.01$). (3) The optimal intervention effect was achieved with an exercise program involving strength training (or other physical activity methods), with each session lasting 30–45 minutes (SMD=1.38, 95% CI [0.51, 2.26], p=0.002), conducted twice weekly (SMD=1.45, 95% CI [0.79, 2.10], $p < 0.001$), and sustained for 8–10 weeks (SMD=1.51, 95% CI [0.89, 2.14], $p < 0.001$).

Quality assessment / Risk of bias analysis The quality assessment of the included literature was independently conducted by two researchers according to the Cochrane Handbook for Systematic Reviews. The evaluation criteria mainly included: random sequence generation (selection bias), allocation concealment (selection bias), blinding of participants and personnel (performance bias), blinding of outcome assessment (detection bias), incomplete outcome data (attrition bias), selective reporting (reporting bias), and other biases. The quality information of the studies included in the analysis was ultimately imported into Review Manager 5.4 to generate a risk of bias graph.

Strategy of data synthesis This study used Review Manager 5.4 and Stata 17 software to statistically analyze the relevant data from the included literature. (1) Since the outcome measures of the included studies were continuous variables with inconsistent units, standardized mean difference (SMD) and its 95% confidence interval (CI) were used for statistical analysis. Referring to the Cochrane Handbook for Systematic Reviews, I^2 and p-values were employed to determine the degree of heterogeneity among studies. I^2 represents the level of heterogeneity between studies, ranging from 0 to 100%. When I^2 is 0, there is no heterogeneity among studies; when $I^2 < 25\%$, there is slight heterogeneity; when 25% 50%, there is high heterogeneity. If $I^2 \leq 50\%$ and $p < 0.05$, a fixed-effects model was selected; otherwise, a random-effects model was used, along with meta-regression to identify sources of heterogeneity. (2) For effect size, this study followed Cohen's criteria, where an effect size below 0.2 indicates a small effect, 0.2–0.8 indicates a moderate effect, and above 0.8 indicates a large effect. (3) Egger's test was used to assess publication bias in the included studies. If publication bias was detected, the trim-and-fill method was applied to evaluate the stability of the pooled results. (4) Two methods were used for sensitivity analysis to ensure the reliability of the results: ① Switching between random-effects and fixed-effects models and re-analyzing all statistical results. ② Sequentially excluding one study at a time to assess the influence of each study.

Given that multiple studies reported various balance parameters (e.g., CoPmax and CoPsd in

the anterior-posterior [A/P] and medial-lateral [M/L] directions) measured under different conditions (e.g., eyes open/closed, single-leg/double-leg stance, foam/firm surface), this statistical analysis uniformly adopted CoPmax-M/L during double-leg stance with eyes open as the measure of balance ability. Additionally, this study referred to the Cochrane Handbook for Systematic Reviews to address the issue of opposite scales in outcome measures by multiplying the mean outcome parameter of individual studies by -1 while keeping the standard deviation unchanged.

Subgroup analysis After confirming that physical activity can significantly improve the balance ability of children and adolescents with intellectual disabilities, this study will use the following as grouping criteria for detailed subgroup analysis: the type of outcome assessed (Dynamic/Static), the type of intervention (Strength training/Aerobic training/Balance training), the duration of each intervention session ($30 \leq T < 45 / T = 45 / 45 \leq T < 60$), the intervention frequency (2 times a week/3 times a week), and the intervention period ($6 \leq C < 8 / 8 \leq C < 10 / 10 \leq C < 24$).

Sensitivity analysis After switching between random-effects and fixed-effects models and re-performing the statistical analysis, it was found that all statistical results showed no significant changes. This indicates that model selection had little impact on the study, and the findings are robust and reliable. The influence of each study was evaluated by sequentially excluding one study at a time.

Language restriction Only Chinese and English literature.

Country(ies) involved China.

Keywords Physical activity; Balance ability; Adolescents; Intellectual disabilities; Systematic review; Meta-analysis.

Contributions of each author

Author 1 - Dandan Li - Writing manuscripts, data analysis, graphic creation, manuscript revision.
Email: 18763873907@163.com
Author 2 - Jinping Hu - writing manuscript, quality control, supervision, verifying manuscript, revising manuscript.