

A Comparative Study of Trampoline vs. Hopscotch on Balance for Children With Autism Spectrum Disorder

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Abstract: Background: Children with ASD are expected to have balance difficulties because postural balance (PB) regulation is not solely directed by reflexes but involves higher brain centers such as the motor cortex, basal ganglia, cerebellum, vestibular cortex, and brainstem. Studies have shown that PB is often impaired in individuals with ASD, with postural abnormalities predicting ASD symptomatology. Specifically, an increase in postural sway reflects impaired perception of body movement relative to postural limits and a decreased ability to coordinate distinct ankle and hip movements to align the body while standing. **AIM** The aim of this study is to compare the effects of hopscotch Vs trampoline on balance in children with autism spectrum disorder (ASD). **OBJECTIVES** To select children with autism spectrum disorder (ASD). To evaluate balance in children with autism spectrum disorder (ASD) To improve balance in children with autism spectrum disorder and To compare the difference between these two activities. **METHODS** A total of 20 children with autism spectrum disorder (ASD) were selected for this study based on specific criteria. Balance was assessed using the Berg Balance Scale (BBS) for both hopscotch and trampoline activities. Balance training was conducted using balancing activities, with each child participating in 20-minute sessions over a period of 12 weeks (36 sessions). Pre and post-tests were conducted to Compare the effects of hopscotch and trampoline training on balance. **RESULTS:** The study demonstrated significant improvements in children's balance following hopscotch training compared to trampoline training. the post-assessment score for the post-assessment score for trampoline M=47.0, SD= 3.55 and the t value is 2.02, P-Value <0.005. The post-assessment score for hopscotch M=50.7, SD= 2.0 and the t value is 2.26, P-Value <0.05 **CONCLUSION** Through this study, it is concluded that, Hopscotch training effectively enhanced children's walking co-ordination and balance patterns, better improvement in children with autism spectrum disorder (ASD), compared to trampoline Training. Balance training via hopscotch warrants integration with other therapeutic activities for optimal paediatric outcomes.

Keywords: Hopscotch game, trampoline game, balance, Berg Balance Scale (BBS), autism spectrum disorder (ASD).

INTRODUCTION

The estimated prevalence of autism in India is around 1 in 68 children. Boys are more commonly affected by autism than girls, with a male-to-female ratio of approximately 3:1. India, with a population of nearly 1.3 billion, has children aged 15 years and under constituting nearly one-third of the population. It is estimated that more than 2 million people in India may be affected by autism spectrum disorder (ASD). the Indian Journal of Paediatrics 2021.

The World Health Organization (WHO) defines autism spectrum disorder as a neurodevelopmental disorder caused by abnormalities in brain development and function. This term encompasses a range of disorders, including conditions that were once considered separate, such as autism and Asperger's syndrome. Although some people still use the term "Asperger's syndrome," it is generally considered to be at the milder end of the autism spectrum.

Autism, also referred to as autism spectrum disorder, represents a diverse group of conditions

related to brain development. Approximately 1 in 100 children globally are diagnosed with autism. While characteristics of autism may be detected in early childhood, diagnosis often occurs much later. The abilities and needs of autistic individuals vary and can change over time. Some people with autism can live independently, while others have severe disabilities that require lifelong care and support. Evidence-based psychological interventions can improve communication and social skills, positively impacting the well-being and quality of life for both autistic individuals and their caregivers. Care for people with autism should be accompanied by actions at the community and societal levels to promote greater accessibility, inclusivity, and support.

Occupational therapists are trained to analyse and promote activities that help children interact with their immediate environment and develop communication and engagement skills. In the context of autism, the primary role of an occupational therapist is to teach daily life skills, including self-care, work, and leisure activities.

This training program includes, trampoline and hopscotch designed to improve balance. These activities were structured with progressive complexity, allowing participants to perform challenge tasks based on their abilities and performance. The children who participated in the program demonstrated increased balance, improved stability, and better postural control.

BALANCE IN AUTISM

Balance is a crucial skill that affects various aspects of daily life, from walking and running to playing sports or even sitting upright. For children with ASD, balance difficulties can significantly impact their physical abilities and overall quality of life. Balance training can benefit individuals with ASD by influencing cerebellar function, motor skills, and muscle strength, thereby enhancing postural balance. In one program, children engaged in balance training through hopscotch and trampoline activities, which involved maintaining balance while jumping on both legs and performing flexion and extension movements with stability. This training led to improved equilibrium reactions, increased stability, and better postural balance.

Balance involves the ability to maintain the body in a desired position, whether static or dynamic. This skill is made possible through the interaction of the proprioceptive, vestibular, and visual systems:

- ❖ The proprioceptive system informs the body of its position relative to surfaces.
- ❖ The vestibular system informs the head's position in space and transmits information about the body's relationship to the environment to the central nervous system.

Hopscotch Training

Hopscotch is a traditional playground game that can be played alone or with others. It involves drawing a series of numbered squares on the ground and hopping through the course on one foot, avoiding the square with a marker. This game requires agility, balance, and concentration, making it a fun and effective way for children to develop physical coordination and social interaction skills. For children with ASD, hopscotch can improve both motor skills and focus. The game can be adapted to suit the needs of children on the autism spectrum, helping them develop sensory, academic, and physical skills.

Hopscotch is a timeless and beloved playground game enjoyed by children around the world. The

game begins with players drawing a series of numbered squares on the ground chalk, typically ranging from numbers 1 to 10. Players take turns throwing a small object, such as a stone or beanbag, onto the numbered squares in sequence, starting with the first. The object is hop through the course on one foot, skipping the square with the marker, without stepping on the lines or losing balance. Upon reaching the end, players turn around and hop back to pick up the marker, continuing the sequence with turn. The game requires agility, balance, and concentration, making it a fun and engaging way for children to develop physical coordination and social interaction. Variations of hopscotch exists, offering different challenges and layouts, but the core essence of the game – a blend of play, competition, and physical activity- remains a cherished aspect of childhood across cultures.

Trampoline Training

Trampoline activities are energetic and enjoyable for children of all ages. The thrill of jumping on a trampoline offers a sense of adventure, burning off excess energy and promoting fitness. Trampoline games can also be beneficial for children with autism, providing physical activity, sensory play, and social interaction in a supportive environment. These games can be customized to meet individual needs, improving motor skills, coordination, and communication while offering sensory input that many children with autism find calming or stimulating.

Need for Study

The purpose of this study was to compare the effects of hopscotch and trampoline exercises on balance in children with Autism Spectrum Disorder (ASD). Children with ASD often face significant challenges at home, school, and in other settings, posing difficulties for both parents and educators. Hopscotch and trampoline trainings are valuable therapeutic and educational interventions for these children. These activities help them address and improve balance and motor skills by integrating somatosensory, visual, and vestibular inputs. As enjoyable and playful games, hopscotch and trampoline trainings can enhance balance skills in children with ASD.

METHODOLOGY

Study design and Sample:

Comparative / experimental study design with Twenty children diagnosed with Autism Spectrum Disorder (ASD) by a paediatrician or psychiatrist,

aged 4-8 years (17 males and 3 females), were included in this study.

Assessment Tool: Berg Balance Scale (BBS)

3.3 Selection Criteria:

3.4.1 Inclusion Criteria

- ❖ Children diagnosed with autism spectrum disorder (ASD) by the physician, paediatrician, and psychiatrist were selected, the age group between 4-8 years.

- ❖ Both male and female children with autism spectrum disorder (ASD) were included in this study.

Exclusion Criteria

- ❖ Children with autism spectrum disorder (ASD) with 8 years and above were excluded in this study

- ❖ Children with Visual impairment, Hearing impairment, Attention deficit hyperactive disorder, Intellectual disability, learning disability were excluded.

Outcome Measure

Balance has been recognized as a crucial factor, as it involves maintaining posture during static stance and transitioning between movements, and it plays a significant role in performing daily activities. Consequently, numerous studies have been conducted to evaluate balance ability over the years.

The Berg Balance Scale (BBS) is the best-known balance measure that assesses balance and fall risk in adults. The BBS consists of 14 items with an ordinal scale of 0 to 4 for a total of 56 points (a lower score indicates higher fall risk). Zero score indicates the lowest level of function and 4 score the highest level of function and it takes approximately 20 minutes to complete. The items evaluate from the static position with increasing difficulty by decreasing the base of support to dynamic activities. The BBS is designed with content closely resembling real-life daily activities, making it easy to learn and allowing for repetitive evaluations. It requires minimal cost, time, and simple equipment. Additionally, even patients in the acute phase of stroke, many of whom may be unable to sit or stand, can undergo the assessment, highlighting its advantages.

The clinical utility of the BBS includes the ability to estimate rehabilitation outcomes using the total score of the scale. Research on estimating rehabilitation outcomes suggests that scores measured at admission using the BBS are inversely

related to the length of hospitalization and can predict the duration of hospitalization and eventual discharge decisions. Additionally, studies have categorized functional levels based on scores; for instance, scores ranging from 0 to 20 indicate the ability to walk with a walking aid, scores from 21 to 40 suggest the ability to walk with assistance, and scores from 41 to 56 indicate independent walking capability. The BBS also serves as a predictor of fall risk, with scores of 41–56 indicating low risk, 21–40 indicating medium risk, and 0–20 indicating high risk. Berg et al. reported that the reliability of the BBS was 0.83 as measured by Cronbach's alpha coefficient in a study involving the general elderly population, and 0.97 in a study involving stroke patients, indicating high reliability. This suggests that the BBS may be particularly useful for assessing balance in stroke patients, showing higher reliability in this population compared to its original purpose of assessing fall risk in the elderly. The BBS has been validated for use in individuals with spinal cord injury and has the advantage of being valuable for other neurologic populations. The Korean version of BBS has also been verified for validity and reliability.

Study Procedure

The purpose of this study was to improve balance in children with Autism Spectrum Disorder (ASD). A total of 20 children with ASD, selected based on specific criteria, participated in the study. All participants were receiving at Sumathy Occupational Therapy Centre in Cuddalore. Balance was assessed using the Berg Balance Scale. The intervention program included trampoline and hopscotch training aimed at improving balance. Each child participated in 20-minute sessions, conducted 3 days /per week over a period of 12 weeks (36 sessions in total). Following the 12-week intervention, balance assessments were repeated. Pre- and post-intervention balance scores were recorded and statistically analyzed.

PROCEDURES

Procedures of Hopscotch Training

The goal of this hopscotch game is to match the feet's jumps to the pictures on the hopscotch play mat, progressing row by row until reaching the end. To begin, one child at a time will align their feet with the boxes in the first row. They will continue to move down the row, matching their feet to the correct boxes. This activity requires coordinating body movements and alternating foot

positions to maintain balance and posture, which is particularly beneficial for children with Autism Spectrum Disorder (ASD).

Procedures of Trampoline Training

The goal of the trampoline game is for the child to stand on both feet in the center of the trampoline, bend their knees, and push gently off their toes to start a low, controlled bounce. Each child will continue bouncing on the trampoline for 20 minutes. The exercise involves repetitive upward and downward movements to enhance balance. This activity requires body movement, maintaining position, and balancing, which is particularly beneficial for children with Autism Spectrum Disorder (ASD).

Protocol for Trampoline Training

Based on balance training, Trampoline was administered on the children with autism spectrum disorder (ASD). Trampoline was used to improve sensory, motor, balance and educational skills of autistic children. It also improving their strength, balance, ability, speed and coordination. This training was conducted 20 minutes daily, 3 days / per weeks over a period of 12 weeks. All children were tested using berg balance scale (BBS) before and after intervention.

Protocol for Hopscotch Training

Based on balance training, hopscotch was administered on the children with autism spectrum disorder (ASD). Hopscotch is used to improve body controls and dexterity, from balancing and gross motor skills. This training was conducted 20 minutes daily, 3 days / per weeks over a period of 12 weeks. All children were tested using berg balance scale (BBS) before and after intervention.

DATA ANALYSIS AND RESULTS

The following table represents the raw data of balance for selected students using berg balance scale.

Table 1: Pre And Post Score For Trampoline Training

S.no	Name	Age	Gender	Berg Balance Scale Assessment	
				Pre Test	Post Test
1.	AH	5 ½	Male child	34	48
2.	BN	4	Male child	8	38
3.	KN	4 ½	Male child	43	47
4.	LN	5	Male child	42	47
5.	NH	6	Male child	40	52
6.	PN	4	Male child	26	48
7.	PH	4 ½	Male child	19	49
8.	SN	4	Male child	21	48
9.	VA	4	Male child	22	46
10.	YI	4	Female child	22	47

Table 2: Pre And Post Score For Hopscotch Training

Berg Balance Assessment	
PRE TEST	POST TEST
21	51
23	52
29	51
41	52
16	50
31	46
41	52
20	52
22	49
27	51

STATISTICAL ANALYSIS

Trampoline Training Statistical Analysis

In this study, data entry was performed using Microsoft Excel. Descriptive statistics, including

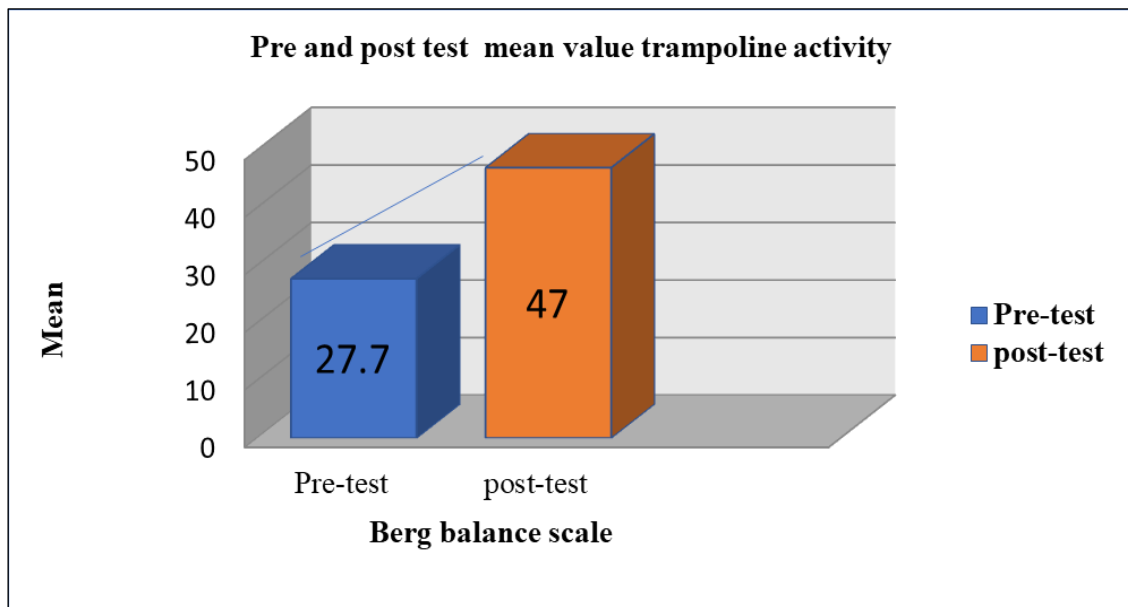
mean and standard deviation, were calculated for continuous variables. A paired sample t-test was conducted to compare the pre-test and post-test scores of the trampoline activity.

Table 3: Paired Sample 'T' Test For Balance In Trampoline

	Mean	SD	Mean difference	t-value	p- value
Pre-test score	27.7	11.57	19.3	1.833	<0.05
Post-test score	47	3.55	19.3	2.26	<0.05

The table-3 represents the paired sample 'to test for balance in trampoline. As it is mentioned above, total number of participants took part in this study is 10. The pre- test (M=27.7, SD=11.57) to

post test (M=47, SD=3.55) is decreased with the mean difference 19.3. The 'p' value (<0.05) for the pre- test and post test score is significant.



Bar Graph – 1

Hopscotch Training Statically Analysis

In this study, data entry was performed using Microsoft Excel. Descriptive statistics, including mean and standard deviation, were calculated for

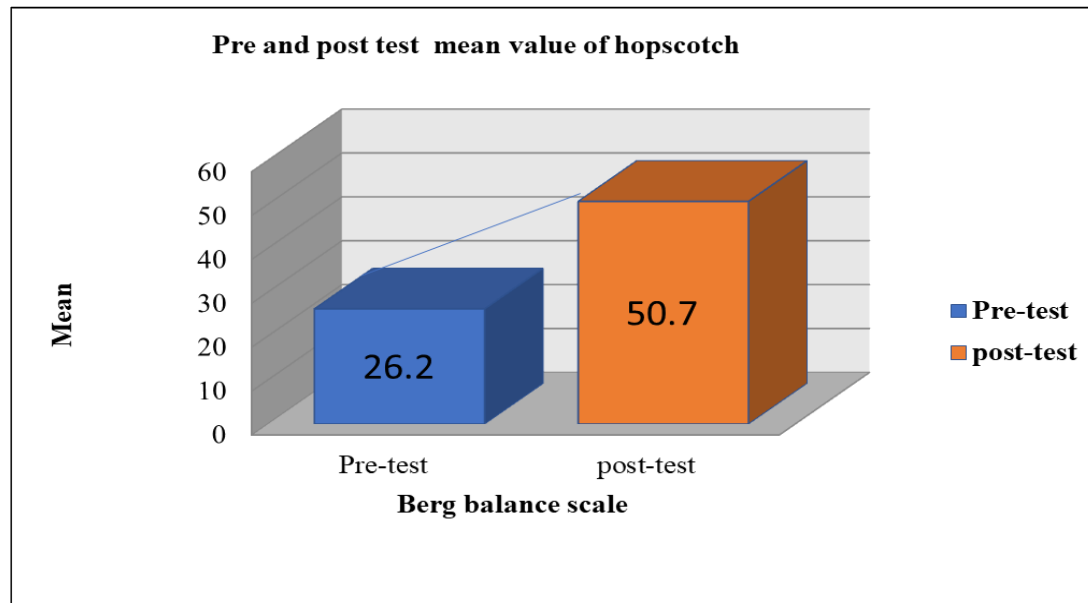
continuous variables. A paired sample t-test was applied to compare pre- test and post-test score of hopscotch activity.

Table 4: Paired sample 't' test for balance in hopscotch

	Mean	SD	Mean difference	t-value	p-value
Pre test	26.2	7.31	24.5	1.83	<0.05
Post test	50.7	2	24.5	2.26	<0.05

The table-4 represents the paired sample 't'test for balance in hopscotch. As it is mentioned above, total number of participants took part in this study is 10. The pre- test (M=26.2, SD=7.31) to post test

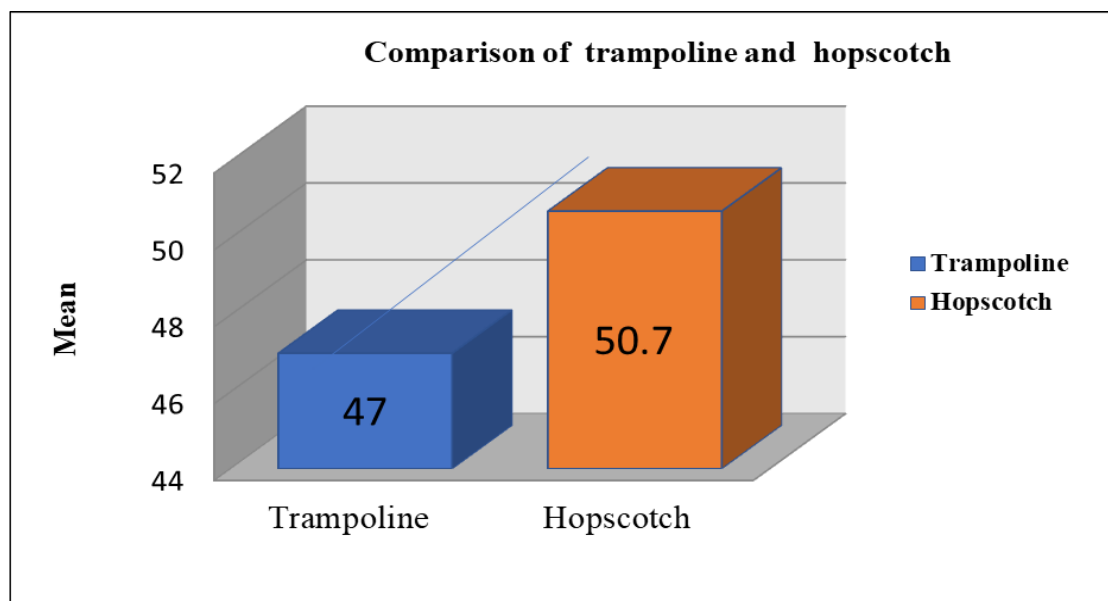
(M=50.7, SD=2) is increased with the mean difference 24.5. The 'p' value (<0.05) for the pre- test and post test score is significant.

**Bargraph - 2**

Comparison of Trampoline And Hopscotch Training

The mean post-assessment score for the hopscotch activity was higher than that for the trampoline activity, indicating that hopscotch is more effective in improving balance. The likely reason for this

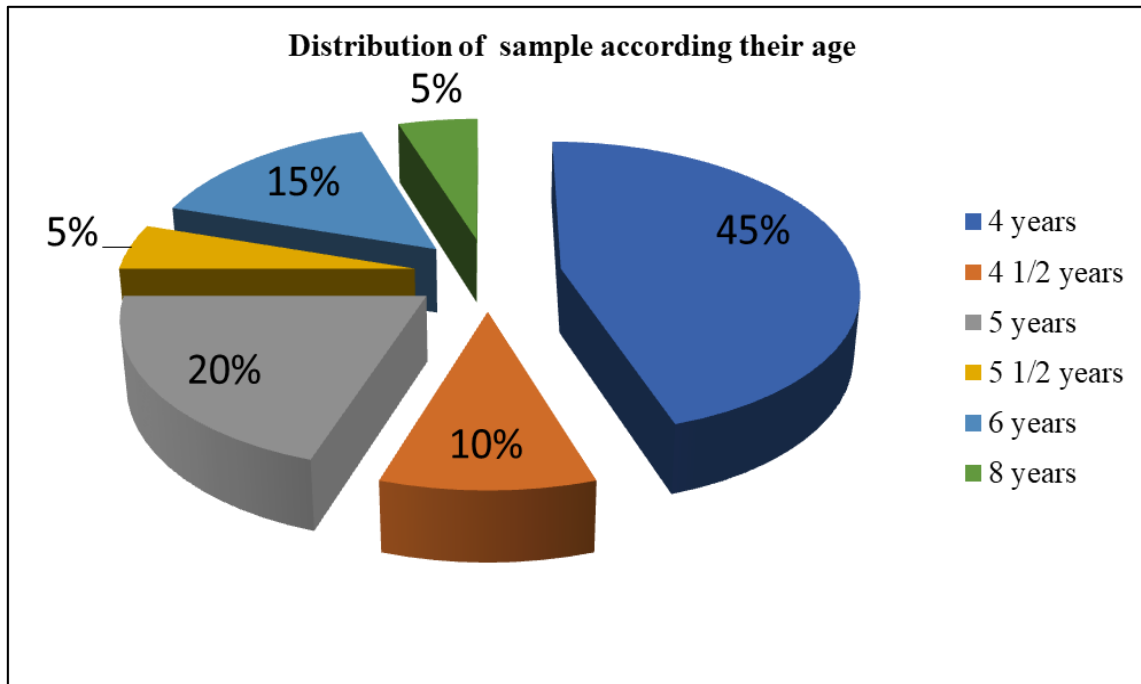
difference is that trampoline activity primarily enhances balance in the vertical direction, while hopscotch helps improve balance in multiple directions, thereby better enhancing the centre of gravity in children with autism.

**Bar Graph 3: Comparison of trampoline Vs hopscotch****Table 5: Distribution Of Sample According To Their Age**

S.no	Age	Number of patients	Percentage
1.	4 Years	9	45.0
2.	4 ½ Years	2	10.0
3.	5 Years	4	20.0
4.	5 ½ Years	1	5.0
5.	6 Years	3	15.0
6.	8 Years	1	5.0
	Total	20	100.0

Out of 20 children, 45.0% of them are 4 years, 10.0% of them are 4 ½ years, 20.0% of them are 5 years, 5% of them are 5 ½ years, 15.0% of them

are 6 years, and 5.0% of them are 8 years old among the children. Hence majority of the children are 4 years old male children.

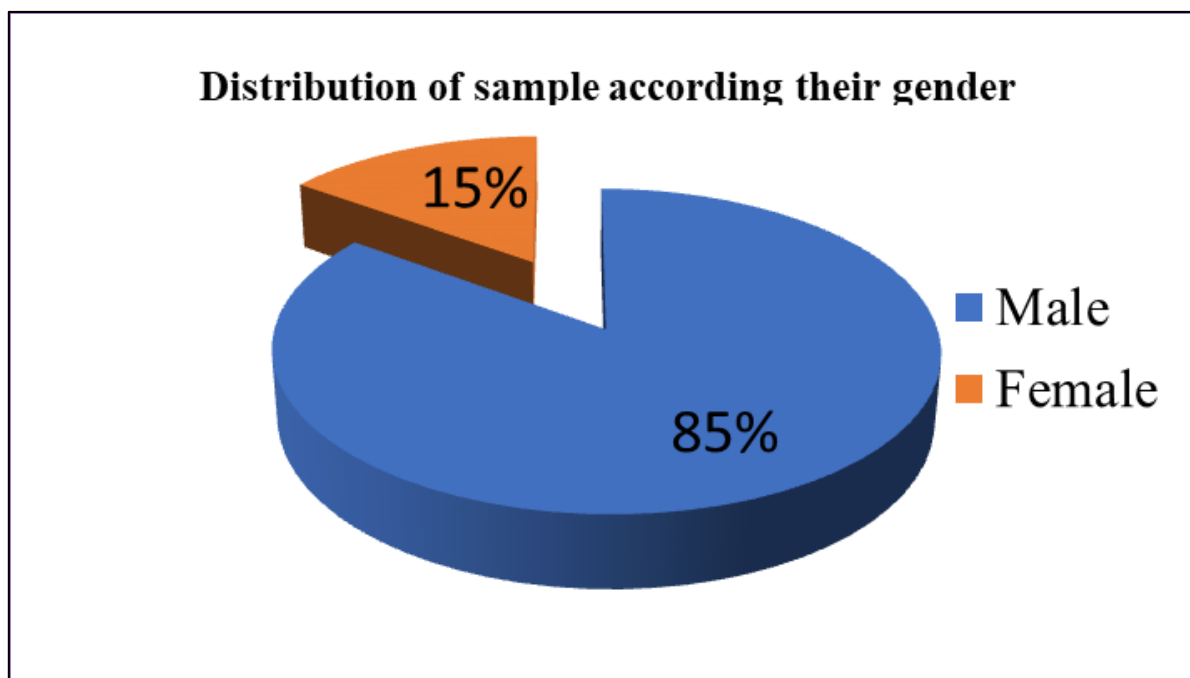


Pie Chart 1: Distribution of Sample According To Their Age

Table 6: Distribution of Sample According To Their Gender

S.NO	GENDER	NUMBER OF PATIENTS	PERCENTAGE
1.	Male child	17	85.0
2.	Female child	3	15.0
	Total	20	100.0

Out of 20 children, 85.0% of them are male child and 15.0% of them are female among the children. Hence majority of the children are male.



Pie Chart 2: Distribution Of Sample According To Their Gender

RESULT

Results were analyzed after 12 weeks of intervention, showing significant improvement in the balance levels of children with Autism Spectrum Disorder (ASD). The pre- and post-test values of the Berg Balance Scale (BBS) for these children revealed that the trampoline activity had a pre-test mean value of 22.7 and a post-test mean value of 47, while the hopscotch activity showed a pre-test mean value of 26.2 and a post-test mean value of 50.7. The comparison between the trampoline mean value (47) and the hopscotch mean value (50.7) indicates that hopscotch has a more positive impact on balance improvement. Therefore, it is suggested that children who participated in hopscotch training demonstrated better balance improvement. The 't' value is 2.26, and the 'p' value is <0.05, indicating statistical significance.

DISCUSSION

This study included 20 children with Autism Spectrum Disorder (ASD) aged 4-8 years, conducted at Sumathy Occupational Therapy Centre in Cuddalore. The intervention spanned 12 weeks, with a total of 36 sessions, each lasting 20 minutes. Pre-assessment of balance levels was performed before the intervention, which involved hopscotch and trampoline activities. The mean pre-test and post-test scores for the trampoline activity were 22.7 and 47, respectively, while the hopscotch activity showed a mean pre-test score of 26 and a post-test score of 50.7. The comparison revealed that hopscotch was more effective than trampoline in improving balance, as indicated by the higher mean post-test score (50.7) compared to trampoline (47). Based on these findings, concluded that hopscotch is more effective than trampoline for improving balance in children with ASD. This study also highlights the benefits of hopscotch in enhancing balance, coordination, and flexibility.

LIMITATION AND RECOMMENDATION

Limitation

- ❖ This study was conducted on a minimal sample and minimal duration
- ❖ This study was included only autism spectrum disorder (ASD) children

Recommendation

- ❖ Study can be done on larger sample size.
- ❖ Study can be done for longer duration.

- ❖ Hopscotch and trampoline can studied on other conditions.
- ❖ Other Hopscotch techniques like geometric arrangement of squares and numeric arrangement of squares were also included in this study.
- ❖ Other trampoline techniques like variable different types and electrical method of jumping were also included in this study.

CONCLUSION

Through this study, it is concluded that, Hopscotch training effectively enhanced children's walking co-ordination and balance patterns, better improvement in children with autism spectrum disorder (ASD), compared to trampoline Training. Balance training via hopscotch warrants integration with other therapeutic activities for optimal paediatric outcomes.

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