

Effect of task-oriented approach based activities to improve balance among children with cochlear implant

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ABSTRACT

Background: Paediatric occupational therapy is vital for fostering children's motor, sensory, and coordination skills, particularly for those with cochlear implants who often experience vestibular system disruptions leading to balance impairments.

Objective: This study evaluates the effectiveness of task-oriented occupational therapy in improving balance among children with cochlear implants compared to conventional therapy.

Materials and methods: A quasi-experimental design was conducted with 30 participants aged 4–8 years, recruited using convenience sampling and divided into two groups: experimental (task-oriented therapy) and control (conventional therapy). Both interventions were delivered over 12 weeks with 30 sessions. Balance was assessed pre- and post-intervention using the Paediatric Balance Scale (PBS). Statistical analysis was performed to compare pre- and post-test scores within and between groups.

Results: The experimental group (N=15) had a mean pre-test PBS score of 33.2 (SD=2.88) and post-test score of 38.87 (SD=3.66), showing a statistically significant improvement ($Z=-3.429$, $p=0.001$). The control group (N=15) had a mean pre-test score of 34.67 (SD=3.79) and post-test score of 36.07 (SD=3.37), also showing significant improvement ($Z=-2.829$, $p=0.005$). Post-test scores between the groups revealed a significantly greater improvement in the experimental group compared to the control group ($Z=-2.032$, $p=0.042$).

Conclusion: Task-oriented occupational therapy significantly enhances balance in children with cochlear implants, yielding better outcomes than conventional therapy. These findings highlight the importance of tailored interventions in addressing vestibular deficits and improving functional independence in this population.

Introduction

Paediatric occupational therapy plays a crucial role in helping children to develop essential skills for daily living, including gross and fine motor abilities, sensory-motor integration, and visual-motor coordination. Targeted interventions in occupational therapy enhance a child's independence and social interaction skills, which are central to their overall development. Therapists assess a child's functional abilities in daily activities, academic tasks, and play behaviours, comparing them to age-appropriate developmental milestones.¹

Hearing is a fundamental aspect of effective communication, which is crucial for a child's cognitive, emotional, and behavioural development. Psychomotor development is closely linked to auditory input. However,

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hearing loss, whether partial or complete, affects approximately 7% of children worldwide, with conductive and sensorineural hearing loss being the most common types.² For children with profound hearing loss, cochlear implants provide a viable solution to restore auditory function.

Cochlear implants consist of an external component placed behind the ear and an internal device surgically embedded under the skin. The system includes a speech processor, a microphone, a transmitter, a receiver/stimulator, and an electrode array. These components work together to convert sound into electrical impulses, which stimulate the auditory nerve, thereby enabling hearing.^{3,4} Despite their success in restoring auditory function, cochlear implants may disrupt the vestibular system, potentially causing postoperative dizziness or balance impairments. Such complications stem from either surgical trauma or electrical stimulation affecting vestibular pathways. Research highlights that up to 75% of cochlear implant recipients may experience vestibular symptoms like vertigo or imbalance, with 34% identifying these as common postoperative effects.⁴ Therefore, assessing and addressing vestibular challenges in cochlear implant patients is crucial for comprehensive rehabilitation.

Children with cochlear implants often face significant balance challenges due to disruptions in their vestibular systems. Previous research, such as Amir *et al.* (2015)⁵, examined the balance performance of deaf children with and without cochlear implants, utilizing the Bruninks-Oseretsky motor proficiency test.⁵ The study identified notable balance deficits among cochlear implant recipients but emphasized the absence of targeted interventions to address these issues.

While numerous studies have explored balance training in children with cochlear implants, there remains a gap in evidence regarding the effectiveness of task-oriented, occupational therapy-based activities. Task-oriented approaches involve practicing meaningful and real-life tasks to improve motor skills, including balance, coordination, and stability.⁶ Such interventions have the potential to enhance functional independence and participation in daily activities for children with cochlear implants.⁷

This study was undertaken to fill the existing gap by investigating the effects of task-oriented approach-based activities on improving balance among children with cochlear implants. The findings aim to provide evidence for integrating task-oriented interventions into occupational therapy programs for this population.

Methodology

Research design

A quasi-experimental study design was employed to investigate the effectiveness of a task-oriented occupational therapy approach on balance skills in children with cochlear implants.

Sampling technique

The study utilized a convenient sampling technique to select participants.

Sample size

A total of 30 subjects participated in this study. The participants were divided equally into two groups including experimental group: 15 subjects underwent task-oriented therapy interventions, and control group: 15 subjects received conventional occupational therapy.

Sample setting

The study was conducted at MGR Home and Higher Secondary School for the Speech and Hearing Impaired.

Selection criteria

Inclusion criteria

1. Children with cochlear implants.
2. Age group: 4-8 years.
3. Children with a Paediatric Balance Scale (PBS) score between 21-40.
4. Both male and female participants were included

Exclusion criteria

1. Children with visual impairments, other vestibular dysfunctions, or neurological conditions.
2. Children with a PBS score below 21 or above 40.
3. Participants outside the specified age range.

Tools used

Paediatric Balance Scale (PBS)⁸

The PBS, a modified version of the Berg Balance Scale, assesses functional balance skills in school-aged children. The scale comprises 14 items, scored from 0 (lowest function) to 4 (highest function), with a maximum score of 56.

Scoring method

- Each item is scored based on the child's best performance. Multiple trials are permitted for some items.
- Points are deducted for not meeting the time or distance requirements, requiring supervision, or using external support.

Reliability

- Test-Retest Reliability: ICC=0.998, indicating excellent stability of the scale over time
- Interrater Reliability: ICC=0.997, confirming high consistency between different raters.

Validity

- Content Validity: Established through expert reviews and adaptation from the well-validated Berg Balance Scale, ensuring relevance for paediatric populations.
- Construct Validity: Strong correlations with self-care measures and motor control tests in children with motor impairments support the scale's ability to assess balance performance.
- Criterion Validity: Demonstrated high correlation with other validated balance and motor performance assessments, confirming its effectiveness in evaluating functional balance skills.

Intervention procedure

The study was conducted over 12 weeks, with participants attending 30 sessions (3 sessions per week), each lasting 45 minutes. The intervention was structured as follows:

- Warm-up activities: a total of 10 minutes with included gross motor tasks and light exercises.
- Program activities: a total of 30 minutes (task-oriented approach for the experimental group and conventional therapy for the control group). The experimental group engaged in task-oriented occupational therapy involving activities to improve balance, coordination, and motor planning. The control group participated in conventional occupational therapy techniques.
- Wind-up activities: 5 minutes.

Conventional occupational therapy for control group^{9,10}

The therapy sessions focused on enhancing the child's ability to adapt to their cochlear implant, improving communication and sensory processing skills, and promoting independence in daily activities. A structured approach was followed to address auditory, motor, and social challenges commonly associated with cochlear implantation.

Auditory training: Activities designed to help children interpret and respond to sounds through their cochlear implants. Tasks included identifying environmental sounds, differentiating between tones, and following verbal instructions to improve auditory processing.

Sensory integration therapy: Focused on managing sensory sensitivities often experienced by children with

cochlear implants. Activities included exposure to varied sensory stimuli, such as textured materials, swings, or weighted vests, to improve sensory processing and tolerance.

Social skills training: Encouraged interaction with peers through structured group activities, emphasizing turn-taking, active listening, and appropriate social responses. Role-playing scenarios were used to teach effective communication in social settings.

Fine and gross motor skill development: Activities to support motor coordination and balance, which can be affected by auditory processing issues. Included tasks like drawing, writing, catching balls, walking on balance beams, or navigating obstacle courses.

Postural training: Addressed balance and spatial orientation issues that might arise due to cochlear implantation. Exercises included maintaining postural control during sitting, standing, and dynamic activities like walking.

Visual-auditory integration: Designed to improve coordination between visual cues and auditory input. Activities included lip-reading, visual tracking combined with sound cues, and matching sounds to visual objects.

Daily living skills training: Focused on age-appropriate tasks like dressing, eating, and personal hygiene. Activities incorporated auditory instructions to help children follow verbal cues and improve functional independence.

Session Duration: 30-45 minutes, 2-3 times per week. Pre- and post-intervention assessments were conducted using PBS.

Table 1. Task oriented occupational therapy for Experimental group.^{11,12}

Session	Material used	Activities
1	-	Pre-test assessed using PBS
2	Tape	Walk on a flat surface with one or two-hand support. Walk within a taped box with support. Cruise along the wall using both hands.
3	Tape, footprint	Walk in the taped box without support. Cruise along the wall with one hand. Walk 5 steps on footprint with support.
4	Tape, footprint	Walk 10-15 steps on a flat surface without support. Follow footprints in taped boxes. Walk 15 steps with alternate feet on footprint.
5	Chalk, footprint	Walk on a straight line made with chalk. Follow footprints in 5 circles.
6	Chalk, footprint	Follow footprints on stairs. Follow footprints in 5 chalk circles.
7	Chalk, skipping rope	Jump on alternate legs in chalk shapes. Learn rhythmical movement using skipping rope (step-hop).
8	Obstacle course	Cross 5 obstacles. Carry objects while crossing 10 obstacles.
9	Obstacle course	Cross 10 obstacles. Carry objects while crossing 15 obstacles.
10	Chalk	Jump on a circle while rotating. Jump, hop, and walk in a tandem on chalk patterns.
11	Chalk, chair	Hop on boxes based on claps. Jump on a chair with eyes open and supported.
12	Water bottle, rings	Place rings on a water bottle from a chair. Hop and do animal jumps with rings.

Table 1. Task oriented occupational therapy for Experimental group.^{11,12} (Continued)

Session	Material used	Activities
13	Tape	Jump 5 times, walk 10 steps, alternate hop 8 steps, and animal jump to the endpoint.
14	Tape, skipping rope	Tip-toe walk, alternate hopping, and pick up objects.
15	Chair, bench	Stand on one leg on a chair for 10 seconds. Hold quadruped and kneeling positions on a bench.
16	Obstacle	Jump over obstacles of different heights.
17	Footprint, note, pencil	Walk on footprints and draw with eyes closed.
18	Single-word puddles	Jump on puddles with the corresponding word written on the board.
19	Chalk	Jump on both legs and alternate legs on chalk patterns.
20	Rolling	Roll forward or backward with arms and legs extended.
21	Chalk or tape	Jump on hopscotch grid, alternating feet, and skip over a square.
22	Spiral (chalk)	Travel and run through spiral paths, moving backward on both spiral and straight paths.
23	Books	Tap elevated targets with hands, with one foot between each.
24	-	Stand on one leg for 20 seconds, feet heel-to-toe for 15 seconds.
25	-	Walk on a hard surface for 10 seconds and backward for 10 seconds. March in place for 15 seconds with eyes open and closed.
26	-	Walk around a big circle for 15 seconds. Stand with feet shoulder-width apart for 20 seconds, eyes open and closed.
27	-	Stand on one leg, moving head horizontally and vertically for 1 minute while focusing on a target.
28	-	Look at the thumb while rotating on a chair for 30 seconds. Walk while moving head horizontally and vertically for 15 seconds each.
29	-	Sit in front of a target, close eyes and recall it 5 times. Open eyes and recall the target 5 times.
30	-	Post-test assessed.

Wind-up Activities: Included relaxation and joyful tasks such as singing, dancing, and round games.

Results

The effectiveness of a task-oriented occupational therapy approach on balance skills in children with cochlear implants was conducted at MGR Home and Higher Secondary School for the Speech and Hearing Impaired. A total of 30 participant was included in the study. This has been categorized into two groups; control (15) and experimental (15). For control group conventional occupational therapy was given whereas for experimental task orientated occupational therapy was given.

The experimental group consisted of 15 participants, including 10 males (66.7%) and 5 females (33.3%), with ages ranging from 6 to 8 years and a mean age of 6.87 years. The pre-test scores in this group ranged from 29 to 40, with a mean of 33.2, while the post-test scores ranged from 33 to 46, with a mean of 38.87. The control group included 15 participants, comprising 10 males (66.7%) and 5 females (33.3%). The age range for this group was slightly broader, from 6 to 9 years, with a mean age of 7.27 years. Pre-test scores in the control group ranged from

30 to 42, with a mean of 34.67, and post-test scores ranged from 32 to 43, with a mean of 36.07.

Both groups were balanced in terms of gender distribution and comparable in age, ensuring the validity of the comparison. The pre-test and post-test scores provide a basis for evaluating the effectiveness of the PBS intervention in both groups.

On comparison between the pre-test and post-test scores in the control group revealed a statistically significant difference. (Table 2) The mean pre-test score was 34.67 (SD=3.79), while the post-test mean score was 36.07 (SD=3.37). The Z value for the comparison was -2.829, and the p-value was 0.005, which is less than the significance level of 0.05. This indicates a statistically significant improvement in the PBS scores of the control group. Consequently, the null hypothesis is rejected, and the alternate hypothesis is accepted, suggesting that the intervention received by the control group led to a significant improvement in their scores.

Table 2. Comparative analysis of pre- and post- scores in the control group.

Control group	Mean	SD	N	Z value	p value
Pre-test	34.66	3.79	15	-2.829	0.005*
Post-test	36.06	3.36	15		

A significant improvement was observed in the experimental group between the pre-test and post-test scores (Table 3). The mean pre-test score was 33.20 (SD=2.88), while the mean post-test score increased to 38.87 (SD=3.66). The Z value was -3.429, and the p-value was 0.001, which is less than the 0.05 threshold

for significance. This indicates that the intervention had a statistically significant positive effect on the PBS scores of the experimental group. As with the control group, the null hypothesis is rejected in favour of the alternate hypothesis, confirming that the intervention contributed to a significant improvement in the experimental group.

Table 3. Comparative analysis of Pre and Post test scores in experimental group.

Experimental group	Mean	SD	N	Z value	p value
Pre-test	33.2	2.88	15	-3.429	0.001*
Post-test	38.86	3.66	15		

The post-test scores between the control and experimental groups, the results indicated a significant difference (Table 4). The mean post-test score for the control group was 36.07 (SD=3.37), while the experimental group achieved a higher mean post-test score of 38.87 (SD=3.66). The Z value for this comparison was -2.032, and the p-value was 0.042, which is below

the significance level of 0.05. This finding suggests that the experimental group experienced a significantly greater improvement in PBS scores compared to the control group. The null hypothesis is rejected, and the alternate hypothesis is accepted, indicating that the intervention in the experimental group was more effective in improving PBS scores than the intervention received by the control group.

Table 4. Comparative analysis of post test scores between control and experimental group.

Post test scores	Mean	SD	N	Z value	p value
Control	36.06	3.36	15	-2.032	0.042*
Experimental	38.86	3.66	15		

The control and experimental groups showed statistically significant improvements in PBS scores from pre-test to post-test. The experimental group exhibited a more substantial improvement compared to the control group, as reflected in the post-test score comparison. These findings highlight the effectiveness of the interventions applied to both groups, with the experimental intervention yielding more pronounced improvements in PBS outcomes.

Discussion

This study evaluated the impact of task-oriented approach-based activities on balance improvement in children with cochlear implants, using the Paediatric Balance Scale (PBS) as the assessment tool. The findings indicate that task-oriented interventions significantly enhanced postural control and balance in the experimental group compared to the control group. Children with cochlear implants often experience challenges in maintaining balance due to vestibular dysfunction associated with hearing impairments. The significant improvement in the experimental group's PBS scores (mean increase from 33.20 to 38.87) demonstrates the effectiveness of task-oriented activities in addressing these deficits. In contrast, the control group showed a smaller improvement (mean increase from 34.67 to

36.07), suggesting that generic interventions are less impactful than targeted approaches.

Franjoine *et al.* highlighted the effectiveness of task-specific training for improving balance in children with motor impairments.¹³ Similarly, the present study demonstrates that tailored balance activities, such as dynamic transitions and single-leg stances, can significantly enhance balance in children with cochlear implants, addressing their unique vestibular challenges. Research by Wiener-Vacher *et al.* emphasized that vestibular rehabilitation is critical for children with cochlear implants to compensate for vestibular dysfunction.¹⁶ The task-oriented activities used in this study align with their recommendations, integrating sensory-motor challenges that promote vestibular adaptation and postural stability. Donahoe-Fillmore *et al.* stressed the importance of dynamic and playful balance activities in paediatric therapy.¹⁵ This study's intervention incorporated engaging and child-friendly tasks, which likely contributed to better adherence and outcomes in the experimental group. According to Verbecque *et al.* task-specific balance training promotes neuroplastic changes in the brain, improving motor control and postural adjustments.¹⁶ These principles underpin the significant improvements observed in this study.

The structured activities were tailored to simulate real-life tasks, enhancing sensory-motor integration and

balance control. This approach likely compensated for vestibular deficits caused by cochlear implantation. Task-oriented activities provided opportunities for vestibular rehabilitation, helping children adapt to balance challenges through repeated practice. This aligns with the findings of Wiener-Vacher *et al.* who noted the importance of vestibular compensation in children with cochlear implants.¹⁷ The playful nature of the interventions enhanced motivation and participation, critical factors for achieving significant balance improvements in children. Gradual increases in task complexity fostered neuroplasticity and improved motor learning, as suggested by Wang *et al.*¹⁸ This study aimed to evaluate the baseline balance performance and the impact of task-oriented interventions on children with cochlear implants.

The pre-test scores confirmed that both groups were comparable before interventions, ensuring the validity of comparisons. The experimental group showed significantly greater improvements in balance, validating the efficacy of task-oriented activities for addressing vestibular and balance challenges in children with cochlear implants. The significant difference in post-test scores between the experimental and control groups highlights the superiority of task-oriented interventions over generic exercises.

The study results indicated an enhanced ability to engage in age-appropriate occupations requiring balance, such as dressing, toileting, and classroom participation. Given that children with cochlear implants often experienced vestibular dysfunction, the findings highlighted the importance of sensorimotor-based interventions directly linked to functional goals.¹⁹ This study reinforced that task oriented interventions should not focus solely on improving impairment-level deficits but should aim to enable participation in meaningful daily routines, an essential principle of the occupational therapy paradigm.²⁰

The use of real-life, play-based, and dynamic balance tasks likely contributed to better engagement and adherence in the experimental group. These elements aligned with core paediatric occupational therapy principles, particularly the concept of providing “just-right challenges” and using play to enhance motivation. Contextualizing therapy tasks allowed children to practice motor strategies in environments resembling their everyday settings, which facilitated the generalization of skills beyond the clinical setting.^{20,21}

Overall, the findings emphasized the need for task-oriented, child-centered balance training programs for children with cochlear implants. Such programs addressed vestibular deficits, enhanced sensory-motor integration, and improved postural control. Therapists were encouraged to incorporate real-life tasks and dynamic challenges into therapy sessions to optimize outcomes.

Limitations

The study has small sample size and short intervention duration limit its generalizability. Future research should include larger populations, long-term follow-up assessments, and evaluations of task-oriented approaches in diverse settings. Additionally, exploring the role of multisensory

integration in balance rehabilitation for children with cochlear implants could provide further insights.

Conclusion

This study demonstrates that task-oriented approach-based activities significantly improve balance in children with cochlear implants. The findings underscore the importance of targeted, progressive, and engaging interventions for addressing vestibular and postural deficits in this population, contributing to better functional outcomes and quality of life.

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