



# Investigation of the Relationship between Physical Activity and Body Mass Index in Children with Down Syndrome

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## ABSTRACT

**Aim:** This study aimed was to investigate the relationship between physical activity levels and the Body Mass index (BMI) of children with Down syndrome (DS).

**Materials and Methods:** This study included 26 children (15 male, 11 female) with DS. In this study, demographic information was recorded, the physical activity was measured with the Eurofit battery; body fat content, muscle weight, protein content, body fluid ratio and basal metabolic rate were measured by Bioelectric Impedance Analysis.

**Results:** The mean age of the participants was 10.96±2.94 years and the mean BMI of the participants was 21.51±6.719. There was moderate correlation between general fat weight and arm motion speed ( $r=0.40$ ); moderate correlation between sit and reach test and general fat weight ( $r=-0.45$ ), trunk fat weight ( $r=-0.52$ ), liquid ratio ( $r=0.54$ ); moderate correlation between basal metabolic rate and right hand grip strength ( $r=0.73$ ), right arm weight without fat ( $r=0.70$ ), right arm muscle weight ( $r=0.69$ ), basal metabolic rate ( $r=0.73$ ); left hand grip muscle with left arm muscle weight ( $r=0.74$ ), left arm weight without fat ( $r=0.75$ ), basal metabolism rate ( $r=0.72$ ), mineral amount ( $r=0.83$ ), amount of protein ( $r=0.83$ ); moderate correlation between thirty-second shuttle and body fat percentage ( $r=-0.44$ ), liquid ratio ( $r=0.45$ ), body density ( $r=0.46$ ); moderate correlation between twisted arm hanging strength and fat rate in arm ( $r=-0.47$ ) with trunk fat rate ( $r=-0.40$ ), fat weight ( $r=-0.39$ ); moderate correlation between twenty-meter resistance and trunk fat rate ( $r=-0.40$ ).

**Conclusion:** It was seen that the physical activity level decreased as the fat ratio increased in individuals with DS. Basal metabolic rate, fluid ratio, and physical activity were found to be correlated.

**Keywords:** Eurofit battery, Down syndrome, bioelectric impedance analysis

## Introduction

Down syndrome (DS) occurs due to the mosaicism, triploidy, or translocation of part or all of the 21<sup>st</sup> chromosome. It is seen in one in every 700 live births (1). Individuals with DS lag in behind in terms of rough and fine motor skills compared to healthy individuals and fine motor skills are slower than their peers (2). It is seen that individuals with DS

have a higher obesity prevalence than healthy individuals. Possible determinants of obesity include low levels of physical activity (3). Differences in various musculoskeletal and biological characteristics of individuals with DS, such as low muscle strength, growth retardation, and low running performance affect the number of participants inactivity (4,5). These specifications cause low levels of physical activity (6). Low physical activity leads to being overweight

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or obese in children with DS (7). Reports from recent years suggest that there is a worldwide pandemic in terms of obesity and a sedentary lifestyle, which are risk factors for multiple negative health outcomes. Studies suggest that physical inactivity doubles health risks and brings a burden of disease compared to smoking, obesity, and hypertension and thus shortens the life span of those with this type of immobility in the middle age (8). Healthy children meet the needs of adequate physical activity by actively participating in daily play activities (9). However, children with disabilities such as DS cannot perform adequate physical activities (10). The aim of this study was to investigate the relationship between the physical activity level and Body Mass index (BMI) of children with DS.

## Materials and Methods

This study was performed with individuals with DS who applied to the Pediatrics Outpatient Clinic of Hatay Mustafa Kemal University Health Application and Research Hospital. Permission was obtained from the Mustafa Kemal University Ethics Committee. Consent was received from the parents and children. The demographic data of the patients was recorded and the body fat ratio, the fat content of the internal organs, bone weight, muscle weight, physical structure, body fluid ratio, and basal metabolic rate were determined. Physical activity was evaluated using the Eurofit battery. Inclusion criteria: those individuals with no serious cardiac problems, no cooperative problems, were included. Bioelectric Impedance Analysis: Bioelectrical impedance analysis was performed with the Tanita - BC 418 instrument. The device consists of a total of 8 electrodes, including two handgrips with anterior and posterior electrodes and four stainless steel rectangular electrodes on the soles of the feet attached to a metal platform placed on force plate 4/12 JournalAgent powered by LookUs transducers for weight measurement. Measurements are performed at 50 kHz with a constant current of 0.8 - mA sine wave and the impedance on the tissues of the subjects is measured by the receiving electrodes for 5 separate zones (trunk, both arms, and both legs). Measurements took approximately 1-2 minutes for each volunteer and the detected values are output from the device. Bioelectric impedance was contained in the output from the analyzer; body weight, BMI, basal metabolic rate, body fat percentage, body fat mass, lean body mass, and total body water measurement data were recorded for evaluation (11-13).

**Eurofit Test Battery:** The Eurofit Test Battery, approved by the Council of Europe, was used to carry out 9 tests evaluating the flexibility, speed, endurance, and strength

characteristics in approximately 45-60 minutes using simple equipment. This battery includes the following;

- flamingo balance test which is a single leg balance test;
- plate tapping-tests which measure the speed of limb movement;
- sit-and-reach-flexibility test (using 15 cm at the level of the feet);
- standing broad jump which measures explosive leg power;
- handgrip test which measures static arm strength;
- sit-ups in 30 seconds which measures trunk strength;
- bent arm hang which measures muscular endurance/functional strength;
- 10x5-meter shuttle run which measures running speed and agility;
- 20 m endurance shuttle-run (bleep test) which measures cardiorespiratory endurance (14,15).

## Statistical Analysis

SPSS 20.0 version statistical program was used in the data analysis of our study. Statistical significance was evaluated at all levels of  $p < 0.05$ . In this study, if Pearson Correlation test and parametric conditions were not provided, Spearman Correlation test was applied. Significance coefficients were defined as follows;

- 0.0-0.2 'very weak'
- 0.21-0.4 'weak'
- 0.41-0.6 'moderate'
- 0.61-0.8 'high'
- 0.81-1.0 'very high'.

## Results

The clinical features of the patients are shown in Table I. According to Bioelectric Impedance Analysis data, 54% of the patients had high weight, 27% had normal weight, and 19% had low weight (Figure 1). The Eurofit battery was found to have a negative correlation with sit and reach and 30-second shuttle parameters, body fat content, fat weight, and BMI. As the fat trunk, fat weight, and BMI increased, access to physical activity and access in the body decreased by thirty seconds. The plate tapping is negatively correlated with fat in general; a decrease in the plate tapping with an increase in fat in general. The bent arm hang parameter was found to be negatively correlated with a fat body, fat weight, and fat in the arm. Fat weight, fat in the arm, and the amount of fat in the trunk increased

with decreasing bent arm hang. It was found that there was a negative correlation between the 20-meter durability and the fat body percentage, while the fluid ratio was correlated positively (Table II).

Handgrip strength was found to correlate positively with basal metabolic rate, lean arm mass, arm muscle mass, amount of mineral, and amount of protein. An increase in grip strength was observed as the mass of the lean arm and muscle mass of the arm increased (Table III).

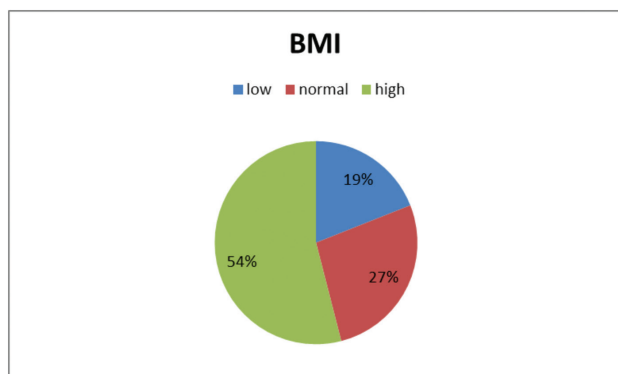
## Discussion

This study aimed was to investigate the relationship between physical activity levels and BMI children with DS. Physical activity was found to be related to basal metabolic rate, fluid ratio, amount of protein, fat, and muscle mass. Individuals with DS show more than 80 clinical features that may affect body fat and physical activity levels (16). Young people with DS have higher obesity and lower levels of physical fitness than their healthy peers, including those without DS but with intellectual disabilities (3). O’Shea et al. (17) evaluated the prevalence of obesity in children with DS by looking at the BMI of children between 4 and 16 years. They found 51.6% of males and 40% of females with DS have a high BMI. It was concluded that children with DS had higher obesity prevalence compared to the normal

**Table I.** Age, Body Mass index, liquid ratio, basal metabolic rate values of individuals ( $\bar{x} \pm SD$ )

Values	$\bar{X} \pm SD$
Age (years)	10.96±2.94
Body Mass index (kg/m <sup>2</sup> )	21.51±6.71
Liquid ratio (%)	57.04±9.91
Basal metabolic rate (Kcal)	1.201.48±667.18

SD: Standard deviation



**Figure 1.** Body mass ratio  
BMI: Body Mass index

population, which was associated with a higher body fat ratio. Similarly, in our study, 66.7% of males and 36.4% of females and 54% of the total had a high BMI. While Minck et al. (18) found no relationship between fitness components and obesity in individuals aged between 6 and 27 years, Pate et al. (19) found inconsistent results in the relationship between sitting and reach and obesity in boys and girls in individuals aged 6 to 18. In our study, a negative relationship was found between fat weight and sit and reach performance. The children who had high-fat weight were found to be less successful in the sit and reach than children with low-fat weight. Raudsepp et al. (20) found no relationship between fat and handgrip strength in prepubertal girls with obesity and balance. In this study, it was found that handgrip strength was correlated positively with basal metabolic rate, lean arm mass, arm muscle mass, amount of mineral, and amount of protein. An increase in grip strength was observed as the mass of the lean arm and muscle mass of the arm increased. Children with DS are more overweight or obese than the general population. The risk of obesity in children with DS increases after 2 years of age. Increased leptin, reduced resting energy consumption, comorbidities, inappropriate diet, and low levels of physical

**Table II.** Eurofit battery parameter with bioelectrical impedance analysis

	Fat trunk	Fat weight	BMI
<b>Sit-and-reach (cm)</b>			
r/rho	-0.524	-0.466	-0.387
p	0.006	0.016	0.051
<b>30 sec shuttle</b>			
r/rho	-0.489	-0.511	-0.438
p	0.011	0.008	0.025
	Fat general	Fat arms	Muscle arms
<b>Plate tapping (sec)</b>			
r/rho	-0.407	-0.253	-0.050
p	0.048	0.212	0.808
	Fat weight	Fat arms	Fat trunk
<b>Bent arm hang (sec)</b>			
r/rho	-0.395	-0.474	-0.402
p	0.046	0.014	0.042
	Fat trunk %	Liquid ratio	Fat leg
<b>20-meter durability</b>			
r/rho	-0.408	0.396	-0.222
p	0.039	0.045	0.275

\*p<0.05 Spearman correlation, BMI: Body Mass index, cm: centimeter

**Table III.** Eurofit battery parameter relation between hand grip strenght and bioelectrical impedance analysis data

	Basal metabolic rate	Lean arm mass right	Arm muscle mass right	Amount of mineral	Amount of protein
<b>Handgrip strength right, kg r/rho p</b>	0.732 0.000	0.700 0.000	0.692 0.000	0.735 0.000	0.735 0.000
	Basal metabolic rate	Lean arm mass left	Arm muscle mass left	Amount of mineral	Amount of protein
<b>Handgrip Strength left, kg r/rho p</b>	0.727 0.000	0.752 0.000	0.747 0.000	0.831 0.000	0.831 0.000

\*p<0.05, kg: kilogram

activity are causative factors of obesity (6). Bertapelli et al. (6) reported that physical activity has an effect on energy balance and that young people with DS who have low energy balance are more likely to be overweight or obese than those without DS. It shows that young people with DS have lower levels of physical activity than those without DS (3). A cross-sectional study by Esposito et al. (21) evaluated 104 children with DS aged 8 to 16 and a weak relationship between physical activity and BMI and body fat ratio was found. In our study, the rate of fat, fat, and BMI increased, and 30-sec shuttle decreased. The increase in BMI showed an increase in the liquid ratio. Gomez et al. (22) reported in their cross-sectional study of 111 adolescents with DS aged 11 to 20 that the level of physical activity does not correlate with BMI and body fat ratio. Glover et al. (23) suggested that further research is needed to examine the effect of physical activity on BMI levels in young people. In our study, it was found that there was a decrease in plate tapping with an increase in general fat. Fat weight, fat in the arm, and the amount of fat in the trunk increased with a decrease in bent arm hang. In the literature, many studies are investigating the effects of physical activity on body composition, muscle strength, obesity, and the cardiovascular system. However, there are not enough studies examining BMI and physical activity levels in children with DS.

### Study Limitations

The lack of a control group consisting of healthy children in the same age group is considered as the limitation of this study.

### Conclusion

Most notably, it was seen that physical activity levels decreased as the fat ratio increased in individuals with DS. Basal metabolic rate, fluid ratio, and physical activity were found to be correlated.

### Ethics

**Ethics Committee Approval:** This study was approved by Ethics Board of Mustafa Kemal University (approval number: 2017/150).

**Informed Consent:** All of the parents of the patients gave their informed consent prior to their child's inclusion in the study.

**Peer-review:** Externally and internally peer-reviewed.

### Authorship Contributions

Surgical and Medical Practices: E.Ç., E.D.H., Ö.G. Concept: E.Ç., E.D.H., Ö.G., Design: E.Ç., E.D.H., Ö.G., Data Collection or Processing: E.D.H., Ö.G., Analysis or Interpretation: E.D.H., Ö.G., Literature Search: E.Ç., E.D.H., Ö.G., Writing: E.Ç., E.D.H., Ö.G.

**Conflict of Interest:** None of the authors had conflict of interest.

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