Using Physical Activities for Improving Spatial Relations of Students with Down Syndrome

Lama Bendak

Correspondence:
Dr Lama Bendak
Faculty of Education, Lebanese University,
Beirut,
Lebanon
Email: lamabendak@gmail.com

Received: December 20, 2017; Accepted: July 2, 2018; Published: August 1, 2018
Citation: Lama Bendak. Using Physical Activities for Improving Spatial Relations of Students with Down Syndrome. World Family Medicine. 2018; 16(8): 38-45. DOI: 10.5742MEWFM.2018.93487

Abstract

The purpose of this study is to highlight the importance of physical activities for Down syndrome students which will reflect positively on their spatial relations. The quantitative approach was adopted where the total number of the Down syndrome students in the field of study was 10, from two private schools. The study is limited to grades 1, 2 and 3 students, whose ages range from 6.4 to 10.11 years. The students were divided into two groups where the control group was 5 Down syndrome students and the experimental group was also 5 Down syndrome students. The measuring instrument or tool that was used in this study was the Woodcock-Johnson III, Test of Achievement limited to the spatial relations section. A pretest was done on all 10 students during the first trimester of the school year. Then the physical activities intervention was applied for two trimesters. After that, the posttest was applied and the results were submitted to analysis, where the means and standard deviations, the independent samples T- test, and the paired samples T- test were calculated. The results of this study showed statistical differences to the benefit of the experimental group over the control group.

Key words: Down syndrome, spatial relations, physical activities, Woodcock-Johnson III, test of achievement-spatial relations

Introduction

The World Health Organization (WHO) defined physical activity as any bodily movement produced by skeletal muscles that requires energy expenditure. The term “physical activity” should not be mistaken with “exercise”. Exercise, is a subcategory of physical activity that is planned, structured, repetitive, and purposeful in the sense that the improvement or maintenance of one or more components of physical fitness is the objective. Physical activity includes exercise as well as other activities which involve bodily movement and are done as part of playing, working, active transportation, house chores and recreational activities.

The pedagogical areas of physical education and physical education for individuals with disabilities (adapted physical education) should be based on what we know about how people learn and control movements (Hoffman, 2013). On the other hand, motor behavior also differs specifically from sport psychology in that sport psychology typically studies elite athletes in competitive settings whereas motor behavior studies people of all skill levels (including elite athletes) (Hoffman, 2013).

According to the British Association of Occupational Therapists (BAOT) spatial awareness is the ability to be aware of oneself in space. It is an organized knowledge of objects in relation to oneself in that given space. Spatial awareness also involves understanding the relationship of these objects when there is a change of position. It can therefore be said that the awareness of spatial relationships is the ability to see and understand two or more objects in relation to each other and to oneself. This is a complex cognitive skill that children need to develop at an early age. Spatial awareness does come naturally to most children but some children have difficulties with this skill and there are things that can be done to help improve spatial awareness.

Any spatial situation can be approached either categorically; the window is to my left, or coordinately, the glass is 20 cm away from the bottle. Since the first description of the distinction between categorical and coordinate spatial relation processing, it has often been shown that they are processed by at least partially different underlying mechanisms, mainly located in the left and right hemisphere, respectively (Van Der Ham, I., Postma, A., Laeng, B. 2014).

Down syndrome (sometimes called Down's syndrome) is a condition in which a child is born with an extra copy of their 21st chromosome, hence its other name, trisomy 21. This causes physical and mental developmental delays and disabilities. In all cases of reproduction, both parents pass their genes on to their children. These genes are carried in chromosomes. When the baby's cells develop, each cell is supposed to receive 23 pairs of chromosomes, for 46 chromosomes total. Half of the chromosomes are from the mother, and half are from the father. In children with Down syndrome, one of the chromosomes doesn't separate properly. The baby ends up with three copies, or an extra partial copy, of chromosome 21, instead of two. This extra chromosome causes problems as the brain and physical features develop. According to the National Down Syndrome Society (NDSS), about 1 in 700 babies in the United States is born with Down syndrome. It's the most common genetic disorder in the United States.

The Diagnostic and Statistical Manual of Mental Disorders DSM-5, places intellectual disability under the Neurodevelopmental Disorders section; which was previously called Mental Retardation, Intellectual Disability and refers to a disorder that starts during the developmental period (American Psychiatric Association, 2013). It consists of certain intellectual deficits and challenges handling aspects of daily life like school, work, home, social life, and health, among other things. Intellectual disability (ID) is an explanatory phrase for sub standard intelligence that occurs below age eighteen, which is the developmental period. According to DSM-5, there are three criteria that must be fulfilled in order for the diagnosis of ID.

(A) Deficits in intellectual functions, such as reasoning, problem solving, planning, abstract thinking, judgment, academic learning, and learning from experience, confirmed by both clinical assessment and individualized, standardized intelligence testing.
(B) Deficits in adaptive functioning that result in failure to meet developmental and socio-cultural standards for personal independence and social responsibility. Without ongoing support, the adaptive deficits limit functioning in one or more activities of daily life, such as communication, social participation, and independent living, across multiple environments, such as home, school, work, and community.
(C) Onset of intellectual and adaptive deficits during the developmental period.(American Psychiatric Association, 2013).

The various levels of severity (mild, moderate, severe, profound) are defined on the basis of adaptive functioning, and not IQ scores, because it is adaptive functioning that determines the level of support required. This applies to students with Down syndrome.

If students are to achieve the highest level of success, they must receive instructions and activity that is purposeful, carefully planned and implemented in a motivational and student-centered manner. Planning begins with the development of program goals and sequential listing of activities both within and between grade levels (Carpenter, 2000). Moreover, we should give them a good model to imitate. James Arthur Baldwin said that children have never been very good at listening to their elders, but they have never failed to imitate them (Silver, 2012).

Imitation is not limited to the elders, but also includes peers and all people around the child, even to characters in movies and games. A major reason for including pupils with Special Educational Needs and Disabilities SEND in mainstream schools is social interaction with other children. When they learn and play among other children of the same age, pupils gain good models of appropriate play, language, and behavior (Briggs, 2016). Led by a teacher or a specialist, classes will help to some extent to develop some skills.

But pupils also need opportunities to try out what they have learned during the interventions and to generalize their new skills in different situations. They need the chance to play (Briggs, 2016). This will boost the development of the child also on the psychological level.

It is good to begin building a foundation of self-efficacy, autonomy, and growth mindsets in children while they are young (Silver, 2012). There are a range of therapies used in some special educational provisions which complement and/or extend activities in classrooms. These includes: Hydrotherapy, Physiotherapy, Rebound therapy, Light therapy, Sound therapy, and Music therapy (Martin-Denham, 2015), two of which were used in this research; sound and rebound therapy. Rebound therapy is the gentle bouncing with pupils on a trampoline. It provides a very powerful sensory experience, which many pupils love (Martin-Denham, 2015).

It appears that naturally occurring hormones and chemicals may be the best method for helping increase attention. During physical activities, endorphins are released in the brain. Endorphins are hormone-like compounds that regulate mood, pleasure, and pain. That same burst of activity also elevates the brain's dopamine, norepinephrine, and serotonin levels. These brain chemicals affect focus and attention (Johnson & Jones, 2016).

A school in Colorado starts off students' days with 20 minutes of aerobic exercise to increase alertness. If they act up in class, they aren't given time-out but time-in, 10 minutes of activity on a stationary bike or an elliptical trainer. The result is that kids realize they can regulate their mood and attention through exercise (Johnson & Jones, 2016).

Communication which over-emphasizes what the child cannot do may damage partnership between home and school. There is of course a need to record the child's next steps' but these should be small, measurable, achievable, realistic (SMART targets) (Glazzard, Stokoe, Hughes, Netherwood, Neve, 2015).

In addition to social and emotional information, your brain processes sensory movement information, going through the stages of input, processing, and output (Gaus, 2011). In grade school, they teach that we have five senses; sight, hearing, smell, taste, and touch. While we do indeed have all of those senses, the fifth one, touch, is really part of a trio of senses that are sometimes called the body senses. They include touch, balance, and motion and are called body senses because they involve information being communicated about and between the brain and the areas below the neck. These are distinguished from sight, hearing, smell, and taste because for them all communication occurs in the head and about the head region. This means that we really have seven senses. Each of these has an 'input device" (sense organ), which is a specialized part of the body with built-in sensors (receptor cells) to pick up a particular type of physical information (Gaus, 2011).

The sensors in those organs translate physical information into a nerve impulse that is sent via specialized pathways to the brain, where it can be processed. The way this happens for each of the seven senses is described below and is also summarized in the table called "Our Seven Senses" which appears below (Gaus, 2011).

Balance involves combining information about body orientation in relation to the ground, and it relies on the physical presence of gravity. Motion translates information about the physical position of the body and each separate part (e.g. arms, legs) that is translated by special cells in our joints and muscles. Movement is detected whenever the position changes. This is called kinesthetic information, and it is sent to the brain via a complex network of neural pathways channeled through the spinal cord (Gaus, 2011).

Literature Review

A case study on teaching perspective-taking skills to an adult with Down syndrome (Montoya-Rodriguez, McHugh, 2017) states that perspective-taking has for many years attracted considerable research attention in the mainstream cognitive developmental literature, under the rubric of Theory of Mind. Recently, the modern behavioral approach to human language and cognition known as Relational Frame Theory suggests that perspective-taking is a form of generalized operant responding involving deictic relations, such as I versus YOU, HERE versus THERE and NOW versus THEN, with different levels of relational complexity. People with intellectual disability often lack perspective-taking, and this deficit can detrimentally impact the quality of their social interactions. The current study is the first to train an adult with Down syndrome in deictic relational responding. The participant was exposed to multiple exemplars consisting of interactive tasks and feedback aimed at training reversed I-YOU, HERE-THERE and NOW-THEN deictic relations. The participant reached mastery on I-YOU, HERE-THERE and NOW-THEN reversed tasks. In line with previous research in the area of deictic relations, more training trials on NOW-THEN relations was required for the participant to meet criterion than I-YOU or HERE-THERE relations. Implications for the use of training deictic relations with individuals diagnosed with Down syndrome are discussed.

Another study on Visuo-spatial knowledge acquisition in individuals with Down syndrome entailed: The role of descriptions and sketch maps (Meneghetti, Lanfranchi, Carretti, Toffalini, 2017) states that few studies on individuals with Down syndrome (DS) have explored how they learn space. The present study examined space learning from verbal descriptions in individuals with DS, and explores the role of external cues (such as a sketch map). Twenty-eight individuals with DS and 28 matched typically-developing (TD) children listened to route or survey descriptions with or without seeing a corresponding sketch map (Description + Sketch Map [D + SM] and Description alone [D], respectively). After hearing each description, they performed tasks that involved recognizing, arranging sequentially, and locating landmarks. The results showed that individuals with DS performed less well in recognizing landmarks and arranging them sequentially. The D + SM condition produced general benefits in both groups' accuracy, though the improvement in locating landmarks was greater in the TD than in the DS group. In both groups, the D + SM condition prompted a better performance than the D condition when participants arranged landmarks sequentially after hearing a description from a route

Our Seven Senses

Sense/ Common Term	Technical Term	Organ or Sensor
Sight	Visual	Eye
Hearing	Auditory	Ear
Smell	Olfactory	Nose
Taste	Gustatory	Tongue plus nose
Touch	Tactile	Skin
Balance	Vestibular	Inner ear
Motion	Kinesthetic	Joints and muscles

perspective, but not from a survey perspective. Overall, our results show that individuals with DS benefited when a spatial description was associated with a corresponding sketch map, albeit to a lesser degree than TD children. The findings are discussed in the light of the literature on DS and on spatial cognition in the TD domain.

Another study on Visuo-spatial ability in individuals with Down syndrome entailed: Is it really a strength? (Yang, Merrill, 2014). Based on that Down syndrome (DS) is associated with extreme difficulty in verbal skills and relatively better visuo-spatial skills. Indeed, visuo-spatial ability is often considered a strength in DS. However, it is not clear whether the visuo-spatial skills strength is only relative to the poor verbal skills, or, more impressively, relative to cognitive ability in general. To answer this question, an extensive literature review of studies on visuo-spatial abilities in people with Down syndrome from January 1987 to May 2013 was conducted. Based on a general taxonomy of spatial abilities patterned after Lohman, Pellegrino, Alderton, and Regian (1987) and Carroll (1993) and existing studies of DS, five different domains of spatial abilities – visuo-spatial memory, visuo-spatial construction, mental rotation, closure, and wayfinding were included. A total of 49 studies including 127 different comparisons were evaluated. Most comparisons involved a group with DS vs. a group with typical development matched on mental age and compared on a task measuring one of the five visuo-spatial abilities. Although further research is needed for firm conclusions on some visuo-spatial abilities, there was no evidence that visuo-spatial ability is a strength in DS relative to general cognitive ability. Rather, the review suggests an uneven profile of visuo-spatial abilities in DS in which some abilities are commensurate with general cognitive ability level, and others are below.

Moreover, a study on Spatial-simultaneous and spatial-sequential working memory in individuals with Down syndrome entailed: The effect of configuration. Research in Developmental Disabilities (Carretti, B., Lanfranchi, S. Mammarella, I. 2013). Earlier research showed that visuo-spatial working memory (VSWM) is better preserved in Down syndrome (DS) than verbal WM. Some differences emerged, however, when VSWM performance was broken down into its various components, and more recent studies revealed that the spatial-simultaneous component of VSWM is more impaired than the spatial-sequential component. The difficulty of managing more than one item at a time is also evident when the information to be recalled is structured. To further analyze this issue, the advantage of material being structured in spatial-simultaneous and spatial-sequential tasks was investigated by comparing the performance of a group of individuals with DS and a group of typically-developing children matched for mental age. Both groups were presented with VSWM tasks in which both the presentation format (simultaneous vs. sequential) and the type of configuration (pattern vs. random) were manipulated. Findings indicated that individuals with DS took less advantage of the pattern configuration in the spatial-simultaneous task than TD children; in contrast, the two groups' performance did not differ in the pattern configuration of the spatial-sequential task. Taken together, these results confirmed difficulties relating to the spatial-simultaneous component of VSWM in individuals with DS, supporting the importance of distinguishing between different components within this system.

A study entitled Profiles of visual perceptual functions in Down syndrome (Ting Wan, Y., Sui Chiang, C., Chia-Ju Chen, S., Chung Wang, C., Pay Wuang, Y. 2015) aimed to investigate the visual perceptual functions measured by the Test of Visual Perceptual Skill-Third Edition (TVPS-3) in Down syndrome (DS). Seventy individuals with DS, seventy with typical development (TD), and forty mental-age-matched participants with intellectual disabilities (ID) were recruited for the assessment session. Significant between-group differences in TVPS-3 were observed between either DS or ID and TD groups. There was no significant difference on TVPS-3 between DS and ID groups. Implications for clinical professionals and recommendations for further research are discussed.

Another study tackled Grouping, semantic relation and imagery effects in individuals with Down syndrome (Smith, E., Jarrold, C. 2014). Down syndrome (DS) is associated with a specific verbal short-term memory (STM) deficit. This study explored the effects of grouping, semantic relations and visual presentation upon verbal STM recall performance in a group of 15 individuals with DS and 15 vocabulary-matched typically developing (TD) children. Participants were presented with memoranda in either a temporally grouped schedule, such that items were grouped as pairs, or in an equally spaced presentation schedule. The two items constituting each pair were either semantically related or unrelated. Performance across these conditions was compared in verbal or verbal plus visual presentation modes. Significant memory recall benefits were observed across populations as a result of temporal grouping, semantic relations and verbal and visual combined presentation. However, a reduced benefit of semantic relation in the DS group compared to the TD group indicated that those with DS were less influenced by LTM relational knowledge. In addition, those with DS only experienced a grouping benefit during verbal and visual combined presentation, in contrast to the TD group who experienced grouping benefits throughout. This indicates that individuals with DS are poorer at encoding temporal context for purely verbal memoranda. These findings were replicated in a follow-up experiment, aimed at aligning baseline performance in the two populations. This study provides encouraging evidence that, despite their difficulties in some areas, individuals with DS can benefit from the use of grouping and LTM knowledge to assist their verbal STM performance under certain circumstances.

A different study entitled Do Equine-assisted Physical Activities Help to Develop Gross Motor Skills in Children with the Down Syndrome? Short-term Results (Voznesenskyy, S., Rivera-Quinatoa, J., Bonilla-Yacelga, K., Cedeño-Zamora, M. 2016) was reviewed. K., Cedeño-Zamora, M. 2016) was reviewed. Equine-assisted physical activities are believed to improve the physical, psychological, and social wellbeing of special needs populations Methods. A study was conducted to assess the effect of an equine-assisted physical activity and an adaptive horseback riding program in comparison with conventional adapted physical education designed to develop gross motor skills measured by the Gross Motor Function Measure (GMFM-88) in children with Down syndrome in a special education institution. According to the fitted ordinary least squares and robust regression models, the equine-assisted activities program had, on average, a large positive effect on children's gross motor development in comparison to the conventional physical education in the control group for 3 months. Evidence is provided with regard to the short-term improvement of the gross motor function in children with Down syndrome participating in equine-assisted activities, in comparison to regular adapted physical education, in a special education institution. Further research is needed to assess medium and long term effects of equine-assisted activities on gross motor development in children with Down syndrome.

Another research entitled Associations of physical activity with fatness and fitness in adolescents with Down syndrome: The UP&DOWN study (Gomez, R., Gómez, D., Villagra, A., Fernhall, B., Veiga, O. 2015) was reviewed. It aimed to examine the associations of objectively measured physical activity (PA) with several markers of fatness and fitness in a relatively large sample of adolescents with Down syndrome (DS). This study comprised a total of 100 adolescents with DS (37 females) aged 11–20 years-old, and a sex-matched sample of 100 adolescents without disabilities, participating in the UP&DOWN study. The ALPHA health-related fitness test battery for adolescents was used to assess fatness and fitness. PA was measured by accelerometer. Adolescents with DS had higher fatness and significantly lower fitness levels in all variables measured than adolescents without DS (all $p < 0.05$). Moderate-to-large effects were observed in fatness variables ($d = 0.65–1.42$), but particularly large values were found in fitness variables ($d = 2.05–2.43$). In addition, PA levels were not associated with fatness variables, whereas total PA and vigorous PA were associated with all fitness variables ($p < 0.05$), and moderate-vigorous PA (MVPA) was associated with muscular fitness ($p < 0.05$), after adjusting for potential confounders. Further analysis revealed that there were differences in fitness by tertiles of vigorous PA between the lowest and the highest groups in all fitness variables (all $p < 0.05$). However, no significant differences were found in fitness by tertiles of MVPA according with PA guidelines (≥60 min in MVPA). Our findings indicate that PA levels are not associated with fatness variables, whereas high PA levels, in particular vigorous PA, are positively associated with high fitness in adolescents with DS.

Statement of Research Question

Based on the importance of physical activities in developing many skills for all students and especially those with special need, it was important to highlight its efficiency with down syndrome students who are integrated in regular schools and are considered high functioning; that is considered before as mild to average cases of intellectually disabled. This arouses the following research question:

Do the physical activities improve the spatial relations of Down syndrome students?

Design and Method

A quantitative method was used in this research. A total of ten Down syndrome students were recruited to participate in this study from two private schools in Lebanon. All ten participants were grade 1, 2 or 3 students with their ages ranging between 6.4 and 10.11 years. The ten participants were divided into two groups, a control group of five participants and an experimental group of another five participants. The pretest, the spatial relations section of Woodcock-Johnson III Test of Achievement, was applied during the first trimester of the 2017-18 school year. Then the physical activities intervention was implemented on the experimental group for two trimesters at a rate of two 20 minute sessions per week. The level of physical activities was set for each student based on his/her average result at the pretest.

The physical activities were planned to cover all seven senses that were previously stated, with a highlight on motion, balance, rebound, and sound games. Bryce-Clegg (2013) has suggested 50 possible outdoor activities. Some of these activities were adopted for the intervention group based on the personal needs of every Down syndrome student in the experimental group. Moreover, activities included card games that were limited to some Down syndrome students who got results on the spatial relations test equivalent and above six years old performance. Decker& Mize (2002) included card games in their book as walking games and activities that suit six to eight years old students. Moreover, blocks were used in the intervention, which is based on structured block play. In observational studies, children who spend more free time playing with puzzles and building blocks score higher on tests of spatial ability (Levine et al., 2012).

Then a similar posttest was applied and the results were analyzed. Descriptive statistics and independent samples t- test were used to explore and assess the results. A significance level (α value) of 0.05 was considered in the current study.

Results

Descriptive statistics of age of participants and their test scores in the control group are presented in Table 1 while those of the experimental group are presented in Table 2. Participants' test scores are illustrated in Figure 1 for the control group and Figure 2 for the experimental group.

Table 1: Spatial relations tests' results of the control group

Initials	Initial Chron. Age (Gr. Level)	Initial Test Score	Initial Age (Gr.) Equiv.	End Chron. Age (Gr. Level)	Final Test Score	Final Age (Gr.) Equival.	Difference in Score
F.R.	6.8 (1.2)	39	5.2 (<K.0)	7.2 (1.8)	42	5.4 (<K.0)	+3
M.K.	7.6 (1.2)	45	5.8 (K.3)	8.0 (1.8)	47	5.11(K.6)	+2
L.T.	7.9 (2.2)	47	5.11 (K.6)	8.5 (2.8)	50	6.4 (1.1)	+3
A.M.	9.8 (3.2)	54	7.0 (1.8)	10.2 (3.8)	57	7.7 (2.5)	+3
C.S.	10.5 (3.2)	58	7.10 (2.8)	10.11 (3.8)	59	8.1 (3.1)	+1

Table 2: Spatial relations tests' results of the experimental group

Initials	Initial Chron. Age (Gr. Level)	Initial Test Score	Initial Age (Gr.) Equiv.	End Chron. Age (Gr. Level)	Final Test Score	Final Age (Gr.) Equival.	Difference in Score
D.A.	6.9 (1.2)	43	5.5 (K.0)	7.3 (1.8)	47	5.11 (K.6)	+4
Z.H.	7.0 (1.2)	44	5.7 (K.2)	7.6 (1.8)	48	6.0 (K.7)	+4
E.G.	7.7 (2.2)	48	6.0 (K.7)	8.1 (2.8)	53	6.9 (1.6)	+5
T.S.	8.5 (2.2)	48	6.0 (K.7)	8.11 (2.8)	54	7.0 (1.8)	+6
J.B.	10.1 (3.2)	52	6.7 (1.4)	10.7 (3.8)	58	7.10 (2.8)	+6

The spatial relations results of both control and experimental groups on the pretest and posttest are displayed in the following figures.

Figure 1: Spatial relations test scores of control group

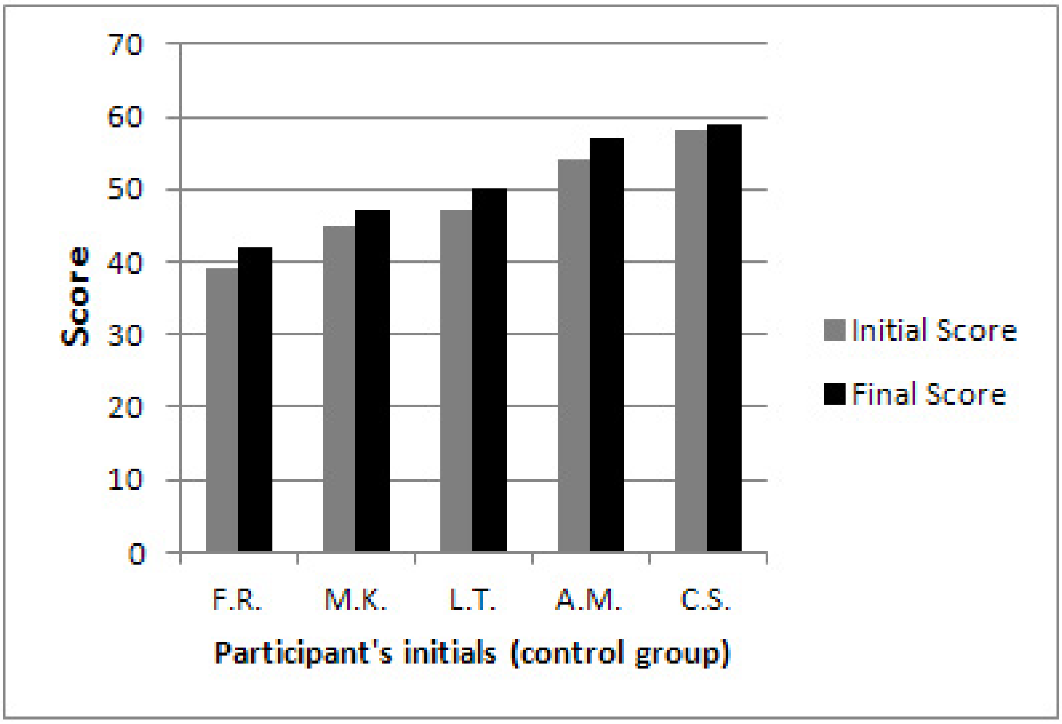
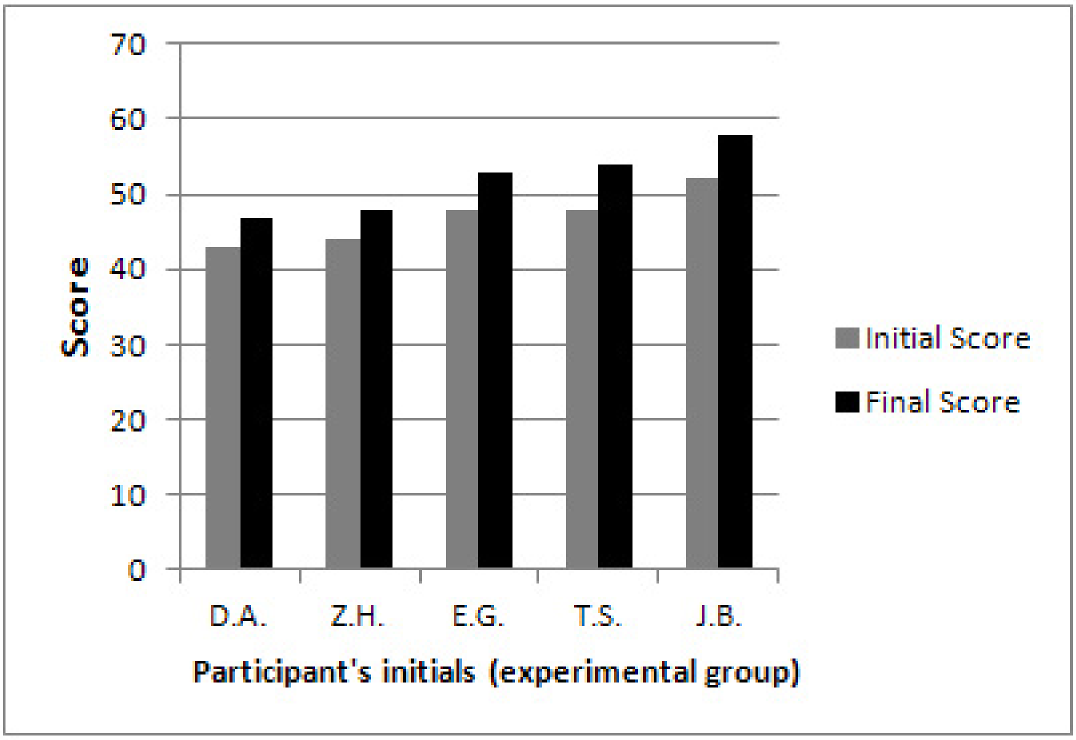


Figure 2: Spatial relations test scores of control group



Then improvement in test scores of all participants within the control group were compared to those of the experimental group using an unpaired single-sided t-test. The test showed that the experimental group showed significantly better performance in spatial relations test score than the control group (p=0.007).

To calculate the effect size of the t-test, Cohen's d value was used. This value is calculated using the formula: Cohen's d = $(M_2 - M_1) / SD_{pooled}$ where M2 is the mean improvement value of experimental group and M1 is the mean improvement value of control group. SD_{pooled} was calculated using the formula $SD_{pooled} = \sqrt{((SD_1^2 + SD_2^2) / 2)}$. SD_{pooled} in this case is found to be equal to 0.81 and Cohen's d value to be equal to 1.98. This reflects that physical activities lead to significant improvement in spatial relations test score of children with Down syndrome.

Limitations

The intervention of physical activities for Down syndrome students was limited to school hours, so it would have given a better perspective if they were able to practice at home with their parents or guardians. Moreover, it can be applied during regular classes and physical education hours.

Conclusion

The physical activities intervention did help the Down syndrome students in developing their spatial relations skills. Based on the Woodcock-Johnson III, Test of Achievement limited to the spatial relations section, the experimental group showed significant improvement. This leads us to recommend including physical activities in the individual educational plans of all Down syndrome students within the courses and have more structured physical education hours in order to boost the spatial relations. This approach lies under the evidence based learning that leads to "good learning".

References

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders: DSM-5 (5th ed.). Washington, DC: Author.

Bird, K., Savage, K. (2014). The ANIE: a math assessment tool that reveals learning and informs teaching. Markham, Ont: Pembroke Publishers Ltd.

Briggs, S. (2016). Meeting special educational needs in primary classrooms: inclusion and how to do it. (2nded.). London: Routledge.

Brown, D., et al. (2013). Engaging students with intellectual disabilities through games based learning and related technologies. Universal Access in Human-Computer Interaction. Applications and Services for quality of life. UAHCI. 8011: 573-582. Springer, Berlin, Heidelberg. doi:10.1007/978-3-642-39194-1_66

Bryce-Clegg, A. (2013). 50 fantastic ideas for physical activity outdoors. London: Featherstone Education.

Carretti, B., Lanfranchi, S. Mammarella, I. (2013). Spatial-simultaneous and spatial-sequential working memory in individuals with Down syndrome: The effect of configuration. Research in Developmental Disabilities. 34(1): 669-675. https://doi.org/10.1016/j.ridd.2012.09.011

Carpenter, J. (2000). P.E. teacher's complete fitness and skills development activities program. West Nyack, N. Y.: Parker Publishing Company.

Decker, J. I., Mize, M. (2002). Walking games and activities. Champaign, Ill

Gaus, V. (2011). Living well on the spectrum: how to use your strengths to meet the challenges of Asperger

syndrome/high-functioning autism. New York: The Guilford Press.
Glazzard, J., Stokoe, J., Hughes, A., Netherwood, A., Neve, L. (2015). Teaching & supporting children with special educational needs & disabilities in primary schools. (2nded.). Los Angeles: Sage Publications Inc.
Gomez, R., Gómez, D., Villagra, A., Fernhall, B., Veiga, O. (2015). Associations of physical activity with fatness and fitness in adolescents with Down syndrome: The UP&DOWN study. Research in Developmental Disabilities. 36: 428-436
https://doi.org/10.1016/j.ridd.2014.10.022
Hoffman, S., (2013). Introduction to kinesiology: studying physical activity. (4thed.). Champaign, IL: Human Kinetics.
Johnson, B., Jones, M., (2016). Learning on your feet: incorporating physical activity into the K-8 classroom. New York: Routledge.
Levine, S. C., Ratliff, K. R., Huttenlocher, J., & Cannon, J. (2012). Early puzzle play: A predictor of preschoolers' spatial transformation skill. Developmental Psychology, 48(2), 530-542.
http://dx.doi.org/10.1037/a0025913
Martin-Denham, S. (2015). Teaching children & young people with special educational needs & disabilities. Los Angeles: Sage Publications Inc.
Meneghetti, C., Lanfranchi, S., Carretti, B., Toffalini, E. (2017). Visuo-spatial knowledge acquisition in individuals with Down syndrome: The role of descriptions and sketch maps. Research in Developmental Disabilities.63:46-58
https://doi.org/10.1016/j.ridd.2017.02.013
Montoya-Rodriguez, M., McHugh, L. (2017). Teaching perspective-taking skills to an adult with Down syndrome: A case study. Journal of Contextual Behavioral Science. 6(3): 293-297
https://doi.org/10.1016/j.jcbs.2017.04.012
Silver, D. (2012). Fall down 7 times, get up 8: teaching kids to succeed. Thousand Oaks, Calif.: Corwin Press.
Smith, E., Jarrold, C. (2014). Grouping, semantic relation and imagery effects in individuals with Down syndrome. Research in Developmental Disabilities. 35(11): 3162-3174.
https://doi.org/10.1016/j.ridd.2014.07.061
Tilly, K. (2010). Active imagination activity book: 50 sensorimotor activities for children to improve focus, attention, strength, & coordination. Arlington. Tex.
Ting Wan, Y., Sui Chiang, C., Chia-Ju Chen, S., Chung Wang, C., Pay Wuang, Y. (2015). Profiles of visual perceptual functions in Down syndrome. Research in Developmental Disabilities. 37:112-118
https://doi.org/10.1016/j.ridd.2014.11.008

Van Der Ham, I., Postma, A., Laeng, B. (2014). Lateralized perception: The role of attention in spatial relation processing. Neuroscience & Biobehavioral Reviews. (45) 142-148.
https://doi.org/10.1016/j.neubiorev.2014.05.006
Voznesenskyy, S., Rivera-Quinatoa, J., Bonilla-Yacelga, K., Cedeño-Zamora, M. (2016). Do Equine-assisted Physical Activities Help to Develop Gross Motor Skills in Children with the Down Syndrome? Short-term Results. Procedia - Social and Behavioral Sciences. 233: 307-312
https://doi.org/10.1016/j.sbspro.2016.10.140Get rights and content
http://www.who.int/dietphysicalactivity/pa/en/
ccupationaltherapyforchildren.over-blog.com/article-spatial-awareness-108726104.html