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Effect of sport stacking on fine motor proficiency of children with Down syndrome

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Abstract

Down syndrome, as the most common reason of mental retardations caused by genetic disorders, causes growth and development disorders and affects fine and gross motor skills. The present paper aims to study the effect of sport stacking on fine motor skills of students with Down syndrome. 15 students (6 girls and 9 boys) with Down syndrome (9±1.87; age, 50-70; IQ) were investigated as the available sample. All subjects underwent 8 weeks of training in sport stacking. Before and during the training period, fine motor skills of subjects were evaluated in three subtests of Bruininks-Oseretsky test. The results of analysis of variance with repeated measurements showed that sport stacking trainings improve fine motor skill in children afflicted by Down syndrome ($p \leq 0.05$). It was concluded that motor problems of such children could be improved using this sport activity.

Keywords: Down syndrome; Sport stacking; Fine motor proficiency

Introduction

Down syndrome is considered as the most common reason of mental retardations caused by genetic disorders, Alan et al., (2006); Barnhart and Connolly (2007); Shields et al., (2010) and it has been reported to occur one in 625 births to one in 1200 births, Alan, et al., (2006); Gupta and Krishna, (2011) Down syndrome is a disorder linked to chromosome 21 and mental retardation is one of its symptoms (Milanifar, 2010). Down syndrome is a subject that has attracted the attention of researchers of various sciences more than other chromosomal abnormalities and several behavioral and training studies have been done on this disorder. Some of the features common in children with Down syndrome can affect the development of motor abilities. These features include ligamentous and joint laxity, short limbs, single crease of palmar, smaller hands compared with normal children, absence of some carpal bones at birth, curvature of the fifth finger, heart problems, infections, visual problems, and delayed cognitive development (Milanifar, 2010). Educational progresses associated with these persons helped some of them to successfully pass university courses (Deborah et al., 2007) and even scientific advances in relation to this disorder have managed to significantly increase life expectancy during the past 30 years (Torr et al., 2010). These new conditions and more lifespan in these persons have caused new issues related to aging such as structures change, physical performances, and limitations of motion in those afflicted by Down syndrome to be taken into account more than ever (Barnhart and Connolly, 2007). Since there is a close relationship between physical activities and lifespan in these individuals, researchers are emphasizing on developing motor programs for them (Vis, et al., 2009).

The first point that should be considered about motor skills of individuals with Down syndrome is that this syndrome affects both fine and gross motor skills (Alan, et al., 2006; Barnhart and Connolly, 2007; Smith, 1999; Deborah et al., 2007; Gallahue, 2003; Gupta and Krishna, 2011). This disease causes delays in motor development and physical activity pattern (Ulrich et al., 2008). Motor development in individuals with Down syndrome is associated with disability, but the sequence of emergence of skills is similar to ordinary people.

These people have less strength and endurance and have difficulty performing complex motor skills. Some of other problems of these persons include eye-hand coordination, balance, walking speed, gross and fine motor abilities, and reaction speed (Lauteslager, 200). The results of a study on motor development in individuals with Down syndrome have shown that this syndrome affects both fine and gross motor skills (Deborah et al., 2007; Gupta and Krishna, 2011; Uder Mann, 2004) Children with Down syndrome acquire motor skills at an older age than their normal peers and as they age, they become more disabled in terms of motor development compared with children with normal growth. Additionally, altered motor development in children with Down syndrome has shown that such children, compared with their ordinary peers, have a two-year delay in performing most motion exercises. This delay continues until mid-childhood especially in lateral superiority and eye-hand coordination (O'Brien and Hayey, 1995).

Failure to perform fine motor skills in children with Down syndrome is due to weakness in eye-hand coordination and coordination of both hands which lead to learning and motion disorder or delay and finally result in frustration in game skills and daily activities (Oelwein, 1995). Studies have also shown that children with Down syndrome, compared with their ordinary peers, suffer an abnormal pattern of movement of the fingers (Latash and Patterson, 2002). In general, children with Down syndrome need trainings in various cognitive and physical aspects, so activities that performing them requires orientation (left to right, up to down, etc.), exercises in which all abilities of hands are applied, and tasks which reach from whole to components and vice versa seem to be more appropriate (Latash and Patterson, 2002).

Many studies have also been conducted in the area of fine motor skills. Smith (1999) showed a significant relationship between stimulations of superficial and deep senses and motor accuracy, dummy drawing test and fine motor skills, and dexterity and yield components (Smith, 1995). Reed (2001) also showed that failure to perform fine movements of hands can affect eye-hand coordination, game skills, and daily activities, leading to motor and training delays. Uyanik (2003) argued that combination of various methods of treatment is more effective in improving the functional abilities of children with Down syndrome. Sazmand and et al., (2012) found that fine motor activities can enhance visual-perceptual skills of individuals with Down syndrome. This could mean the need for planning for fine motor interventions for children with Down syndrome and training their parents in this area (Sazmand et al., 2012). Spano and et al., (1999) in a study on children with Down syndrome (4 to 14 years old), observed that all aspects of fine motor skills of these children had been severely damaged and were not developed in proportion to age.

Individuals suffering from Down syndrome, compared with others and even those mentally retarded, have a greater weakness in motor-cognitive processes. Virji et al., (2006) showed that when people with Down syndrome are going to perform skills such as taking, they need temporal and spatial predictions for a successful taking. However, this group of people have difficulties in temporal and spatial judgments for accurate implementation of such actions. They state that intervention programs are necessary to improve perceptual-motor processes in people with Down syndrome for better performance of physical skills and richer social interactions (Virji, et al., 2006). These programs also improve gross motor skills, self-growth, and earlier onset of motor activities in these individuals (Platzer, 1976). Hence, evaluation of motor skills of individuals with developmental disorders and developing programs to improve these abilities are of great value and can be effective in getting back these individuals to the society and enhancing their physical and mental health.

Sport stacking (also known as cup stacking or speed stacking) in which arrangement and collection of numbers of cups based on a specific guideline is intended. The history of this game goes back to the early 1980s and formally started its activities in 1995. The first national tournament of this game was held in 1998 in Texas. Now, this sport is widespread around the world under the leading of World Sport Stacking Association (WSSA). This sport was firstly played in Iran in February, 2009. Due to the simultaneous use of both hands, sport stacking provides the best context for increased focus, nerve-muscle and eye-hand coordination, and simultaneous use of both hemispheres of the brain and body. This sport also improves eye-hand cooperation and increases reaction time by 30% (Uder Mann, 2004). There is no limitation in terms of age or physical condition in this sport. It should be noted that speed is the main point in this game. Since it has been known that individuals with Down syndrome have difficulties in fine motor skills and eye-hand coordination, the authors aimed to study the effect of modified sport stacking on fine motor proficiency in students afflicted by Down syndrome.

Material and Methods

Due to deliver of practical results and in terms of method, the present study was an applied and semi-empirical research. Statistical population included all girl and boy between 7 to 12 years old (9.1 ± 1.87) suffering from Down syndrome in the cities of Ghaemshahr and Sari. Among the statistical population, 15 persons (9 boys and 6 girls) were selected as the available sample. The IQ of subjects was between 50 and 70, measured by Wechsler Intelligence Test. Some information such as date of birth, height, weight, and history of orthopedic, neurologic, and hear diseases, etc. were collected using a questionnaire. To ensure lateral superiority of subjects, Briggs-Nebes Handedness Inventory was used (10; right-handed, 5; left-handed).

Investigation plan:

To measure fine motor skills, short form of Bruininks-Oseretsky test was used which can assess motor function of subjects who are 4.5-14.5 years old. This test consists of 8 subscale and 14 articles, part of the total 48 articles is related to the full form of Bruininks-Oseretsky test which measures running speed and dexterity (one article), static and dynamic balance (two articles), bilateral coordination (two articles), leg muscle strength (one article), coordination of upper limb (two articles), reaction speed (one article), visual-motor control (three articles), and dexterity and upper limb speed (two articles). Reliability and retest coefficient of this test in full form and short form is reported to be 0.78 and 0.86, respectively (Gallahue and Ozomun, 2005). According to subject of this study, three subtests (6-8) of 8 subtests of Bruininks-Oseretsky test were used to achieve an index of fine motor abilities. In subtest 6, reaction speed was measured the reaction ruler. Subtest 7, which measures visual-motion control, includes 8 tests, two of which (cutting a circle with the superior hand and drawing lines in interrupted courses) were used in the present study. Subtest 8, which measures dexterity and upper limb speed, consists of 8 tests, two of which (cards sorting with the superior hand and arranging the beads around a string) were used.

Several studies throughout the world have investigated the effect of exercise in people with Down syndrome. An overview of these studies indicates that a period of 8 to 12 weeks suffices for making significant effects in various variables of physical characteristics and psychomotor skills in individuals afflicted by Down syndrome (Gallahue and Ozomun, 2005; Gupta and Krishna, 2011, Latash, Patterson, 2002). Accordingly, the present study was done during 8 weeks in which subjects performed individual and group exercise of sport stacking two sessions per week for 30 minutes. At first, edutainment like videos was used for patterning. Since speed is point of emphasis in sport stacking and time is recorded by a stopwatch, technique and proper execution of movements were more emphasized in the present study in order to avoid the negative motivational and emotional consequences. There are several rules in this sport for picking the cups, 3-3 picking method was used in the present study to control the complexity of the exercise. Additionally, in order to eschew the effects of individual differences on the results, intergroup plans were used and the subjects were measured many times (pretest; every 2 weeks) during the trial. Firstly, descriptive statistics were used to classify the raw data and draw tables and figures. Shapiro-Wilk test (to check the normality of data), Levene's test (to assess the homogeneity of variances), ANOVA with repeated measures, and Bonferroni degrees of freedom corrections were used to analyze the collected data. Statistical analyses were performed using SPSS 18 software and significance level was considered $p \leq 0.05$.

Results

The results of ANOVA with repeated measures, regarding the Mauchly sphericity assumption (p=0.87), showed that sport stacking exercise has a significant impact on reaction speed of children with Down syndrome (F=75.52; p=0.000; η^2_p=0.84). Additionally, improvement followed a linear trend but no difference was observed between genders in this regard (p=0.62).

Table 1: within-subject effects on reaction speed

Test	F	df	P	η^2_p
Reaction speed	75.52	4	*0.000	0.84

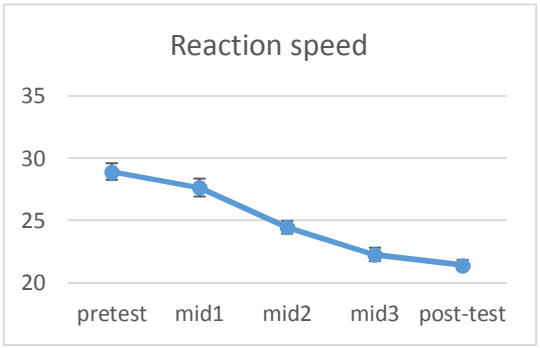


Table 2: comparison of paired means measured at different stages in terms of reaction speed.

Pairs		Md	SD	P
Pre-test	2	1.26	0.5	0.24
	3	4.46	0.61	0.001
	4	6.66	0.45	0.001
	Post-test	7.53	0.49	0.001

As Table 3 shows, the effects of sport stacking on vision control was significant in circle cutting task (F=57.84; p=0.000; η^2_p=0.80) and vision control was significant in drawing lines in interrupted courses (F=35.35; p=0.000; η^2_p=0.71), improving vision control in these individuals. Furthermore, no significant difference was observed between two sexes in these two tasks.

Table 3: within-subject effects of on vision control

Test	F	df	P	η^2_p	Test	F	df	P	η^2_p
Circle cutting	57.84	4	0.0001	0.80	Drawing lines	35.35	4	0.000	0.71

Table 4 and Table 5 show comparison of paired means measured at different stages of tests in circle cutting and drawing lines tasks with the superior hand.

Table 4: Comparison of means in circle cutting task

	Pairs	Md	SD	p
Pre-test	2	-0.2	0.1	0.82
	3	-0.53	0.13	0.01
	4	-1.2	0.14	0.001
	Post-test	-1.93	0.15	0.001

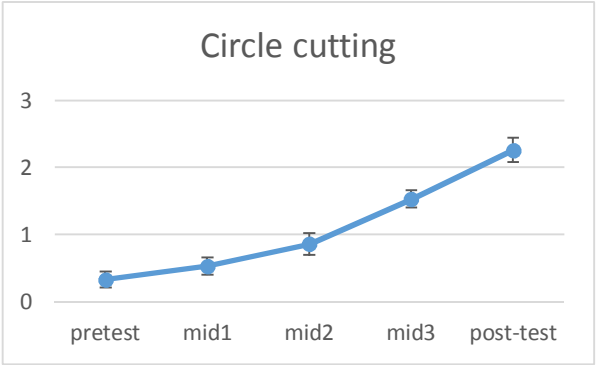
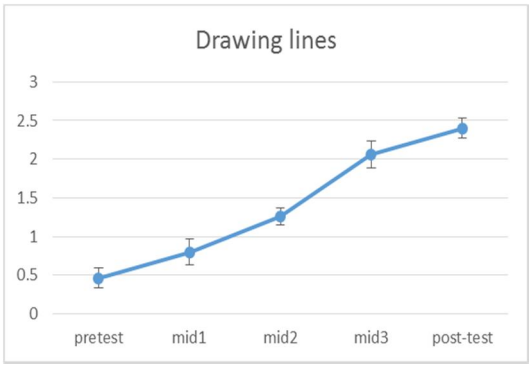


Table 5: Comparison of means in drawing lines

Pairs		Md	SD	p
Pre-test	2	-0.33	0.15	0.55
	3	-0.80	0.17	0.29
	4	-1.60	0.19	0.001
	Post-test	-1.93	0.20	0.001



The results of ANOVA showed that the effect of sport stacking exercise on upper limb speed and dexterity in fine task of cards sorting with superior hand (F=7.89; p=0.000; η^2_p=0.36) and arranging the beads around a string (F=23.01; p=0.000; η^2_p=0.62) was significant, indicating improved ability after the exercise (Table 6). No significant difference was observed between two sexes in these two tasks.

Table 6: within-subject effects on upper limb speed and dexterity

Test	F	df	P	η^2_p	Test	F	df	P	η^2_p
Cards sorting	7.89	2.85	0.000	0.36	Arranging the beads around a string	23.01	4	0.000	0.62

Table 7: Comparison of means in cards sorting task

Pairs		Md	SD	p
Pre-test	2	-0.20	0.10	0.82
	3	-0.33	0.12	0.19
	4	-0.80	0.20	0.01
	Post-test	-0.93	0.18	0.002

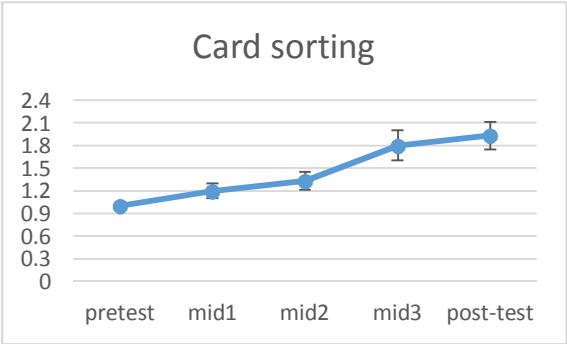
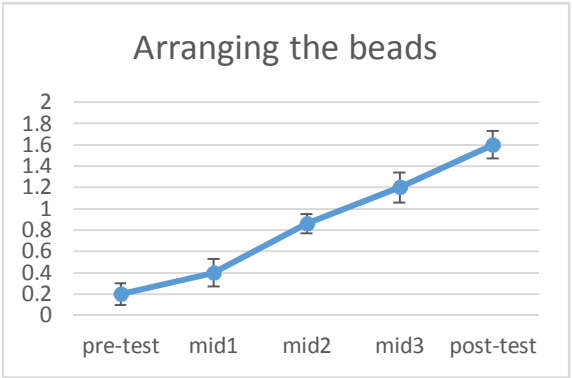


Table 8: Comparison of means in arranging the beads

Pairs		Md	SD	p
Pre-test	2	-0.020	.0.17	1.00
	3	-0.66	0.12	0.001
	4	-1.00	0.19	0.002
	Post-test	-1.40	0.14	0.001



Discussion and Conclusion

Fundamental motor skills underlie all motion experiences of a person throughout life. In the past it was thought that basic skills develop only with maturation, but nowadays studies show that early interventions and early childhood education are as important as maturation in developing these skills. Down syndrome is one of the most common genetic diseases that affects motor functions of afflicted individuals throughout their life. Children and teenagers with Down syndrome form a unique population of in physical fitness factors associated with health. Body composition in children with Down syndrome is in a worse situation compared with their healthy peers. Higher body mass index and body fat percentage, lower lean mass, and lower bone density are some of body traits of such individuals. They also have lower levels of muscular strength and cardiovascular capacity compared with healthy persons. These factors lead to reduced quality of life in these patients. Findings of the present study showed that sport stacking has a significant impact on fine motor skill in students with Down syndrome and improves their performance in visual-motion control and upper limb speed and dexterity. Visual-motion perception allows us to focus our eyes on an object and move toward it. Eye-hand coordination requires coordination between various structures in the central nervous system. The results of the present study are consistent with the findings of other studies (Sazmand et al., 2012; Smith, 1999; Deborah, Fidler, Lynn, 2007; Platzer, 1976; Spano et al., 1999) which focused on the effect of various motor activities on fundamental skills. What distinguishes this study with other studies is the use of sport stacking. Three factors play an effective role in encouraging individuals afflicted by Down syndrome to perform physical activities. These three factors include receiving help and support from others, fun nature of physical activity or its attractive purpose, familiarity with these activities and their routine nature. Providing appropriate facilities, sport stacking seems to be able to give them the opportunity to children, that their parents couldn't provide it, to enrich their motor experiences and achieve a higher motor development. In addition, due to lack of targeted and regular programs, the desired results would not obtained in schools. Adequate facilities, equipment, and time are vital for growth of motor skills. Parents and educators who are not capable of providing opportunities for learning fundamental motor skills basically restrict the growth talent of children and their success in sport skills, especially in the secondary childhood, adolescence, and adulthood (Gallahue and Ozomun, 2005) It seems that the quality of education offered to the sample is another important factor in the impact of sport stacking on improvement of fine motor skills. Variety of programs and incentives are of important factors of education quality. Sport stacking is a game, on the one hand, and has a competitive excitement, on the other hand, which both makes the child willingly participate in it. Motivation is one of the important environmental factors affecting motor skills. Game is an important motivational factor for children making them willingly participate in activities. In fact, the factor of obligation gives way to individual desire. In general, it can be stated that sport stacking, due to providing appropriate training opportunities to participants with proper time and facilities on the one hand and having a program that its content is consistent with eye-hand coordination on the other hand, had a positive impact on improvement of fine motor skills. As a result, educators and practitioners of planning in the area of children with Down syndrome can be recommended use sport stacking in rehabilitation and motion programs for these children.

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