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Effects of Rhythmic Aerobic Exercises on Functional Balance in Children with Down Syndrome

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Abstract
Over 400,000 individuals in the US have Down syndrome (DS), the most prevalent genetic disorder. As a mother matures, her likelihood of having a child with DS increases. Trisomy 21 is a chromosomal abnormality associated with Down syndrome. Due to anomalies in the central nervous system's maturation, these changes are to blame for the delay in motor and cognitive development. The aim of this study was to determine the effect of rhythmic aerobic exercises for improving functional balance in children with DS. This investigation was a randomized controlled trial. Forty patients were split into two groups, with the experimental group doing combination of rhythmic aerobic activities, strength and balance exercises twice a week for 30 minutes each session for a total of eight weeks. After utilizing rhythmic auditory stimulation through a portable device with 8 beats at first, then advanced to 16 beats per minute in experimental group. Only strength and balance exercises were done with the control group. The patient's functional balance was evaluated by comparing the patient's sit-to-stand and stand-to-sit performance on the appropriate Pediatric Balance Scale and Timed Up and Go test sections. Among 36 participants, 15 (41.7%) were male and 21 (58.3%) were female. In current study results show experimental group shows better result than control group. The results of Pediatric Balance Scale after intervention were 34.56±3.053 $p<0.002$ and for Timed Up and Go test was 14.44±2.064 $p<0.000$. Conclusion This controlled trial concluded that there was significant effect of rhythmic aerobic exercise on functional balance in children with Down syndrome.

Key words: Down syndrome, Functional balance, Pediatric balance scale, Rhythmic aerobic exercise.

Introduction

A congenital condition with a genetic basis is called Down syndrome (DS). Down syndrome is caused by one of the three chromosomal abnormalities: non-disjunction, translocation, and/or trisomy 21, which is the most prevalent. A different kind of mosaicism occurs when some cells have the normal 46 chromosomes while others have 47. The chromosome change that occurs throughout the fetus's development—more specifically, during cell division—will determine the syndrome's symptoms and indicators A genetic test is used to diagnose DS, typically using a blood sample. A developmental deficit, to varying degrees, affects the majority of individuals with Down syndrome(Andresen et al. 2023). When it comes to intellectual impairment and developmental delay, this is the most common hereditary component. The outlook for people with down syndrome has improved dramatically in recent years(Ilinca et al. 2019). Down syndrome is a condition that runs in families. The estimated global prevalence is 0.1% of live births. When it comes to intellectual impairment and developmental delay, this is the most common hereditary component. Children with Down syndrome frequently experience delays in the development of motor skills, including poor bilateral coordination, delayed development of muscle and ligamentous laxity, hypotonia in the muscles, and reduced balancing response (Bahiraei et al. 2023)Children with Down syndrome may experience co-occurring medical conditions and intellectual disabilities due to additional genetic material originating from chromosome 21. That being said, phenotype is malleable. Down syndrome causes considerable developmental delays, multiple medical issues, intellectual difficulties, and mental health problems. Their lack of activity is another characteristic in common (Bullet al. 2022). Down syndrome is one common neurodevelopmental condition (DS). The prevalence of Down syndrome (DS) may range from one in 650 to just one in 1200 births, according to reports. Compared to other chromosomal disorders, down syndrome is the subject of more investigation. Some individuals with this genetic mutation attend college (Tenorioet al. 2023). Individuals with down syndrome now have a life expectancy that is only a few years shorter than the general population, thanks to significant

growth over the past 30 years. Individuals who have down syndrome struggle with both fine and gross motor abilities. It is projected to affect 1 in 732 live births in the United States. According to recent research, people with down syndrome spent a mean of 60 years during the past 50 years, with an average annual gain of 0.94 life-years (Reffat et al. 2022).The main characteristics of down syndrome are laxity of the ligaments, delayed neuro-psychomotor development, and global muscular hypotonia, which affect cognitive function and take an average of two years to develop gait. Aberrant postural control, which results from motor irregularities and alters gait patterns in addition to consuming more energy and performing worse, frequently leads to instability (Reffat et al. 2022).The way individuals carry out motor tasks is another way that those with and without down syndrome differ from one another. Due to a range of motor disorders, including inadequate tone in the muscles supporting posture, poor depth perception, inadequate contractions of the muscles around the joints, and hyperactivity of the joints, youngsters with this chromosomal abnormality (DS) have poor motor development. For those with down syndrome, inadequate motor development, weakness in specific sporting events, and inactivity even in daily activities can all significantly reduce quality of life (Kashi et al. 2023).

In addition, people with down syndrome have comorbidity traits. The comorbid traits include an inclination towards retreat, difficulty paying attention, maladaptive behavioral issues, obstinacy, anger, anxiety, and oppositional personality (Takahashi et al.2023). The World Health Organization has guidelines and recommendations that offer particular information for individuals facing various challenges and across various age groups. Additionally, include information on how much physical activity is necessary for optimum health for those with disabilities. The WHO advises children and teenagers with disabilities to participate in moderate-to-intense physical activity, mainly in the form of aerobic activities, for a minimum of sixty minutes every day of the week. In addition, they ought to engage in strenuous cardiovascular exercise and bone- and muscle-building exercises three days a week. It is well recognized that kids and teenagers with down syndrome run the risk of becoming obese, being inactive, and losing their physical fitness (Andresen et al. 2023).In teens participating in DS exercise Programmes, social interaction and daily activities are positively observable in terms of improving static-dynamic balance. Studies on children who have rhythmic movement and down syndrome are scarce. On the other hand, McGuire et al. demonstrate how children with down syndrome can benefit from rhythmic movement in terms of social involvement. improves cerebral, physical, and emotional aspects as well as gross motor skills (Adorno et al. 2022).The process of developing motor skills is dynamic, age-specific, and has no beginning or end. A few studies claim that children with down syndrome reach their motor milestone two times later than typically developing children (Jain et al. 2022).

Children who have these chromosomal abnormalities (DS) are less able to manage objects, explore the space, and engage with the environment because they have mild cognitive problems such as learning impairments and attention issues. Their participation in athletics, leisure activities, and daily responsibilities all depend heavily on their capacity to balance tasks and motor talents. As such, these conditions are having an effect on their quality of life (Zulfiqar et al. 2022). In their study, Riquelme Agulló et al. come to the conclusion that children with Down syndrome (DS) exhibit a delay in reaching gross motor milestones such as sitting, reaching, crawling, and walking, in contrast to typically developing neonates who pick these abilities up within the first year of life. Individuals with Down syndrome therefore exhibit several aspects of developmental delays due to these motor dysfunctions that result in decreased physical activity (Jain et al. 2022).Rapid initial loss of muscle mass is a characteristic of premature ageing that is exclusive to Empowering rhythmic talents through music-movement treatments has many practical benefits. These advantages demonstrate the close connections between language and memory and cognitive processes and physical movements. Additionally, with movement intervention, preschoolers can enhance their capacity for self-regulation following the execution of a rhythm(Koshelevaet al. 2022).Children with impairments cause a great deal of stress for their families due to their repeating pattern behavior. Their poor social development may make it more difficult for them to fit in. When developing remedial strategies for this group of kids, motor activity should be taken into account(Laureet al. 2023).

Materials And Methods

Ethical Approval

Ethical clearance was obtained from Rising sun institute for special children, Lahore and Rehab poly clinic, Lahore

Participants

The study was conducted at Rising sun institute for special children, Lahore and Rehab poly clinic, Lahore, Pakistan, with a sample size of 40 patients over a six-month duration. The study utilized Non probability convenience design to evaluate rhythmic aerobic exercises on functional balance in children with down syndrome and consents were taken on Performa by patient's caretakers.

Inclusion Criteria:

Patients with Down syndrome of age 9 to 14year-old, having functional capacity adequate to comprehend dialogue, give instructions, and follow advice, have ability to walk 60 meters independently according to 6-minute walk test and aerobic capacity accessed by heart rate and VO2 max value on pulse oximeter were included.

Exclusion Criteria:

Patients did not adapt to the training program, or were not willing to participate in the study, could not stand and walk on their own, could not follow simple verbal instructions and Study participants with intellectual disabilities, such as those brought on by meningitis, encephalitis, metabolic disorders, vitamin deficiencies, cardiovascular issues and tumors were not accepted.

Interventions

Patients who matched the eligibility criteria were recruited after taking informed consent. Informed consent was taken prior to allocation. It was done using the paper-based lottery method to assign patients in each intervention group. It was a single blinded study. Accessor (clinical assistant) was blinded. Patients were familiarized with rhythmic aerobic exercises and strength and balance exercises in 2 sessions before treatment after allocation to both groups. The intervention was executed for 30 minutes, two days in a week for total of 8 weeks. Experimental group; In experimental group the pattern of functional movements was comprising both right and left foot movements. To improve muscle strength and the capacity to maintain balance, exercises including running in place, side steps, walking while eating, and turning in place were used. The rhythmic aerobic group linked their motions to the rhythmic auditory stimuli in order to perform in a rhythmic manner. After utilizing rhythmic auditory stimulation with 8 beats (bpm) at first, the rhythmic training group advanced to 16 beats (bpm). Rhythmic auditory stimulation was given by portable device. Strengthening and balance exercises were also performed in experimental group. The pattern of movements includes one leg stand, tandem stance and get out of a chair, then take a seat without using your hands . Time for rhythmic aerobic exercises and for strengthening and balance exercises was 15 minutes per subject respectively. For both exercises total time was 30 minutes for two days in a week for total of 8 weeks. Control group; The control group was engaged in strength and balance exercises where they stood with weight on one leg and raised the other leg to the side or back. In a tandem stance, place your foot heel directly in front of your toe. Get out of a chair, then take a seat without using your hands. Time for exercise was 30 minutes per subject, two days in a week for total of 8 weeks.

Results

Out of 36 participants, 15 (41.7%) were male and 21 (58.3%) were female. The mean and standard deviation for this was 10.78 ± 1.476 for n=36. Age was measured in years and it ranges between 9-14 years. Total number of participants were divided equally (n=18) into two groups. One group was characterized as experimental group (rhythmic aerobic exercises + strength and balance exercises) and other was labeled as control group (strength and balance exercises). The Shapiro-Wilk test was utilized to determine the normality of the data, and a significant p value less than 0.05 was selected. Given that the p value was greater than 0.05 and the data was found to be normally distributed, parametric tests were employed to do additional analysis.

VARIABLES		**Experimental Group (Rhythmic aerobic exercises + Strength and balance exercises)**		**Control Group (Strength and balance exercises)**	
		Mean ± SD	**P Value**	**Mean ± SD**	**P Value**
Pediatric Balance Scale	Before	19.28±3.739	0.000	20.83±3.915	0.000
	After	34.56±3.053		28.72±6.267	
Timed Up & Go Test	Before	25.22±2.861	0.000	25.83±2.662	0.007
	After	14.44±2.064		22.11±3.833	

Table 2. Paired sample T test for Within the Group Analysis

Variables	**Group**	**N**	**Mean**	**Sd**	**P Value**
Pre-Pediatric Balance Scale	Experimental group	18	19.28	3.739	0.231
	Control group	18	20.83	3.915	
Post Pediatric Balance scale	Experimental group	18	34.56	3.053	0.002
	Control group	18	28.72	6.267	

Table 3. Independent sample T test for Between the Group Comparison of PBS

Variables	**Group**	**N**	**Mean**	**Sd**	**P Value**
Pre Timed up & Go test	Experimental group	18	25.22	2.861	0.512
	Control group	18	25.83	2.662	
Post Timed Up & Go test	Experimental group	18	14.44	2.064	0.000
	Control group	18	22.11	3.833	

Table 4: Independent sample T test for between the group comparison of TUG

Within group analysis paired sample t tests results showed that before and after intervention within group, experimental group (rhythmic aerobic exercises + strength and balance exercises) improved more rapidly than control group (strength and balance exercises). The p value of pre and post intervention of PBS experimental group was p=0.000; as the p value is less than 0.05 it means the result is statistically significant for PBS within group. The p value of pre and post intervention of TUG experimental group was p=0.000; as the p value is less than 0.05 it means the result is statistically significant for TUG within group. so this data shows that null hypothesis is rejected. Result shows very strongly statistically significant improvement in post intervention within group variables of experimental group. To find out if there were any variations among both groups independent sample t test was employed. Experimental group shows better results than control group.

Discussions

This present randomized controlled experiment set out to assess the benefits of aerobic exercise with rhythm on individuals with down syndrome who have trouble balancing on a regular basis. In a similar spirit, the results of a previous investigation conducted in 2017 support the findings of the present research due to the increasing efficacy. The study's objective was to investigate how older persons' levels of depression and balance were affected by aerobic exercise, whether it was rhythmic or not. Both the rhythmic aerobic exercise group and the nonrhythmic aerobic exercise group showed a significant improvement in this study's BBS, BDI, and FES measures, with a p value of less than 0.05. In comparison to the non-rhythmic aerobic exercise group, the rhythmic aerobic exercise group showed a significant improvement in BBS change values. Research has demonstrated that dynamic balancing skills benefited more from rhythmic aerobic training(Kwon et al. 2017). The data analysis of current research revealed that experimental group with rhythmic aerobic exercises demonstrated more promising outcome as compared to the control group without rhythmic aerobic exercises. The findings of present research indicate the potential advantage of rhythmic aerobic exercises and strength and balance exercises in down syndrome children. The rhythmic aerobic exercises exhibited more improvements in functional balance as evidence by significant changes in PBS scale and TUG test score. According to the results of a previous study done in 2021, aerobic exercise combined with rhythmic auditory stimulation was superior than aerobic exercise done alone for improving motor competence and emotional intelligence. It showed that, in terms of both factors, aerobic exercise combined with rhythmic auditory stimulation had advanced more than aerobic exercise alone(Zarian et al. 2021). The results of this study showed that the experimental group's post-intervention improvement was greater than that of the control group, with mean values of 34.56±3.053, 14.44±2.064 for PBS and TUG. The p-value between the two groups was found to be p=0.002, p=0.000, respectively, indicating a statistically significant distinction between the two groups. These results suggest that rhythmic aerobic exercises have a promising effect. The purpose of a 2021 study was to ascertain whether tempo matching played a major role in the beneficial benefits of cardiovascular exercise and rhythmic auditory stimulation on the executive function of young adults. Adolescents were randomly assigned to three mismatched exercise heart rate groups: the faster group (FMG, with rhythmic auditory stimulation at 155–165 bpm), the matched category (MG, with rhythmic auditory stimulation at 120–140 bpm), and the slower group (SMG, with rhythmic auditory stimulation at 60–65 bpm). The beneficial effects of rhythmic auditory stimulation on executive function during physical activity have been shown in numerous research. The update scores for the MG and the other two categories were substantially different from each other(Chen Chenet al. 2021). The current study set out to assess the benefits of aerobic exercise with rhythm for individuals with down syndrome who struggle with balance in their daily lives. The rhythmic aerobic workouts in this study were done at a pace ranging from 8 to 16 rhythms per minute. According to the current study's findings, the experimental group saw more benefits from rhythmic aerobic exercise on functional balance. Certain studies suggest that aerobic exercise improves executive function by increasing activation of prefrontal cortex regions of the brain. Because the heart pulses rhythmically when exercising, the brain is regularly affected by neurotransmitters(Feiss et al. 2021).The current study's findings demonstrate a very strong statistically significant advancement in the experimental group intervention's post-intervention group variables (rhythmic aerobic exercise plus strength and balance activities). An investigation into the advantages of aerobic exercise and rhythmic auditory stimulation for elderly female patients was the goal of a 2019 randomized controlled experiment. The female members of the experimental group performed the functional movement exercises while being stimulated by rhythmic noises. Comparing the two groups, it was shown that the experimental group's use of rhythmic auditory stimulation improved the older female participants' functional movement and overall quality of life more than the other group.(Shim et al. 2019). Children with down syndrome who were part of the experimental group in this study performed aerobic workouts while receiving rhythmic auditory stimulation through a portable device. The findings of this study suggest that rhythmic aerobic exercises have substantial outcome for down syndrome youngsters. Six to eleven-year-olds were divided into two groups for a prior study on rhythmic exercise: a physical education programme or a rhythmic programme. The Programmes ran for a total of seven weeks. Using whole-body movements, clapping, and drumsticks to create various rhythmic patterns, as well as responding to the beat of the rhythmic auditory stimulation, were the main goals of the rhythmic programme. Children in the rhythmic and physical education groups experienced the programme well and engaged in exercising at equal levels. Both groups experienced improvements in balancing and cool executive function, and there were significant correlations between the two change scores(Vazou et al. 2020). In the current investigation, rhythmic aerobic workouts were carried out using a portable device that provided rhythmic auditory stimulation at 8 to 16 beats per minute. It suggests that children with down syndrome may benefit from strength and balance workouts as well as rhythmic aerobic exercises. The results of the TUG test and the PBS scale showed that the rhythmic aerobic activities significantly improved functional balance.

Conclusion

In this controlled trial both groups showed improvements in functional balance but that there were more significant effects of rhythmic aerobic exercises on functional balance in children with down syndrome. However, it is essential to acknowledge the intricacy associated with balance in down syndrome and need further research to resolve balance issues in down syndrome.

Recommendations

It is imperative that future studies examine how the various aerobic exercises with rhythmic auditory stimulation affect balance in down syndrome children. This study should be done in different hospitals, rehabilitation centers in different cities. Follow up should be extended to study long term effects of these techniques on study population.

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