Influence of 12-Week Training on Aerobic Capacity and Respiratory Functions of Adolescents with down Syndrome

Yüksel Savucu

School of Physical Education and Sports, Fırat University, Elazığ, Turkey

Abstract: The study aimed to determine the influence of 12-week training on aerobic capacity and spirometric respiratory functions in adolescents with Down syndrome (DS). Twenty male individuals (mean=14.86±7.07yrs.) participated to this study. Subject assessments included physical parameters, aerobic capacity and respiratory function tests. According to the pre-training and post-training values, there was a significant differences between Weight, BMI, Percent body fat-PBF %, Mass body fat-MBF kg, Soft lean mass-SLM kg, Waist/hip-WHR parameters (p<0.05). Also it was seen significant differences statistically in VO\textsubscript{max}, FVC, FEV\textsubscript{1}, PEF, FEV\textsubscript{1}/FVC, FEF\textsubscript{25-75}, MVV values (p<0.05). The analysis of data (SPSS Inc, USA) was performed by using Wilcoxon Signed-Ranked Test. The significance of the changes observed was ascertained at level of p<0.05. The results that support the use of training programs for adolescents with DS have low physical fitness level, aerobic capacity and poor lung functions. Sedentary lifestyle and low physical work capacity are factors that may explain low physical and cardiorespiratory fitness.

Key words: Down syndrome - Spirometry - Aerobic capacity - Physical parameters - Exercise

INTRODUCTION

Down syndrome (DS), the most commonly identified cause of mental retardation, occurs in about 1 in 800 births [1]. DS is a genetic condition owing to complete or at least partial trisomy of chromosome 21 (i.e., three instead of two 21\textsuperscript{st} chromosomes). The condition is the most common cause of mental retardation in the world [2]. In DS, metabolic syndrome might be even more prevalent, as it has been frequently associated with an alteration in lipid profile [3, 4].

There have been relationships of anthropometrical parameters such as body mass index, exercise and disability status in individuals with intellectual disability [5]. Bioelectrical impedance analysis (BIA) is a simple, convenient and inexpensive method for assessing body composition, which has gained increasing popularity in the past decade. The method depends on measuring the resistance to an electrical current travelling through body tissues [6].

Due to poor coordination, slow reaction time and overall greater movement variability, persons with DS have difficulties in many activities of daily living and physical work capacity. Also they have diminished work capacity, concomitant with reduced peak oxygen consumption [7, 8]. Reduced heart rate response to exercise has been identified as the primary contributor to the low physical work capacity and cardiorespiratory fitness in this population [9]. It has also been suggested that their low levels of spontaneous physical activity, compared to their non-disabled peers [10], may be due to inefficient activity performance as a result of both anatomical and functional characteristics [11].

A modified 16-m shuttle run are valid and reliable indicators of aerobic capacity, suggesting that this test can be used to predict VO\textsubscript{max} in children with mild and moderate mental retardation [12]. In fact trainings for individuals with intellectual disability should consist of warm-up, the fitness program and cool-down. The actual fitness portion of program should primarily aerobic [13].

MATERIALS AND METHODS

Participants: 20 male adolescents with DS (M\text{age}=14.86 years, age range: 12-18 years) were participated to this research. IQ assessments of the adolescents with DS were performed by methods, namely the Wechsler Intelligence Scales for Children (WISC) for those older than six years old (ranged between 40 and 60).
Measurements and Tests: In all tests were done according to the principles of the Helsinki declaration. Therefore, written informed consent for tests was obtained from each participant’s parents.

Anthropometrical measurements were performed by a single observer. Body composition was measured by bioelectric impedance method (BIA). Body weight and percentage body fat (PBF) were measured using a portable Tanita body fat scale (Model TBF-410 M). Waist circumference (WC) was measured to the nearest midway between the lowest rib and the superior border of the iliac crest with a measuring tape. The WHR was evaluated from the minimal waist and the maximal hip girth in the standing position [6].

We determined modified 16-m shuttle run test to measure aerobic capacity (VO₂peak) of subjects. VO₂max is the maximum amount of oxygen in milliliters, one can use in one minute per kilogram of body weight. The single most important component of health-related physical fitness is cardiovascular (aerobic) endurance (e.g., running tests of various distances and durations). Before the start of the test, subjects were motivated well. For the evaluation of the test, the athlete has the form level. Switching each of the 16 meter line, the form is placed on the sign. At the end of the test and evaluation of the athlete’s signs calculated value of the table, the subject's maximal VO₂ ml/min was calculated as estimated [12, 13].

Lung functions were measured using Vitalograph Spirometer according to standard of American Thoracic Society/European Respiratory Society. [14, 15]. The spirometry unit was calibrated according to manufacturer’s specifications prior to each assessment. They were able to perform the procedure correctly and reliably, demonstrating less than 10% variation between the final two forced volumes in 1 s (FEV1) and between the final two forced vital capacity (FVC) values [16]. The FEV1 and FVC were also expressed as % predicted [17].

Implementation: None had taken part in a regular exercise program for at least six months before entering our study. Program for adolescents with DS was approximate an hour in length and met 3 days a week, adhering to the following format: Warm-up, 10 to 15 minutes of slow walking and simple stretching exercise (e.g., trunk twisters); also strengthening exercises such as sit-ups for 1 minute. Run/walk, each participant ran or walked for 30 minutes around a 220-yard indoor track at the athletic complex on the university campus in the community. Cool down, 10 to 15 minutes of easy walking and slow stretching. Once again, each participant was periodically responsible for leading the group through the cool-down session [13].

Statistical Analysis: Results were expressed as mean ±SD. The statistical analysis of data was performed by using Wilcoxon Signed-Ranked Test. The significance of the changes observed was ascertained at level of p<0.05. Impaired-Samples T test was used to analyze pre- and post-measurements. The analysis of data was performed by using 15.0 Statistical Package for the Social Sciences (SPSS Inc, Chicago, IL, USA).

RESULTS AND DISCUSSION

The results showed significantly increases in all parameters after the 12-week aerobic training. Adolescents with DS had low physical fitness level, aerobic capacity and spirometric respiratory functions at first. Sedentary lifestyle and low physical work capacity are factors that may explain low physical and cardiorespiratory fitness. Training programs to increase level of health could contribute positively in the DS population. After training, significance was found at p<0.05 in Weight, BMI, WHR, PBF, MBF and SLM values (Table 1) and in VO₂max, FVC %, FEV₁, %, FEV₁/FVC %, PEF %, FEF<br>₂₅⁻₇₅, %, MVV parameters (Table 2) and results were expressed as mean ±SD. N=20.

Table 1: Physical characteristics of adolescents with DS

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>14.86±7.070</td>
<td>14.86±7.070</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>129.00±17.28</td>
<td>129.00±17.28</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>46.39±16.79</td>
<td>44.10±16.91</td>
<td>6.149</td>
<td>0.000*</td>
</tr>
<tr>
<td>Body mass index BMI (kg/m²)</td>
<td>31.92±8.630</td>
<td>28.80±4.940</td>
<td>3.269</td>
<td>0.007*</td>
</tr>
<tr>
<td>Waist/hip-WHR (N&lt; 1)</td>
<td>0.87±0.150</td>
<td>0.84±0.170</td>
<td>2.394</td>
<td>0.040*</td>
</tr>
<tr>
<td>Percent body fat-PBF (%)</td>
<td>34.17±7.280</td>
<td>27.96±8.160</td>
<td>3.130</td>
<td>0.016*</td>
</tr>
<tr>
<td>Mass body fat-MBF (kg)</td>
<td>16.29±7.250</td>
<td>12.22±4.890</td>
<td>4.505</td>
<td>0.004*</td>
</tr>
<tr>
<td>Soft lean mass-SLM (kg)</td>
<td>27.48±9.600</td>
<td>32.63±10.40</td>
<td>-11.881</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

* Significance was found at p<0.05 and results was expressed as mean ±SD. N=20
Table 2: Aerobic capacity and spirometric respiratory functions of adolescents with DS

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO(_2) max (ml•kg(^{-1})•min(^{-1}))</td>
<td>20.91±4.280</td>
<td>22.35±4.300</td>
<td>3.631</td>
<td>0.002*</td>
</tr>
<tr>
<td>FVC % predicted</td>
<td>67.33±17.36</td>
<td>73.5±17.20</td>
<td>3.277</td>
<td>0.017*</td>
</tr>
<tr>
<td>FEV(_1) % predicted</td>
<td>77.56±18.68</td>
<td>81.67±17.37</td>
<td>2.266</td>
<td>0.044*</td>
</tr>
<tr>
<td>FEV(_1)/FVC % predicted</td>
<td>118.33±6.420</td>
<td>121.11±5.600</td>
<td>2.375</td>
<td>0.018*</td>
</tr>
<tr>
<td>PEF % predicted</td>
<td>65.67±16.48</td>
<td>70.50±16.88</td>
<td>2.077</td>
<td>0.038*</td>
</tr>
<tr>
<td>FEF(_{25-75}) % predicted</td>
<td>77.89±20.23</td>
<td>85.22±22.04</td>
<td>2.196</td>
<td>0.028*</td>
</tr>
<tr>
<td>MVV lt/dk</td>
<td>88.11±24.52</td>
<td>99.22±32.69</td>
<td>2.433</td>
<td>0.015*</td>
</tr>
</tbody>
</table>

* Significance was found at p<0.05 and results was expressed as mean ±SD. N=20

Adolescents and children with intellectual disability typically do less vigorous activity and recreational activity than their peers [18, 19]. So the sedentary lifestyle of individuals with DS is believed to be among the main factors contributing to their decreased levels of physical fitness. This in turn can increase their risk of health problems. Cardiovascular and aerobic exercise programs for people with DS can be an effective means of improving the physical fitness of these people [20]. Consequently, the implementation of programs designed to increase physical activity levels should be recommended to ensure quality of life and functional independence of these individuals [21].

Previous studies had successfully explored the relationship of anthropometrical parameters such as body mass index and body weight and maximal oxygen consumption (VO\(_2\) max) in mentally retarded adults and individuals with DS. Results indicated that further favorable changes occurred on subjects during the course of physical training program [5]. In addition, they have a high prevalence of congenital cardiovascular anomalies [22]. For the reasons mentioned we implemented a 12-week training program for adolescent with DS with the main objective of reducing their fat mass percentage.

In parallel with our study, after the 12-week aerobic training program, Ordonez et al. found that a significant decrease at baseline the weight (kg) was reduced from 78.7±4.8 to 75.1±4 and mean fat mass percentage was reduced from 31.8±3.7% to 22.6±2.3% in the male adolescents with DS [23].

We investigated the effects of an aerobic training on adolescents with DS with the modified 16-m shuttle run. This field test is valid and reliable indicators of aerobic capacity, suggesting that the test can be used to predict VO\(_2\) max in children with mild and moderate mental retardation [12]. Pitetti and Fernhall, evaluated the 20 m. running performance of persons (11-18 ages) with DS. Although values of running found the lower than normal individuals performance results was significantly [24]. In a similar study, Savucu et al., (2006) implemented 3-month training program 30 educable mentally retarded children between 18 and 25 ages and compared before and after training results of the 16-m shuttle run. Running test was found significantly [25].

A study evaluated the cardiorespiratory capacity of persons with MR with and without DS. Individuals with mental retardation have low levels of peak VO\(_2\), consistent with low levels of cardiovascular fitness. Individuals with DS have even lower levels of peak VO\(_2\) than their peers without DS, a finding that is possibly mitigated by the lower peak heart rates of the individuals with DS [7]. It is possible that the cardiovascular capacities in the subjects with DS could be related to the lower peripheral oxygen extraction of the DS, requiring a higher cardiac output to maintain oxygen consumption [2].

Individuals with DS have lower levels of cardiovascular fitness than the rest of the community [8]. Sedentary behavior as well as the physical impairments commonly associated with the condition, such as muscle weakness and hypotonia and a higher prevalence of heart defects and circulatory abnormalities, low maximal heart rates and pulmonary abnormalities have been suggested as reasons for their poor levels of physical fitness [26].

Respiratory infections are common in young people with DS [27, 28]. Even when well, children and adolescents with DS or other forms of intellectual disability appear to have reduced lung function compared to healthy, age-matched controls [29, 30]. Khalili and Elkins compared to lung functions (FEV1% predicted and FVC% predicted) with a control group. Significant improvement was recorded in individuals with DS than the control group after 8-week exercise. They undertook walking, running and cycling for 30-minute, five times per week for eight weeks and identified a small but statistically-significant effect of exercise on two measures of lung function [16].
However, the studies of lung function in these groups have contradictory results and are limited by small cohorts. That data are lost is due largely to inadequate technical performance of spirometry by the participants [30], potentially skewing the results. With substantial practice, however, children and adolescents with DS are able to achieve reproducible and valid results on spirometric testing [29].

In recent studies, FEV1, FVC, MIP and MEP values of their found lower compared to controls (p<0.001). Hypotonia, sedentary lifestyle and obesity are factors that may explain lower MIP and MEP in DS [31]. In other a study, a training program for individuals with mental retardation was applied for 10-week, two times weekly for 40 minute each session. Pre and post tests measurements were taken in FVC, FEV1, MEF%50, PEF, MVV, V C max and FEV1/VC parameters using a spirometer. Program had significant effect on certain parameters (p<0.05) [32].

In conclusion, the results of this review support the use of aerobic training programs. It can be said that aerobic training programs can only have significant difference on certain parameters of individuals with DS. This could be related to their physical and physiological structures as a result of exercise quality (mode, intensity, or duration of the training) and also longer period of time is needed to have a significant effect on respiratory functions of individuals with DS. However, various trainings have statistically-significant effects on lung function in individuals with DS. But it is possible that adverse effects from training may occur in the DS population. Future investigations should determine the effects of different exercises on the respiratory and pulmonary functions of those people.

ACKNOWLEDGMENTS

I thank Cengiz Arslan, PhD, School of Physical Education and Sport, Inönü University and Gamze Korkül, PhD, Faculty of Medicine, Fýrat University, for their advice and comments on this manuscript.

REFERENCES