

Full Length Research Paper

The Effects of Physical Activities on Physical Performance, Motor Skills, and BMI Values in Children and Youth having Down Syndrome (DS)

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Abstract

This study was carried out with the aim of determining the effects of physical exercises on social developments, motor skills, and physical performances of over-weight individuals having DS with IQ levels between 40 and 60. Twenty-six over-weight individuals having DS as study-group, and 25 healthy individuals of similar age as control-group were involved. In this study, jogging, cycling, and power exercises were carried out for 50 min thrice a week. The exercises resulted in decrease in bodyweight and BMI value, and increase in muscles power, elasticity, and physical performances in individuals with DS. The children having DS showed a lower performance than their healthy peers in the control group. During the 28-week long regular physical activity, positive improvements were observed in social skills of the children besides motor skills. There were significant differences between groups in terms of body weight, BMI, muscle power, elasticity, and balance skills.

Keywords: Down Syndrome, Social Developments, Physical Activity, Physical Exercise, Social Developments, Physical Performances.

INTRODUCTION

DS, which is a genetic disorder occurring due to the presence of 3 Trisomy 21 chromosomes rather than 2, is seen in 1 per 800-1000 new born babies (Aksay, 2014; George and Capone, 2001), DS is present in 1 out of 800-1000 newborn children (Ferencz et al., 2003; Smith, 2001). Birthing at elder age is found to be associated with DS. It has been determined that the possibility of birthing a baby with DS in an elder woman (more than 35 age) is 35 times more than that of a younger age (Shin et al., 2009). However, the risk of Down syndrome due to translocation is not related to the mother's age (Cummings, 2013).

Health Profile of Individuals with DS

The children and youth having DS experience some limitations in their physical activity, health and other anatomic, physiologic, cognitive and psychosocial aspects. Although, the children having DS show slower development than the normal healthy children in their

motoric and cognitive development aspects (Aksay, 2014; Fidler, 2008; Hodall et al., 1999), and social and motoric aspects (Aksay, 2013; Hamilton, 2005) but they show more improvement than other mentally disabled individuals (Weber and French, 1988), those having limitations in daily-life activities such as speaking, reading, writing, dressing, going to toilet, cooking, and transportation (Boulet et al., 2008), but these limitations vary depending on the level of disability (Cohen, 1996). Most part of cognitive disability is labeled as soft (IQ 50-55-69) or mild (30-35 to 50-55), and a small part is labeled as severe (20-25 to 30-35) (Boulet et al., 2008). In addition to that, there are also some secondary (possibly life-long) disabilities such as congenital heart problems, sleep disorder, eye diseases, hearing-loss, thyroid disorders, and stomach-bowel problems (Pitteti et al., 1989). These disorders (heart problems, sleep disorder, eye diseases, hearing-loss, thyroid disorders, and stomach-bowel problems) are 13-times more frequent in children having DS than their healthy peers (Boulet et al., 2008). Congenital heart disorders are seen

in more than half of children having DS, but they can be treated right after the birth. If the heart diseases are not treated right after the birth or in due time, life-span of individuals having DS decreases (Lotan, 2007). In addition to this, the respiratory tract infections and some types of mental disorders (Friez et al., 2006) are seen in young DS patients leading to early deaths (Chaney and Eyman, 2000). In recent years, with the developments in social and medical aspects of life, the life-span of individuals having DS has raised up to 60 years (Day et al., 2005).

DS and Physical Activity

Although physical activity has same importance for health in each age group, it is observed in studies on physical performances of children and youth having DS that the exercises performed are significantly insufficient. Although children having DS show slower motoric development than their non-disabled peers (Aksay, 2014; Fidler et al., 2008; Block, 1991), they can participate in many sportive activities. These individuals in lack of adequate exercise face many problems. The existence of acute health problems may act as an impediment for physical exercise.

Previous studies have shown that the low cognitive and motor skills of individuals having DS (Oates et al., 2011) limit participation in physical activities (Barr and Shields, 2011; Menear, 2007). Because in general these individuals move slowly, the movement safety and movement quality may vary. As in non-disabled individuals, the physical activity skills are higher in youth-period, which degrade as age increases (Menear, 2007). The studies show that physical activity provides advantages in psychological and physiological aspects (Gignac, 2003; Rall and Roubenoff, 1996), affects health positively, eliminates the sleep disorders (North et al., 1990), decrease in the contraction of chronic diseases as rhinitis and reactive airway (Ram and Chinen, 2001), protects the body and improves spiritual health (Biddle et al., 2000). Other positive effects of regular physical activity are decrease in heart-blood circulation system disorders, respiratory tract diseases, muscle functions and coronary heart diseases (Franklin et al., 2000).

METHODS

The experimental group (EG) consisted of 26 children having DS (trisomy 21), 13-16 years of age. Twenty-five children in the same age-group were involved in the study as control group (CG). Both group, consists of overweight juveniles having DS and OSB with BMI values higher than 25. During this 28-week study, a 50 min. exercise program was implemented thrice a week. The study was started with 30 children having DS, but 4 children had to be excluded because they did not

perform more than 6 exercises or their parents wanted the participation to be discontinued.

BMI Calculations

In order to calculate the pre- and post-study BMI values and determine the development, the body weights and heights of the children were measured.

Intervention Program

In this study, a 50 min. exercise program was implemented to participants under personal control for 28 weeks. The endurance-oriented activities such as walking, running and cycling were performed in open air (athleticism field, forest, etc.); and power, balance, and elasticity improving activities were performed in hall.

In other times, no physical activity other than those described above was performed, excluding the daily routine activities such as handcrafts and painting. The control group also did not participate in any other physical activity program except the daily routine activities. At the beginning of study, the families and teachers were informed about this study, and were asked to record possible changes that may occur to their children. During the study, the observation reports were recorded daily for every child, and the performed tests were video recorded. The daily records were utilized in order to determine the performance and behavior changes of the children.

Measuring physical and motor abilities

To measure the physical and motor abilities, the Brockport Physical Fitness Test (BPTF) and the Movement Assessment Battery for Children (MABC) were used.

BPTF

BPTF includes 27 sub-tests; by which only two tests (muscle power endurance and flexibility) were chosen to determine the children's level of physical ability.

DS individuals have multi-dimensional motor skills with limited motor coordination. Thus, several changes were made to apply the chosen conditions and to perform standard scoring for each child. To determine the muscle power and endurance, push-up and sit-up tests were used.

Push-up: During push-ups, a round red foam rubber pad 70 cm in diameter and 10 cm thick was placed on the floor at the point where the child's chest should touch in order to ensure proper performance of the activity. The movement was considered properly executed when

the chest touched the determined point. The number of completed push-ups was counted, and the test score recorded.

Sit-up: The child lay on his/her back with knees bent and hands held over the chest. A stick 20 cm in diameter and 120 cm in length with a ball 35 cm in diameter fixed on the top was suspended above the child. The length of the stick could be changed depending on the child's height. To score the movement as correct, the back had to be raised from level to a 70° angle, and the chest had to touch the designated point on the ball. To consider the movement correctly performed, an interval of 3 seconds had to be maintained between sit-ups. If the child could not maintain his/her speed or could not continue, the test was stopped, and the final test score recorded.

Flexibility: The child sat on a designated platform with one leg extended, knee stiff, and reached toward the extended foot. The movement was repeated three times, and the final position was held for measurement. The measurement was repeated separately for each leg. The test score was recorded in cm.

MABC

Children's physical ability for static and dynamic balance (DB) was determined by MABC with several modifications to implement and apply a standard scoring for each child. In static balance test, separate measurements were made for right (SBR) and left legs (SBL).

Static test: The child raised his/her foot with the hands on the waist. Then, the child raised each leg separately. The raised foot had to be at least 20 cm above the floor. Moving from the designated place, not holding the hands on the waist, and lowering the foot below 20 cm were considered faults. The time this position was held without any mistake was recorded in seconds.

Dynamic test: Two different tests were used for dynamic testing. In the first test, the child walked on his/her toes along a wooden frame 5 cm wide, 10 m long, and 3 cm high without stepping off the frame. Touching the floor with the heel and going outside the lines were considered faults. The steps taken without any mistake were counted, and the total score recorded. All the measurements were recorded with a camera.

Selection of Subjects

The subjects were chosen among 41 DS-patient children participating in Rehabilitation Sports Physical Activity Program of Department of Exercise and Sport Education for Disabled People, İnönü University, having IQ level between 40 and 60 according to the Wechsler Intelligence Scales for Children (WISC). Subjects had never participated in any regular physical activity

program before.

Trainers

The exercise program was implemented by sport experts having 3-9 years of practical experience with disabled individuals. Also, during the study, students of Department of Exercise and Sport Education for Disabled People participated voluntarily in the study. All of the assigned trainers were present at the activity location during the whole course of the study. Trainers implemented the exercise program prepared by researchers under their supervision.

Statistical analyses

IBM SPSS 21 software has been utilized in statistical analyses, while t Test has been utilized in standard deviation, mean value and other comparisons. A p-value <0.05 was considered significant.

Parental Consent and Ethic

The families of participant children having DS were informed about the research before the beginning of the study. The patient information and parental consent forms were prepared by researchers, and filled and signed by the parents.

The study was executed in accordance with Helsinki Principles, and approved by Ethics Council of Malatya İnönü University.

RESULTS

In the 28-week physical activity program, 26 children having DS, and 25 non-disabled individuals participated. The mean age of participant children having DS was 14.1 years, while the mean age of the control group was 14.3 years.

Positive improvements were observed in body weights, BMI values, physical fitness, and motor skills of participant children in both the groups.

Body Weight and BMI

In order to decrease the body weights and BMIs of children, walking, jogging and cycling programs were implemented. Children in EG had difficulties in exercise at the beginning of the study, but they could continue to participate in exercise without any difficulty after 4 weeks. The mean body weight of the CG group (75,6kg) was higher than that of the EG group (73.32), and the mean weight losses, as a result of the 28-week physical

Table 1. Results of the overall age, height, weight and BMI

		Experiment	Control	F	P
Age (years)	Pre-Test	14,11±1,107	14,36±1,113	,076	0,435
	Post-Test	14,11±1,107	14,36±1,113	,076	0,435
Height (cm)	Pre-Test	1,665±,0540	1,655±,0549	,006	0,713
	Post-Test	1,665±,0537	1,660±,0552	,059	0,759
Weight (kg)	Pre-Test	75,46±5,194	73,32±5,942	,875	0,176
	Post-Test	73,03±5,436	69,60±5,354	,044	0,027
BMI (kg/m ²)	Pre-Test	27,31±1,045	26,75±1,091	,150	0,068
	Post-Test	26,31±1,170	25,20±,8607	1,918	0,001*

* Significance was found at $p < 0.05$ and results was expressed as mean \pm SD.

exercise program, were 2.43 kg and 3.72 kg in the EG and CG group, respectively (Table 1).

In pre-test, both of the groups were in limit of overweight as defined in BMI classification of World Health Organization (WHO). At the end of the exercise program a significant decrease was noted in mean BMI values of EG ($p < 0.027$) and CG ($p < 0.001$) (Table 1).

BPTF

In push-up and sit-up tests performed in order to determine the improvements in muscle power and endurance, a significant increase ($p < 0.001$) in performance was observed in both EG ($2.34^{\text{pre}} = 9.8^{\text{post}}$) and CG ($5.60^{\text{pre}} = 15.3^{\text{post}}$), but success rate was higher in CG than EG (Table 2).

Separate measurements for right and left legs were performed to determine improvements in elasticity in all of participants. As a result of 28-week exercise program, improvement in elasticity of the left legs in CG (0.7 cm, 9.89^{pre} vs. 10.6^{post} cm) was 3 times lower than that in EG (2.1 cm, 10.6^{pre} vs. 12.7^{post} cm) (Table 2). However, in case of right legs, elasticity improvement in CG (1.1 cm, 10.6^{pre} vs. 11.7^{post} cm) was similar to EG (1.1 cm, 11.7^{pre} vs., 12.8^{post} cm). It can be concluded that the elasticity improvement in left legs was better than that in right legs in both EG. All these differences were statistically significant ($p < 0.001$).

MABC

The balance skills were measured via static and dynamic balance tests. In static balance test, separate measurements were made for right and left legs. An improvement in performance for participants' SBL, SBR and DB skills was observed (Table 3).

After 2 weeks of the exercise program, the SBL skill in CG (12.3^{pre} vs. 18.6^{post} sec) was higher than SBL skill in EG (4.230^{pre} vs. 9.42^{post} sec). An improvement of 5.1 sec was observed in balance SBL skill of EG, the improvement observed in EG was 6.3 sec (Table 3).

Similarly, SBR skill in CG (12.9^{pre} vs. 18.3^{post} sec) was higher than that in EG (3.34^{pre} vs. 10.9^{post} sec). Approximately 7.6 sec improvement in SBR skill in EG, and 5.4 sec in CG was observed.

The SBL and SBR skill tests were performed at various time points in order to determine the static balance improvement. All the changes noted were statistically significant ($p < 0.001$).

The DB skill test was performed on a line of 10 m length and 5 cm width. Performance improvements were observed in general averages at both of the groups (Table 2).

After 28-week exercise program, the DB skill in CG ($11.2^{\text{pre}} = 14.1^{\text{post}}$) was higher than that of EG ($6.53^{\text{pre}} = 9.53^{\text{post}}$). Approximately improvement of 3 steps in DB skill of SG, and 2.9 steps in CG was observed (Table 3).

The DB skill tests were performed at various time points in order to determine the dynamic balance improvement. Statistically significant changes were noted in all cases ($p < 0.001$).

General Evaluations of Families and Teachers

The teachers of participant DS patients reported positive changes in the patients as conveyed in interviews conducted after the study. These positive changes were in fields such as communicating with others in school, concentration, motivation, encouragement, understanding verbal communication, game skills, creativeness etc. An increase in interest in lessons and participation rates were also increased; and children became more successful in courses. Similarly, their success in physical education courses and improvement in their leadership skills were also noteworthy.

Observations among their family members were not much different from their teachers. Positive improvements in social skills were reported after physical activities. It was stated that communication with the family members was increased, and self-damaging behaviors and aggressiveness were decreased. They completed the given tasks, and showed positive

Table 2. Resultsofthe Brockport Physical Fitness Test (BPTF).

		Experiment	Control	F	P
Push-up	Pre-Test	2,384±1,387	5,680±1,249	,691	0,001*
	Post-Test	9,807±1,789	15,32±2,286	1,433	0,001*
Sit-up	Pre-Test	3,576±1,172	12,76±3,269	11,88	0,001*
	Post-Test	11,65±4,058	21,04±4,843	,349	0,001*
Flexibility Left	Pre-Test	9,896±1,386	10,63±1,573	,427	0,081
	Post-Test	11,09±1,419	12,78±,8828	5,058	0,001*
Flexibility Right	Pre-Test	10,65±1,031	11,07±,7512	2,147	0,105
	Post-Test	11,73±1,038	12,89±,7772	4,293	0,001*

* Significance was found at $p<0.05$ and results was expressed as mean \pm SD.

Table 3. Results ofthe overall balance tests of the Movement Assessment Battery for Children (MABC)

		Experiment	Control	F	P
SBL	Pre-Test	4,230±1,142	12,36±2,059	8,537	0,001*
	Post-Test	9,423±2,230	18,68±2,076	,022	0,001*
BBR	Pre-Test	3,346±,7452	12,96±2,573	37,77	0,001*
	Post-Test	10,96±1,865	18,36±3,225	6,076	0,001*
DB	Pre-Test	6,538±1,529	11,20±2,397	5,707	0,001*
	Post-Test	9,538±1,580	14,16±1,993	,940	0,001*

* Significance was found at $p<0.05$ and results was expressed as mean \pm SD.

changes in completing daily tasks and have regular sleep pattern.

DISCUSSION

Children and youth having DS participate limitedly in physical activities (Aksay, 2013) and many studies have shown that physical performance of disabled individuals is lower than that of their non-disabled peers (Pitetti et al., 2013; Pitetti and Boneh, 1995; King and Mace, 1990). Similar results were obtained in this study, and it has been determined that children and youth having DS have lack of physical performance compare with their non-disabled peers. Despite the slower motor development in DS (van Eck et al., 2008), obtained results that shows that a regularly implemented exercise program of 28 weeks can positively affect physical performance and motor skills. Excessive immobility causes occurrence of overweight and obesity in individuals having DS (De et al., 2008; Rubin et al., 1998). It has been shown that walking, jogging and cycling activities, performed 3 days a week, bring significant performance improvement in liver functions (Khalili and Elkins, 2009), and reduce body weights and BMI values (Ordoñez et al., 2006). This study, which showed decrease in body weights and BMI values in children and youth having DS after regular physical activity, corroborates the results of other studies.

An aerobic increase has been observed in individuals having DS after fitness (Ulrich et al., 1995)

and jogging programs (Heller et al., 2004; Tsimaras and Fotiadou 2004; Carmeli et al., 2002). Some other studies also elaborate developments in physical parameters such as muscle power, endurance (Shields and Taylor, 2010; Weber and French, 1998; Horvat et al., 1997) and elasticity (Heyward, 2006; Reid et al., 1985), similar to the results reported in this study.

The static and dynamic balance performances of mentally-disabled individuals are lower than those of non-disabled individuals (Suomi and Koceja, 1994). However, it has been observed that regular physical activities improve the balance skills of juveniles having DS (Kokubun et al., 1997). As observed in other studies, it was also observed in this study that regular physical activities increase the balance and elasticity capacities of children having DS (Kokubun et al., 1997; Connolly and Michael, 1986).

Physical activity plays generally an important role in cognitive processes of mentally-disordered individuals (Aksay and Güllü, 2014; Aksay, 2013). The studies on physical activities show that they provide advantage in psychological and physiological developments (Gignac, 2003; Biddle et al., 2000). Many studies have shown that physical activities affect positively spiritual health of mentally-disordered individuals and decrease sleep disorders (Aksay and Alp, 2014; Aksay and Güllü, 2014; North et al., 1990). In interviews with teachers and parents, it was found that positive developments were achieved in children and youth having DS, and sleep disorders were decreased. Hence, these results corroborate with similar studies.

EVALUATION

Individuals having DS show lower physical performance and motor skills compare with their non-disabled peers. Consequently, high BMI values and body compositions such as limited muscle mass of individuals having DS are worse than their non-disabled peers from the aspect of health. The tests performed within the aim of this study have shown that individuals having DS have shown worse performances than their non-disabled peers both before and after exercise program. However, through a regular exercise program, as in non-disabled individuals, decrease in body weights and BMI values can be obtained in individuals having DS, as well improvement in muscle power, elasticity and balance skills.

Physical activity can be an important tool for minimizing and even eliminating many problems (sleep disorders, chronic diseases, movement quality, heart-blood circulation system disorders, respiratory tract diseases, muscle functions, and coronary heart diseases) accompanying DS. It can contribute positively not only to motor skill field but also to some other fields such as psychosocial, self-sufficiency, and life satisfaction in individuals having DS. In order for activities made with children with DS to be successful and to achieve the goals, one should pay attention to where, when and how to implement the appropriate and high-quality education techniques. The activity planning made with appropriate teaching method will improve the motivation of child for participating in activity by considering individual characteristics.

Better results in children's physical performances and motor skills may be obtained in very short time by implementing the appropriate method. More vivid colors and an environment away from noise may satisfy the motivation deficiency of participants, and may decrease the anxious and maladaptive behaviors during activity.

It shouldn't be forgotten that individuals with DS may response to performed exercises in different ways. That's why; individual development should be considered while preparing the exercise programs for children with DS. It should also be considered which will be implemented when, where and how while adapting the exercise duration and hardness to individual development of child.

The conducted studies showed that trainers have important role in guidance to exercise and in overcoming the barriers. That's why; first of all, the trainers who will implement the physical activity with individuals with DS should be educated.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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