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Research Article

INVESTIGATING THE IMPACT OF AEROBIC AND DUAL-TASK BALANCE TRAINING ON BALANCE AND FUNCTIONAL ABILITIES IN CHILDREN WITH INTELLECTUAL DISABILITY

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Abstract

Background: Children who have an intellectual disability frequently show restrictions in postural stability, coordination of movement, physical fitness, and independence in daily tasks. Organised exercise programmes that place cognitive and motor demands on the child at the same time could offer a practical way of enhancing these capacities.

Methodology: Forty children, 3–8 years old, with mild intellectual disability were enrolled from Santosh Medical College and hospital, Ghaziabad and the Little Masters Child Development Center, New Delhi, in this randomized controlled trial. They were divided at random into an experimental arm (n=20) that performed dual-task balance activities along with aerobic exercise, and a control arm (n=20) that performed the dual-task balance activities only; sessions lasted 30 minutes and took place two times per week across 8 weeks. The Paediatric Balance Scale (PBS) and WeeFIM served as measures of postural stability and daily functional performance, respectively, and BMI was noted as well.

Results: PBS scores rose more in the experimental arm, moving from 39.15 ± 5.17 to 43.65 ± 5.04, while the control arm moved from 39.45 ± 4.10 to 39.95 ± 4.02. For WeeFIM, the experimental arm went from 89.75 ± 12.93 to 96.10 ± 12.13, and the control arm went from 87.05 ± 8.76 to 87.60 ± 8.87. After the programme, the two arms differed significantly on PBS (t=-2.567, p=0.015) as well as on WeeFIM (t=-2.53, p=0.016). No change in BMI was seen in either arm.

Conclusion: Adding aerobic exercise to dual-task balance activities led to clearly larger gains in postural stability and daily functional performance compared with dual-task balance activities performed on their own.

Keywords: Intellectual disability, aerobic exercise, dual-task balance training, balance, functional independence.

1. Introduction

The term "intellectual disability" (ID) describes a broad spectrum of people's behavior. They include children with modest delays who are usually indistinguishable from their peers and children with severe developmental issues who need continuous care.

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These kids had varied results as well. Every person with ID has a distinctly low level of intellectual functioning, which includes challenges with perceive and process new information, learning fast and effectively, using knowledge and skills to solve problems, creative and flexible thinking, and respond quickly and accurately. Adaptive functioning is also significantly impaired in those with ID. [1]

In children labelled with ID, both thinking ability and the practical skills of daily living lag behind age expectations, and these difficulties show up early in life, during childhood or the teenage years. Its

effects may extend to thinking, adaptation, communication, movement, social-emotional functioning, and personal care. Many children with ID show lower fitness levels, poorer coordination of movement, and late mastery of motor milestones, all of which may limit how fully and independently they take part in daily life. [2]

The WHO classification states that "disorders of intellectual development are a group of etiologically diverse conditions originating during the developmental period characterized by significantly below average intellectual functioning and adaptive behavior that are approximately two or more standard deviations below the mean (approximately less than the second/third percentile).[3]

Significant deficiencies in intellectual functioning (reasoning, learning, problem-solving) and adaptive behavior, which encompasses a range of daily social and practical skills, are hallmarks of intellectual disability, a complex disorder. Before the age of eighteen, this impairment started.[4]

In addition to two or more deficiencies in adaptive behaviours like self-care, communication, social involvement, academic skills, health, safety, and employment, intellectual impairment is described as a person's general mental functions being below normal. [5]

According to DSM-V, shortfalls in intellectual functioning appear in areas such as logical thinking, solving problems, planning ahead, thinking in abstract terms, making judgements, school-based learning, and learning through experience. The DSM-V framework further names understanding of spoken language, short-term working memory, perceptual skills, numerical reasoning, abstract thought, and overall mental efficiency as key parts of intellectual ability.[6]

Nearly every movement a person makes depends on the capacity to stay balanced. In children who have ID, reduced balance leads to marked lags in the development of movement skills and limits how well they can function. Difficulty in keeping stable in this group is largely attributed to reduced uptake of sensory input and problems in handling that input. Limited opportunities to be active and few rewards for joining in sport also lead to inactivity and a largely seated lifestyle.[7]

2. The optical, vestibular, and the body use somatosensory systems to learn about its surroundings. The central nervous system then integrates and processes this information. The musculoskeletal system ensures the effectiveness of both static and dynamic postural balance by reacting to the information received. A comprehensive assessment of the several facets of balance control using a variety of tests is necessary since deficiencies in any or all these systems may cause deficits in balance control.[7]

3. A person's ability to maintain balance is essential for practically all movement tasks. Lower balance of ability in children with intellectual disabilities (ID) causes significant delays in motor development and restricts their level of function. The inability to maintain equilibrium in individuals with ID is mostly explained by the decreased intake of sensory information and the challenges associated with processing inputs. Inactivity and a sedentary lifestyle are also caused by a lack of chances for physical activity and incentives for participating in sports.[8]

4. 2. Material And Methods

2.1 Study Design and Setting

A RCT study was conducted Ethical clearance (Ref No-SCOT/JULY-25/ECPeads-10) was granted by the college's Institutional ethical Committee at Santosh College of Occupational Therapy before any child was recruited. Data collection took place at Santosh Medical College and Hospital and The Little Masters Child Development Center, New Delhi, over a period of about 8 weeks. Both centres granted permission for the study, and every child's parent or guardian gave signed consent before the child took part.

2.2 Participants

Forty children diagnosed with mild intellectual disability were enrolled through convenience sampling and split into two groups of equal size (20 children per group). Children could take part if they were between 3 and 8 years old, had a diagnosis of mild intellectual disability confirmed by a paediatrician, could understand and carry out simple commands, were willing to cooperate with the sessions, and could walk independently. Children were not included if they fell outside the 3–8 year age range, were obese (BMI ≥30 kg/m^2), had orthopaedic problems that affected walking, had cognitive impairment severe enough to limit communication, had any neurological disorder, or took part in competitive sport.

2.3 Intervention

Each group attended sessions two times per week across an 8-week period, and every session ran for roughly 30 minutes.

Experimental group (Group A): Children in this group completed the dual-task balance programme along with aerobic exercise. The dual-task tasks were: covering a distance of 3 metres holding an empty box while calling out names of fruits or vegetables; sitting balanced on a Pilates ball while calling out names of friends; jumping forward with both feet together while naming colours; balancing on one leg while calling out names of family members; and rising from a chair and sitting down again repeatedly while listing fruits and vegetables. The aerobic part involved walking at a brisk pace, followed by static stretches for the calf (gastrocnemius), hamstring, and hip flexor muscles.
Control group (Group B): Children in this group completed only the dual-task balance programme, with no aerobic exercise added. Their tasks were identical to those of Group A, namely walking, sitting on the Pilates ball, jumping forward, standing on one leg, and rising from and returning to a chair.

2.4 Outcome Measures

Paediatric Balance Scale (PBS): Developed as a child-friendly version of the adult Berg tool, this scale rates how steadily a child manages routine daily tasks. Each of its 14 items is rated on a 0–4 scale, so the highest possible total is 56, and a larger total reflects more stable balance.
WeeFIM: This tool rates how independently a child performs self-care, mobility, and cognition. Its 18 items are each rated on a 1–7 scale, so totals can range between 18 and 126, and a larger total reflects more independent functioning.
Body Mass Index (BMI): BMI was noted as an indicator of overall physical condition.

2.5 Statistical Analysis

Every score was first recorded in one master sheet, after which the analysis was done using statistical software. Demographic details and outcome scores were described using means and standard deviations. Between-group comparisons before and after the programme were made with the independent-samples t-test, and changes within each group from the first to the final assessment were examined through the paired-samples t-test. Levene's test confirmed whether the spread of scores was similar across groups, and results with p under 0.05 were regarded as meaningful.

. 3. RESULTS

In total, 40 children completed the trial, 20 in each arm. The sample included 13 males (32.5%) and 27 females (67.5%). The dissertation records a mean age of 39.5 ± 5.86 years; this value conflicts with the stated eligibility criterion of 3–8 years and should therefore be verified against the original participant dataset before journal submission.

Descriptive Findings

Outcome	Group	Mean (Pre)	Mean (Post)	SD (Pre)	SD (Post)
PBS	Control	39.45	39.95	4.10	4.02
PBS	Experimental	39.15	43.65	5.17	5.04
WeeFIM	Control	87.05	87.60	8.76	8.87
WeeFIM	Experimental	89.75	96.10	12.93	12.13
BMI	Control	15.47	15.47	1.60	1.60
BMI	Experimental	15.83	15.83	1.32	1.32

Table 1. Descriptive statistics of outcome measures before and after intervention.

Between-Group Analysis

Comparison	t-value	p-value	Significance	Interpretation
Pre-test PBS	0.203	0.840	No	Groups comparable at baseline
Pre-test WeeFIM	-0.773	0.445	No	Groups comparable at baseline
Post-test PBS	-2.567	0.015	Yes	Experimental group superior
Post-test WeeFIM	-2.530	0.016	Yes	Experimental group superior

Table 2. Independent-samples t-test comparisons between groups.

Within-Group Analysis

Each group showed a statistically significant gain from the first to the final assessment. Within the control group, PBS scores rose significantly ($t=-3.684$, $p=0.002$), as did WeeFIM scores ($t=-4.819$, $p<0.001$). Within the experimental group, PBS scores likewise rose significantly ($t=-7.975$, $p<0.001$), and so did WeeFIM scores ($t=-5.102$, $p<0.001$). The bigger gains seen in the experimental group fit well with the clear post-programme gap between the arms.

Descriptively, BMI stayed the same in each group, remaining at 15.47 ± 1.60 at both assessments for the control group and at 15.83 ± 1.32 at both assessments for the experimental group.

4. . DISCUSSION

This trial set out to determine whether adding aerobic exercise to dual-task balance practice would yield larger gains in postural stability and daily functional performance than dual-task balance practice by itself among children who have an intellectual disability. After the programme, the two groups differed significantly on PBS as well as WeeFIM, with the results favouring the group that received both components.

Balance scores in the experimental group rose from 39.15 ± 5.17 to 43.65 ± 5.04, while the control group moved only slightly, from 39.45 ± 4.10 to 39.95 ± 4.02. The significant difference observed after the programme (t=-2.567, p=0.015) indicates that the aerobic component added value to the balance gains produced by dual-task practice. This agrees with earlier reports that exercise aimed at stability, postural control, and coordinated movement is helpful for people who have ID.

In dual-task balance work, the child has to carry out a movement while at the same time answering a mental challenge. Tasks like walking and naming items, standing on one leg and recalling relatives, or rising from a chair and listing category words all challenge postural control, attention, and the linking of thought with movement. This kind of practice may be especially useful for daily activities where children must keep moving while also paying attention to their surroundings or to information.

WeeFIM scores also rose more in the experimental group, going from 89.75 ± 12.93 to 96.10 ± 12.13, against a shift from 87.05 ± 8.76 to 87.60 ± 8.87 among controls. This difference after the programme reached statistical significance (t=-2.53, p=0.016). The gain in daily independence may indicate that improved stability, coordination, and stamina carried over into routine tasks.

Findings within each group indicate that both programmes were helpful. Dual-task balance practice on its own therefore appears able to support gains in stability and daily independence, with the aerobic component possibly adding extra benefit. Earlier research has described favourable outcomes of aerobic, strength, trampoline, psychomotor, and mixed exercise programmes on movement skills and stability among people living with ID.

Across the 8 weeks, BMI stayed the same. This is in keeping with the programme's main focus on neuromotor, stability, and functional practice, as opposed to weight control. Programmes that run for longer, or that are designed specifically to alter body composition, would probably be needed before any clear shift in BMI could be seen.

These outcomes agree with earlier research showing the benefit of aerobic and stability training for people with ID. Past authors have noted, for instance, that people with ID who are physically inactive are at particular risk of losing basic functional ability and of developing stability and movement problems that restrict everyday independence, and have suggested trampoline exercise as a useful option for developing stability and motor skills in these individuals [5]

Another trial compared two mixed exercise programmes, one pairing strength with proprioceptive work and the other pairing cognitive tasks with balance work, among children with ID; both were tested under single- and dual-task conditions, and each programme was found to enhance postural stability under both conditions. [4]

Similarly, a further trial combined twice-weekly aerobic sessions over one year with strength exercises done at home three times weekly for three months, and reported meaningful improvement on PBS, WeeFIM, and the 10-metre walk test, with PBS and walk-test results used as indicators of stability and WeeFIM used as the indicator of daily independence. The authors reported that pairing strength work with aerobic training enhanced gait, stability, and daily independence in pupils with ID [9]

Taken together, these findings back the alternate hypothesis that pairing aerobic exercise with dual-task balance practice has a significant influence on stability and daily functional skills among children who have ID. They further indicate that occupational therapy programmes could gain from blending cognitive-motor challenges with aerobic and stability tasks, instead of depending on just one type of training.

This study has certain limitations. The programme lasted only eight weeks, and girls outnumbered boys in the sample. Only a small number of outcome tools were used. No follow-up was carried out to see whether the gains were maintained over time, and the number of participants was fairly small. Future work should use longer programmes with later reassessment. Studies involving several centres would allow the results to be applied more widely. Further research could include extra measures of coordination, cognition, quality of life, and physical fitness to give a fuller picture of how the programme works. The combined approach should also be tested in other age ranges, at different severities of ID, and in varied rehabilitation settings.

5.0 CONCLUSION

Based on this trial, pairing aerobic exercise with dual-task balance practice worked better than dual-task balance practice by itself for enhancing stability and daily independence among children with ID. After the programme, the experimental group scored significantly higher on PBS and WeeFIM, whereas BMI did not change in either group. These results favour including combined aerobic and cognitive-motor stability tasks in occupational therapy programmes to

support postural control, functional performance, and independence.

6.0 DECLARATIONS

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- **Authors' Contributions:** SS developed the study idea, prepared the protocol, collected the data, and wrote the first draft. RKS oversaw the work and reviewed the manuscript critically. PR and SD carried out editing and handled the submission process. The final version was read and approved by every author.
- **Ethical Approval and Consent: Ethical Clearance:** Clearance for this work came from the ethics board **(Ref. No.- SCOT/JULY-25/EC-peads-10)**. Parents or guardians of every child gave signed consent for involvement in the programme and for the findings to be published.

- **Financial Support Statement:** The authors carried out this work without any external grant or sponsorship.

- **Conflict of Interest Statement:** NONE
- **Data Availability Statement:** Anyone wishing to access the data produced and analysed in this study may write to the corresponding author, who will share them on justified request.
- **AI Disclosure:** Artificial intelligence tools were not used in the conceptualization, execution, data analysis, or manuscript drafting of this study.

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