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RESEARCH ARTICLE

EFFECT OF SENSORY MOTOR INTEGRATION ON AGILITY AND MOTOR COORDINATION IN CHILDREN WITH DOWN SYNDROME

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ABSTRACT

Background: Down syndrome is characterized by general mental and physical disorders, or by isolated walking, cognitive, growth, or sensory disorders. ***Objective:*** The study examined the impact of an integrated sensory approach on the improvement of balance and motor coordination in children suffering from Down syndrome. ***Methods:*** Thirty children were randomly divided into two categories: group A received a combination of sensory integration and physical therapy, Group B received only the physiotherapy program. The motor skill and balance were assessedprior to and following the exercise by the Bruininks - Oseretsky Test of Motor Competence - 2nd Edition. ***Results:*** The data evaluation was performed in 30participants suffering from Down syndrome using a t-test in pairs to assess the variations in pre- and post-test scores and effect size. Statistical significance was determined at $p < 0.05$. The group's results before and after treatment showed significant improvements in forward walking, upper-limb coordination, ball retrieval capacity, and agility ($p = 0.0001$). ***Conclusions****:* It is recommended to add a sensory integration program to specific physical therapy for enhancing the balance and coordination of motor function in those suffering from Down syndrome. Therefore, this practical approach should be used as an option for effective intervention.

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INTRODUCTION

Down syndrome (DS) represents a chromosol disorder that contains a partial orcompletechromosomal 21 copy. Individuals from all racial backgrounds, social classes, and nationalities experience it with the same frequency. Economically different, with an average of 1 birth for every 600 births globally (National Down Syndrome Society, 2017 and Sherman, 2007). Children suffering from Down syndrome experience a range of motor features, including decreased deep tendon reflexes, hypotonia, increased joint mobility, as well as developmental delays in time of reaction and balance response, which can lead to delayed reaching advanced stages (Kliegman, 2011 and Batshaw et al., 2019). These children often have difficulties with balance, movement, vestibular defects, and sensory integration (Adibsereshki, 2015). The intellectual function and adaptive behavior of people with Down syndrome are significantly impaired, which is evident in their conceptual, social, and practical adaptability. Varying degrees of sensory dysfunction is found in children suffering from developmental disabilities. Moreover, sensory integration disorders can develop because of limited sensory knowledge because of limited motor behavior (Hallahan et al., 2015). The child's capacity to identify and integrate sensory information, plan and create targeted behavior, and learn is dependent on adaptive skills. Sensory integration describes how the nervous system receives messages from multimodal sensory information systems to maintain balance and posture, by monitoring head movement and eye-to-mouth stabilization (Ayres, 1972). The vestibular and tactile systems always interact with the auditory and visual systems to give the multisensory the sensory integration theory. Valuable action (Bundy, 2002). Sensory and neurodevelopmental integrative therapeutic approaches are powerful approaches that can be utilized as occupational/physical therapy interventions in distinct programs or in combination with interventions. Behavioral, educational, and pharmacological use in children suffering from intellectual disabilities (Uyanik, 2003). This research aimed to assess the impact of integrated sensory approaches on coordination and balance in children suffering from DS.

METHODS

Study design and participants: From May 2021 to February 2022, a randomised clinical trial was conducted at Cairo University's Faculty of Physical Therapy's Pediatric Outpatient Clinic. Theparents provideda written informed consent agreeing to participate and publish the results. The Faculty of Physical Therapy Ethics Committee at Cairo University, Egypt, gave its approval to this study. The sample size calculations led to the selection of 30 DS-affected children to take part in this study.To diagnose, assess age, and determine exclusion and inclusion criteria, they were screened and evaluated. Inclusion Criteria: Children aged 5 to 10 years diagnosed with DS who can walk and have an IQ greater than 75%. Children with severe neurological disorders (epilepsy), orthopedic problems, upper or lower extremity surgery, hearing or vision issues, medication usage that alters focus or behavior, and impaired progressive academic performance were excluded from the study. Participants were split into two equal groups at random. Sealed envelopes were utilized to randomly assign children. Individuals who did not take part

participants were randomly distributedinto group (A) and simultaneously receiveda conservative physiotherapy training program and sensory integration therapy (SIT), while group (B) completed a standard physiotherapy training program. For group A, a 45-minute individual SIT treatment session and a 45-minute physiotherapy program were administered for 3 months(3 days/week) in the physiotherapy treatment room located in the Faculty of Physical Therapy in the outpatient department.Additionally, for the course of the three-month treatment period, the whole subjects participated in a regular home program for 3 hours/day.The only exercise regimen given to the group (B) was standard physical therapy.

MEASURES OF RESULTS

To assess children's and adolescents' fine motor skills and overall gross, the Bruininks-Oseretsky Test of Motor Proficiency - Second Edition (BOT-2) was created. It is founded on statistical norms for individuals between 4 and 21 years old.BOTMP-2 incorporates eight test sub domains to measure four fine motor skills (i.e., athletic performance, fine motor integration, and measures fine motor precision) and four gross motor skills (i.e., strength, balance, running speed, bilateral coordination, and agility). Coordination of the upper extremity coordination and manual mobility) (Bruininks, 2005). The whole participants were examined prior to training initiation (pretreatment) and after three months of therapy (post treatment) through an investigator blinded to the group of each participant. BOT-2, which includes her four measures of gross motor performance (i.e., stance length, running speed and agility, balance, and bilateral coordination), was employed to evaluate their motor skills. It was done.

converting each item's performance (raw candidate score) using the specified scale. The item with the best performance was chosen for items with multiple lanes. On the scale's right side, the item scores were entered. After finalizing each subtest, the overall scores were recorded and transformed to scale scores by the relevant manual tables, taking age and gender into account. At last, baseline values concerning his 4 connections in the engine area were determined (Bruininks, 2005).

Interventions: Group (A) received the following combined sensory therapy program. Proprioceptive stimulation, which is triggered by the muscles influenced by squeezing or pressing, and tactile stimulation, which is based on the activation of pro-receptors with protective and discriminating capabilities, are two examples of sensory integration treatment. The joints receive traction activity and influence motor planning activity, as well as vestibular stimulation therapy that relies on the reception of motor stimuli and strength to improve eye movements, muscle tone, posture, and balance. Therefore, it is thought to be important for the improvement of motor skills, including gross and fine (Uyanik, 2010). Functional tactile, proprioceptive and vestibular training activities are applied as follows training for postural stability using training for vestibular stimulation.

Athletics planning: Throw and catch balls of different sizes and shapes,

Weights and textures: Stand, walk, run, jump and jump on various surfaces (slippery, smooth, rough, and rubber). − Quadrupedal activity: as a play boat in the sea (perturbation and tumbling). − Employment activities: pushing, climbing stairs, and pulling, carrying heavy objects, jumping, jumping, drawing, etc. (visuospatial perception: puzzle training, block layout, layout copy, Series activities (Nadkarni, 2012) such as tiered pen and pinboard activities.

Table 1. Patient demographics

Variables	Control group N = 15	Study group N = 15	P-value
Sex N %	8 (53%) 7 (46%)	Boys 5 (33%) Girls 10 (66%)	0.32
Age	7.20 ± 1.26	5.07 ± 0.96	0.68
Handdominance N %	12 (80 %) 3 (20 %)	Right 10 (66.66%) Left 5 (33.33%)	0.36

Table 2. Pre- and post-test results for the BOT2 subtests for agility, balance, and upper limb and bilateral coordinations

Test elements	Group A				Group B			
	Pre-testscore	Post-testscore	p-value	Effect size	Pre-test score	Post-testscore	p-value	Effect size
Balance	5.50	7.50	0.180	0.756	5.78	6.78	0.282	0.378
WFL	2.25	3.25	0.007*	0.817	2.67	3.11	0.347	0.111
SLS-EO	1.63	1.75	0.598	0.204	1.11	1.44	0.397	0.301
SL-EC	1.63	2.50	0.111	0.568	2.00	2.22	0.719	0.130
Bilateral Coordination								
TN-EC	2.25	2.75	0.104	0.577	2.89	3.00	0.347	0.111
Upper Limb Coord.	4.75	6.25	0.009*	0.802	3.56	6.56	0.024*	0.701
CTB-BH	2.50	3.50	0.007*	0.817	1.89	3.22	0.017*	0.756
CDB-BH	2.25	2.75	0.170	0.511	1.67	3.33	0.319	0.620
Agility								
SSBB	3.25	5.00	0.001*	0.904	3.78	5.00	0.001*	0.889

*Indicate significant improvement

Balance subtest items were walking forward in a line (WFL) and standing on one leg (eyes closed and eyes open) (SLS-EO and SLS-EC). The index finger was placed on the nose, and the eyes were closed as the bilateral coordinating element (TN-CS). Upper limb coordination subtests were used to drop and catch balls and catch thrown balls (CTB-BH and CDB-BH). Flexibility during sideways walking on the balance beam (SSBB) was evaluated. Prior to data collection, each subtest task was explained and shown to every participant in one test session. The subjects were given the opportunity to do a mock test for each activity prior to proceeding to the assessed route. For each test, the participant's response was reported. The most reliable studies were employed in the analysis. Following the test's administration, a score was generated by

The groups underwent a conventional physical treatment training program as follows: Core Posture Training: Upright sitting training, including graded active exercises for correcting core muscles (abnormal sitting, sitting with pelvis tilted back, rounded trunk, head on shoulders), - Balance training by promoting postural responses, - Functional training by walking (walking on sand, bearing weight on legs, climbing stairs), and - Coordination Ex. Take steps from toe to toe, from toe to nose, heel to knee, and form a circle and an 8 with your feet. Start slow, then fast, open your arms, then your eyes.

Statistical analysis: P-values for independent and dependent variables were calculated by the SPSS statistical software, and within-subject paired sample t-tests were used to determine differences in scores and

effect sizes before and after testing. The threshold for statistical significance was set at $p<0.05$.

RESULTS

Table 1 shows patient demographics and analytical characteristics of all patients. There were 17 girls (56.66%) and 13 boys (43.33%), and regarding right-handedness, left-handedness was reported in 22 patients (73.33%) and 8 patients (26.66%). There were no representative changes in age ($p = 0.68$), sex ($p = 0.32$), or hand dominance ($p = 0.36$) in any group. No statistically significant difference was found in the overall balance of the individual tests in the study and control group test scores. In addition, the bilateral coordination and receiving of the dropped ball did not reach statistical significance in both groups. Upper limb coordination, overall balance, and row-forward walking are significantly improved. Grabbing the ball with both hands and agility also demonstrated a significant enhancement in scores after the test compared to scores before the test.

DISCUSSION

Child rehabilitation includes improving mobility, preventing deformities, and educating parents about children's problems. This includes helping your child learn skills needed in everyday life, at school, and when playing with friends. Ultimately, rehabilitation means a reduction in complications arising from the child's neuromuscular abnormalities (Galli, 2007). The outcomes of the present research indicate that Children suffering from DS who struggle with agility and upper limb coordination may benefit from sensory integration treatment. People with Down syndrome tend to be more affected by static positions, and it is speculated that the current study's time frame was insufficient to cause an alteration in effect. Street walking is a sign of dynamic equilibrium that can be enhanced via adopting new coping mechanisms (Aruin, 1997). Therapeutic methods include sensory integration therapies, particularly in the perception of tactile, sensory, and vestibular cues. Interpret sensations associated with muscletone and strength, besides correcting body posture and movement, and monitor motor progress (Williamson, 2001). Basic motor abilities, including gripping objects and walking, require bilateral coordination, which is the coordinated movement of the body's sides. The current investigation did not show a change in bilateral coordination. This may be due to a single measure that necessitated participants to close their eyes. There are no maze exercises done with the eyes closed. Therefore, no specific instructions are required (Silva, 2017).

This is consistent with a previous study (Wuang, 2011), which revealed no alteration in bilateral coordination when employing Wii as a treatment modality. Synchronization of the upper body and extremities is essential to harmonize hand and arm actions with visual tracking. Few investigations focused on upper limb coordination. Ina research, Using the Wii three times per week for eight weeks resulted in a significant improvement in upper limb coordination (Berg, 2012). After playing the Wii, a child suffering from DS demonstrated better upper limb competency on their motor scores (Patti, 2012). Agility represents the capacity to alter direction effectively and necessitates the incorporation of motor skills, including strength, reaction time, and balance. As a result, it represents a sign of an individual's capacity to respond to the environment. The whole participants demonstrated a significant enhancement in mobility, which was consistent with research showing a significant enhancement in a range of motion in those suffering from DS after a 20-minute exercise treatment for 6 weeks using a Wii [21] considering planning with multi-sensory integration. Mobility improved in those suffering from intellectual disabilities following 6 months of training in mechanical movement, which is consistent with the study results. Exercises that simultaneously stimulate the sensory and tactile systems have been used to enhance the body image perception, motor strength, and body map (Laformefiss, 2009). Based on Ayres' research and the positive results, using strategies that combine different senses to perform tasks with a small sample could cooperate with our capability to distinguish minor and continuous alterations within certain boundaries (Uyanik, 2003). However, visual stimulation exercises combined with sensory and exercises to stimulate the vestibular and auditory systems have had a major impact on children's responses and how sensory systems can be used to compensate for their shortcomings (Jenkins, 1983). Always try to incorporate different approaches that can help your child go to school and prepare them for society.

CONCLUSIONS

It is recommended that sensory integration treatment be supplemented with particular physical therapy exercises to help children suffering from DS with their motor and balance skills. This proposed approach can be used as an effective intervention to preserve and improve functional skills in these children.

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