

Combined Effect of Aerobic and Strength-Based Exercise Program on Cognitive Function in Adults with Down Syndrome - A Narrative Review

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Abstract: ***Background:** Down syndrome is the most common congenital chromosomal disorder that is always present with mental retardation. Down's syndrome is characterized by abnormalities in learning, memory, and language that lead to mild-to profound impairment in intellectual functioning. Physical activity has an important role in the management of Down syndrome. Various studies have supported that Aerobic exercise improves both cognition and attention span in down syndrome. **Objective:** To find out the Combined effect of aerobic and strength-based exercise program on cognitive function in adults with Down Syndrome. **Study selection:** This narrative review is conducted on databases from Pub med, Google scholar, Research Gate and Cochrane library. This review included 6 studies on the Combined effect of aerobic and strength-based exercise program on cognitive function in adults with Down Syndrome. **Conclusion:** It is concluded that Combined effect of aerobic and strength-based exercise program effective in cognitive impairments in adults with Down syndrome.*

Keywords: Down syndrome, Aerobic and strength-based exercise, Cognitive function.

1. Introduction

Down syndrome is the most common congenital chromosomal disorder that is always present with mental retardation.¹ Down syndrome also known as trisomy 21, are due to presence of an extra copy of 21st chromosome. In this type of Down Syndrome (Trisomy 21) baby is born with 3 chromosomes, rather than the usual pair. These cases of down syndrome are not inherited and is caused by non-disjunction.² Down syndrome is caused by the over-expression of normal genetic material, usually an extra chromosome 21. Trisomy 21 occurs by meiotic non-disjunction, when the egg or sperm carries an extra copy of chromosome 21.³

Down syndrome is the most common genetic cause of intellectual disability occurring in approx. 1 in 800 births worldwide.³ 80 % of Down syndrome children are seen in mothers older than 35 years.⁴

The condition can be identified during pregnancy by screening or karyotyping, or shortly after delivery through muscle hypotonia (low muscle tone) or other symptoms, with blood work serving as confirmation.⁵ Recent biomedical and molecular studies have suggested that the Down syndrome chromosomal anomaly determines a number of changes in protein expression patterns that lead to specific biochemical, physiological, anatomical, and behavioural 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.⁵

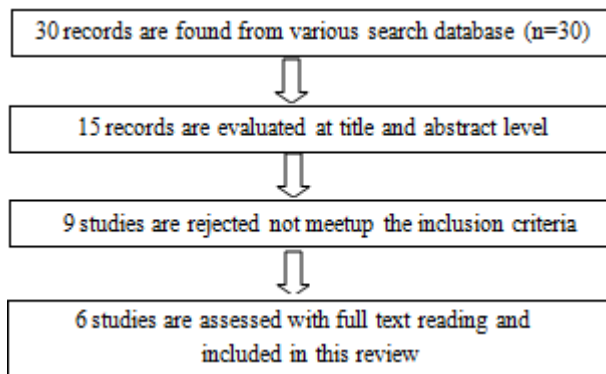
Down's syndrome is characterized by abnormalities in learning, memory, and language that lead to mild-to profound impairment in intellectual functioning.⁶ Individuals with down syndrome may have the following physical features- brachycephaly with flat occiput, flat facial profile, flat nasal bridge, protruding tongue, small mouth, low set ears, upward slant of palpebral fissures, squint, short and broad neck, abundant neck skin, short and broad hands, clinodactyly, simian crease, sandal gap, hypotonia, hyperflexibility.⁷ Individuals with down syndrome may have a higher risk of many conditions including arteriosclerosis, cardiovascular diseases, endocrine disorders, some cancers, Alzheimer's, dementia, osteopenia, ophthalmic disorders, dysmenorrhea.⁸

Physical activity provides opportunities to interact with the environment, facilitating motor, social and cognitive development.³ Previous studies showed that positive memory changes are associated with increase in local grey matter volume in the prefrontal and cingulate cortex, and brain derived neurotrophic factor level as a result of increased physical activity.⁹ Physical activity has an important role in the management of Down syndrome. Aerobic exercise improves both cognition and attention span in down syndrome by increasing the expression of neurotrophin, such as brain derived neurotrophic factor and elevated blood flow in the certain areas of brain.⁹

2. Methods

Studies are search from the following search engine PubMed, Google scholar, ResearchGate and Cochrane library to review the literature. Studies include that Cognitive function. Key words used to search studies are

Down syndrome, Aerobic and strength based exercise, Cognitive function.



Authors	Objectives	Designs	Characteristics of participants sample size	Methods	Outcomes	Results
Keita Kamijo et. all 2009 ¹⁰	Acute Effects of Aerobic Exercise on Cognitive Function in Older Adults	Experimental study	N =30 older adults aged 60–74 years and younger adults aged 19–25 years	Thirty healthy males were recruited and classified into two groups based on age. Data from six participants were discarded due to excessive noise in the electroencephalogram (EEG) signal. Thus, all analysis were conduct on the data from 24 participants. Acute exercise intervention- The work rate corresponding to 30% and vo _{2max} on the GXT was kept for 20min in each exercise session.	MMSE, Beck depression inventory, International physical activity questionnaire	These findings suggest that light and moderate exercise improve cognitive function across the adult lifespan, although the mechanism underlying the effects of observed acute aerobic exercise on cognitive function may be age dependent.
Hsiu-Ching Lin I, Yee-Pay Wuang 2012 ¹¹	Strength and agility training in adolescents with Down syndrome	randomized controlled trial	N= 92 The mean age for the exercise is 13-18yr old.	Ninety-two adolescents were recruited and evenly randomized to two intervention groups (exercise group vs. control group). The exercise training program consisted of a 5-min treadmill exercise and one 20-min virtual-reality based activity administered three times a week for 6 weeks.	Hand held Dynamometer, Bruininks-Oseretsky Test of Motor Proficiency	exercise training program used in this study is capable of improving muscle strength and agility performance of adolescents with DS.
C.C (JJ) Chen et al. 2016 ⁹	The association between a single bout of moderate physical activity and executive function in young adults with Down Syndrome	Preliminary study	N=18	Participants were assigned to high- intensity exercise (i.e. 75% -85% of predicted maximum heart rate) (N=6), moderate intensity exercise (I.e. 50-75% of predicted maximum heart rate) (N=6), or attentional control (N=6) group. Two exercise groups walked on tredmil using an incremental intensity walking protocol, and the attentional control group watched a vedio for 20minutes.	Anthropometric variables, Peabody Picture Vocabulary test, Heart rate, Choice reaction time test, Dimensional change card sorting test, Knock -tap test.	Results indicted that the performance in choice reaction time test was imaired in the high- intensity exercise, whereas improved performance was observed in the moderate - intensity exercise.
Bruna Barboza Seron et. all 2017 ¹²	Effects of aerobic and resistance training on the cardiorespiratory fitness of young	Experimental study	N =41 individuals of both sexes with Down syndrome aged 12-20 years	Forty-one individuals of both sexes with Down syndrome were divided into three groups: CG (control group) with 10 participants; ATG group (aerobic training	maximal exercise test	Training programs led to an improvement in cardiac efficiency during submaximal

	people with Down Syndrome			group) with 16 participants; and RTG (resistance training group) with 15 participants. The training program lasted 12 weeks, with frequency of 3 days a week for ATG and two RTG, and duration of 50 minutes per session. Aerobic training consisted of exercise on a treadmill// stationary bike, while resistance training was composed of nine exercises performed on three sets of 12 maximum repetitions for each exercise.		activities and increased maximum ventilation, which demonstrates a cardiorespiratory improvement
Lauren T. Ptomey et al, 2018 ¹³	Changes in cognitive function after a 12 -week exercise intervention in adults with down syndrome : an experimental study	Randomize,e xperimental study	N= 27 participants 18-35 years of age with a diagnosis of Down Syndrome	Participants were randomized to attend 30 minute group exercise session 1 or 2 times a week for 12 weeks. The exercise sessions were delivered via video conferencing on a tablet computer to groups of 5-8 participants. Sessions consisted of aerobic based exercise such as walking and jogging to music, dancing as well as strength based exercises such as vertical jumps, biceps curls, and squats.	Cognitive function was assesed using the Cantab Dementia Battery for ipad at baseline and 12 weeks.	Increased exercise may have positive change on memory and other cognitive functions.
Alexandra Perrot et. all 2021 ¹⁴	Effect of exergaming on physical fitness, functional mobility, and cognitive functioning in adults with Down Syndrome	Randomize experimental study	N=12 Twelve participants between the ages of 35-64.	Twelve participants between the ages of 35-64, were randomly allocated to either the experimental group(wii based exercise program n= 6) or the control group (no lifestyle changes n=6).For the exergaming training we used the Nintendo Wii , a vedio game console with integrated motion sensitive technology. The experimental group completed a 12 week Wii-based program.	Timed up and go test and Timed up and down stairs test, 30 Second chair stand test, 6-min walk test, Corsi block tapping test, Stimulus barrage test.	greater improvements were observed in the Wii-based exercise intervention group in physical fitness and functional outcomes , with no changes in cognitive outcomes.

3. Discussion

Stroop colour and word test and cognitive scale for down syndrome can be improved by aerobic and strength-based exercises. The combined effect of aerobic and strength-based exercise program on cognitive impairments are effective in adults with Down syndrome. The main objective of this review is to find out the Combined effect of aerobic and strength-based exercise program on cognitive function in adults with Down Syndrome. Previous research in older adults without down syndrome has found similar improvements in memory after a physical activity intervention. Ruscheweyh et al. found that memory scores improved in older adults over the prescribed 150 min per week of either low or moderate intensity physical activity.

All of these findings point to the possibility that exercise might help people with down syndrome avoid or treat memory loss. Previous research suggests that positive memory changes are associated with increases in local grey matter volume in the pre-frontal and cingulate cortex as well as brain derived neurotropic factors as a result of increased physical activity.¹⁵ However, further investigation is required to determine the exact mechanism by which physical activity may impact memory in individuals with down syndrome. A study by Lauren T. Ptomey et al. proven that increased exercise may have positive change on memory and other cognitive functions.¹³ Similarly, Pastula and colleagues observed significant improvement in decision speed and mental processing speed, which are similar to reaction time, and attention, respectively.¹⁶ Chen et al.

Found that adults with DS who completed moderate-intensity PA demonstrated improvements in reaction time, while those who did vigorous intensity had impaired scores.¹⁷ All things considered, our findings suggest that elevated PA could enhance focus and response speed, but more studies on dose and intensity are necessary. A study by Hsiu-Ching Lin et al. proved that exercise training program is capable of improving muscle strength and agility performance of adolescents with DS.¹¹

Through the above studies, it is found that aerobic and strength-based exercises improve cognition in adults with down syndrome.

4. Conclusion

The Combined effect of aerobic and strength-based exercise are effective method for improvement of cognitive function. All the above mention studies have multiple limitations such as inadequate sample size, short intervention period. Due to multiple limitations in studies conducted till date, no definitive protocol of aerobic and strength-based exercise on down syndrome adults could be framed. In order to establish a definitive protocol for down syndrome adults more studies should be conducted. Although there are studies which shows the effect of aerobic and strength-based exercise intervention on cognitive function in adults with Down Syndrome in abroad countries such as USA but there is no such study conducted on Indian population. So, this study will be conducted to know the effect of this intervention in Indian population.

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