

# Effect of 6 Week Aerobic And Strength Based Exercise Program on Attention Span and Cognitive Function in Adults with Down Syndrome. A Quasi-Experimental Study

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**Abstract: -Objectives:** The objective of this study is to investigate the combined impact of an aerobic and strength-based exercise program on cognitive function and attention span in adults with Down syndrome, who experience challenges in learning, memory, and language, leading to varying degrees of intellectual impairment.

**Materials and methods:** This study utilized a quasi-experimental research design. A total of 25 adults with Down syndrome, aged 18 to 25 years, were recruited from SIRTAR School in Rohtak District, Haryana. Cognitive function was assessed using the Cognitive Scale for Down Syndrome, while attention span was measured using the Stroop Color and Word Test. Evaluations were conducted both before and after a six-week exercise intervention program.

**Results:** Data analysis was conducted using SPSS software version 21.0. Within-group comparisons were performed using repeated measures ANOVA, with a p-value of  $\leq 0.05$  considered statistically significant. The repeated measures ANOVA test demonstrated a significant effect of the aerobic and strength-based exercise program on cognitive function and attention span in adults with Down syndrome.

**Conclusion:** Aerobic and strength-based exercises have been shown to enhance cognition and attention in this population. These findings are significant for developing effective interventions and treatment strategies aimed at improving the quality of life for adults with Down syndrome.

**Keywords:** Cognition, Attention span, Down syndrome

## INTRODUCTION

Down syndrome is the most common congenital chromosomal disorder that is always present with

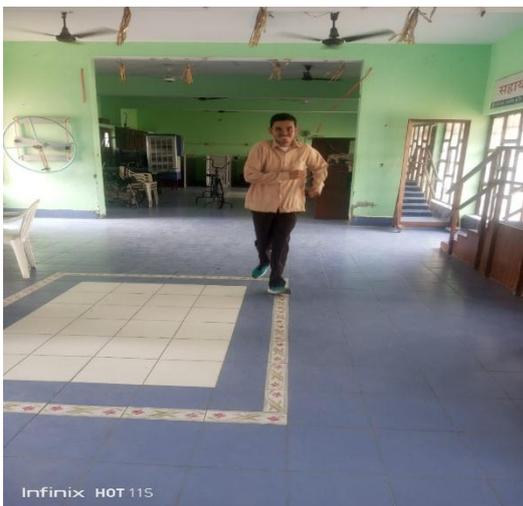
mental retardation<sup>1</sup>. DS was first clinically described in 1866 by Langdon Down in London. Down syndrome is the most common genetic cause of intellectual disability occurring in approx. 1 in 800 births worldwide.<sup>3</sup> Birth rates are seen more in mothers of older age<sup>2</sup>. The prevalence according to age is one in 400 at 35 years of age, one in 105 at 40 years of age, one in 12 at 45 years of age. While 80 % of Down syndrome children are seen in mothers older than 35 years.<sup>4</sup> There is another type of down syndrome, trans-location down syndrome also known as partial trisomy 21 which can be inherited. In this type of down syndrome an additional chromosome 21 is attached to another chromosome mosaic. It is the result of mutation during mitosis where the embryo has combination of typical cells as well as with third copy of chromosome 21<sup>3</sup>. the Down syndrome chromosomal anomaly determines a number of changes in protein expression patterns that lead to specific biochemical, physiological, anatomical, and behavioral characteristics like an imbalance of the oxidative metabolism, mitochondrial dysfunction, impaired nervous system, musculoskeletal disorders, congenital problems of the heart, narrowed airways, obesity, premature aging, and poor sleep<sup>4,5</sup>. People with DS also display generalized muscle hypotonia, ligamentous laxity, articular hypermobility and difficulties in agonist and antagonist muscle contraction. Consequently, they experience changes in dynamic balance, postural control and other motor proficiency domains, as they are slower to adapt to motor task demands and environmental changes and have less ability to perform anticipatory postural adjustments<sup>6</sup>.

These changes also impair visual motor integration, agility, muscle strength, motor control and movement reaction time<sup>5,7</sup>. Physical exercise interventions can effectively improve cardiovascular fitness, muscle strength and balance as well as daily life activities and social participation in individuals with DS<sup>8</sup>. exercise can promote positive cognitive changes associated with exercise-induced trophic factor enhancement, which further encourages exercise interventions Down's syndrome is characterized by abnormalities in learning, memory, and language that lead to mild-to profound impairment in intellectual functioning<sup>9</sup>. Down syndrome is a lifelong condition, and cognitive decline is nearly universal in older adults, becoming more pronounced with age. Regular physical activity is associated with better cognitive functioning and less cognitive decline in later life. The attention span is a mandatory requirement to gather relevant and sufficient information from the environment. Attention span is the amount of time spent concentrating on a task before becoming distracted. Previous studies indicate that aerobic and strength based exercise showed positive results on attention span and cognition in adults with down syndrome<sup>8</sup>.The severity of cognitive disability and type of cognitive function affected vary greatly in the cognitive profiles of peoples with down syndrome<sup>10</sup>. The aim of this study was to evaluate the combined effect of aerobic and strength-based

exercise program on cognitive function and attention span in adults with down syndrome.

### METHODOLOGY

It was a quasi-experimental study conducted in the different special schools (SIRTAR, Arpan Institute for Mentally Handicapped Children etc.) of Rohtak district, Haryana. . A total of 25 adults with down syndrome age between 18-35 years old were enrolled in study. severe gastrointestinal disorders (duodenal atresia), orthopedic disorders (atlanto-occipital subluxation), severe hearing defects and uncontrolled hyperthyroidism were excluded from study. This study was approved by the ethical committee vide letter No. BREC/23/TH-physiotherapy/39, date-20/07/2023 and informed consent was taken from all the participants. Permission was taken from the head of the concerned school. Baseline reading was taken by using Stroop color and word test, and cognitive scale to measure their attention span and cognitive function. After the baseline reading experimental group were provided with 18 sessions (each session was 30 minutes, conducted thrice a week for 6 weeks) of aerobic and strength-based exercise program<sup>11</sup>. After intervention assessment for all variables were taken again at 3 weeks and 6 weeks by using stroop color and word test, and cognitive scale for down syndrome.



### RESULT

Statistical analysis of data was performed using SPSS software version 21.0. within group analysis repeated measures of ANOVA was used. For all statistical tests, a p-value of  $\leq 0.05$  was taken as a

significant difference. Table11. shows using an ANOVA with repeated measures with a Greenhouse-Geisser correction as assumption of sphericity violated, the mean scores for all variable were statistically significantly different as obtained value for p was  $\leq 0.05$ .

Variable	Mean ± SD		Mean difference	P value	Confidence interval
Attention span Correct responses	Baseline 95.32±6.725	3 weeks 98.72±6.760	74.000	.000**	[67.677, 80.323]
	3 weeks 98.72±6.760	6 weeks 101.52±6.403	17.960	.000**	[14.820, 21.100]
	Baseline 95.32±6.725	6 weeks 101.52±6.403	91.960	.000**	[-96.303,-87.617 ]
Attention span incorrect responses	Baseline 21.32±5.82	3 weeks 18.60±5.97	59.085	.000**	[-67.053, 80.323]
	3 weeks 18.60±5.97	6 weeks 16.92±5.65	51.616	.000**	[31.797, 21.100]
	Baseline 21.32±5.82	6 weeks 16.92±5.65	7.470	.531 <sup>NS</sup>	[-6.346,21.286]
Attention span no responses	Baseline 3.360±2.70	3 weeks 2.640±2.62	15.960	.000**	[12.727, 19.193 ]
	3 weeks 2.640±2.62	6weeks 1.560±1.89	85.089	.000**	[-95.878,-74.300]
	Baseline 3.360±2.7061	6weeks 1.560±1.89	85.089	.000**	[74.300, 95.878]
Attention span congruent responses time (sec.)	Baseline 91.250± 21.76	3 weeks 87.728± 21.54	45.895	.000**	[26.565, 31.573]
	3 weeks 87.728± 21.54	6 weeks 85.248± 21.45	84.600	.000**	[78.457, -16.260]
	Baseline 91.250± 21.76	6 weeks 85.248± 21.45	130.495	.000**	[-146.113, -5.089]
Attention span incongruent responses time (sec.)	Baseline 150.36± 33.84	3 weeks 147.41± 33.38	83.688	.000**	[-94.593, -72.783]
	3 weeks 147.41± 33.38	6 weeks 144.89± 32.91	59.646	.000**	[-67.683, -51.609]
	Baseline 150.36± 33.84	6 weeks 144.89± 32.91	143.334	.000**	[126.555,160.113]
Executive Function Domain (EFD) of CS-DS	Baseline 23.960±8.862	3 weeks 6.04±8.648	12.040	0.000**	[9.172,14.908]
	3 weeks 6.04±8.648	6 weeks 28.12±8.47	5.880	0.000**	[4.805,6.955]
	Baseline 23.960±8.862	6 weeks 28.12±8.47	17.920	0.000**	[-21.107,-14.733]
Memory Domain of CS-DS	Baseline 11.92± 4.24	3 weeks 13.64± 4.44	15.920	.000**	[11.914,19.926]
	3 weeks 13.64± 4.44	6 weeks 15.20± 4.35	12.400	.000**	[9.705,15.095]

	Baseline 11.92± 4.24	6 weeks 15.20± 4.35	28.320	.000**	[-34.444,-22.196]
Language Domain of CS- DS	Baseline 6.040±3.44	3 weeks 7.760±3.35	38.640	.000**	[-44.831,-32.449]
	3 weeks 7.760±3.35	6 weeks 9.520±3.98	18.280	.000**	[32.449,44.831]
	Baseline 6.040±3.44	6 weeks 9.520±3.98	20.360	.000**	[17.229,23.491]
CS-DS total	Baseline 41.960±15.82	3 weeks 46.40±14.57	5.680	.000**	[4.404,6.956]
	3 weeks 46.40±14.57	6 weeks 52.840±15.784	43.320	.000**	[-49.697,-36.943]
	Baseline 41.960±15.82	6 weeks 52.840±15.784	37.640	.000**	[31.577,43.703]
**Highly significant (p<0.001), NS Non significant					

## DISCUSSION

The aim of the study was examining the effect of aerobic and strength-based exercise program on cognitive function and attention span in adults with down syndrome. Pre and post analysis of cognition is concluding that that aerobic and strength-based exercise program improved the cognition EFD by 17% (p=0.00), LD By 57%(p=0.00), MD By 27% (p=0.00) and CS-DS total by 25% (p=0.00) in adults with down syndrome, which is statistically significant differences (p<0.05) at 3<sup>rd</sup> week and 6<sup>th</sup> week. Findings showed that exercise program improved the attention span correct response (p=0.00), incorrect response (p=0.00), no response (p=0.00), congruent time (p=0.00) and incongruent time (p=0.00) in adults with down syndrome. The possible explanation for improvement of cognition and attention span can be that aerobic and strength-based exercise promoting neuroplasticity, the brain's ability to adapt and form new connections<sup>12</sup>. Strength training stimulates the release of brain-derived neurotrophic factor (BDNF), a protein essential for brain cell growth, learning, and memory<sup>13</sup>. As a result, individuals with Down syndrome who engage in regular resistance exercises often experience improvements in cognitive skills such as problem-solving, memory retention, and decision-making<sup>14</sup>. positive memory changes are associated with increases in local grey matter volume in the pre-frontal and cingulate cortex and brain derived neurotropic factors as a result of increased physical activity. Strength training stimulates the release of brain-derived neurotrophic factor (BDNF), a protein essential for

brain cell growth, learning, and memory<sup>15</sup>. As a result, individuals with Down syndrome who engage in regular resistance exercises often experience improvements in cognitive skills such as problem-solving, memory retention, and decision-making<sup>16</sup>. Strength based resistance exercises enhance the brain's ability to plan, organize, and focus, which are critical skills for daily activities. This improvement is largely attributed to increased levels of neurotransmitters like dopamine and norepinephrine, which play a major role in attention and concentration. By improving these neurochemical pathways, strength training helps individuals maintain better focus on tasks, thereby enhancing their learning abilities<sup>17</sup>. Exercise helps to control cortisol, the stress hormone, leading to a calmer mental state and improved mood<sup>18</sup>. strength based exercises improve motor coordination and body awareness, which are closely linked to cognitive function. Enhanced movement skills support better engagement in tasks that require fine motor control, such as writing or using tools<sup>19</sup>.

## CONCLUSION

It was concluded that cognition and attention span are improved by 6 week aerobic and strength-based exercise program. These findings have important implication for the development of effective interventions and treatment strategies to enhance the lives of adults with down syndrome.

## LIMITATIONS OF THE STUDY

Small sample size and intervention period of exercise was also short.

### FUTURE SCOPE OF THE STUDY

Future studies could explore whether attention span and cognition improve or diminish over time after receiving aerobic and strength-based exercise therapy. The attention span and cognition can also be measured with the help of computerized tests.

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No

Conflict of interest

There is no conflict of interest.

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