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# THE EFFECT OF 8-WEEK BALL-HANDLING TRAINING PROGRAM ON UPPER-LOWER EXTREMITY MUSCULAR STRENGTH OF INDIVIDUALS WITH DOWN SYNDROME

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**Abstract:**

**Purpose:** In this study, it has been aimed to determine the effect of 8-week ball-handling training program on upper-lower extremity muscular strength of individuals with Down syndrome.

**Method:** In the study, twenty one individuals who had been medically diagnosed with trisomy down syndrome and still attending special education and rehabilitation centres have participated as voluntarily. The participants have been selected randomly and divided into exercise (10 participants) and control groups (11 participants). The exercise group was trained with Ball-handling Training Program for 8 weeks; 2 days a week and a 60 minute per day. However, the control group did not participate in any activities regularly. In the study, Takei hand grip dynamometer was used to measure upper extremity strength. For the measurement of lower extremity strength, standing broad jump–vertical jump, wall squat test and Takei leg dynamometer strength tests were utilized. The statistical analyses of the data were realized by using SPSS 21.0 package program.

**Results:** The means of after eight weeks, leg strength test (pre:22.47±13.12; post:30.90±13.87; p=.005) wall squat test (pre:23.55±10.95; post:30.92±13.87; p=.005) and dominant hand grip strength (pre:11.35±5.74; post:14.55±7.18; p=.024) were found more significant than the means of baseline in exercise group. But, It was not significant differences between post measurements of exercise and control groups (p>0.05).

**Conclusion:** The findings of the study have revealed that 8-week ball-handling training program made a positive effect on upper-lower extremity strength of individuals with Down syndrome. However, it is assumed that if the program implemented is

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maintained for a longer period of time, the positive effect of the training on individuals with DS will increase.

**Keywords:** ball-handling training, upper-lower extremity muscular strength, Down syndrome

## 1. Introduction

Down Syndrome (DS) is a congenital, autosomal anomaly characterized with growth and intellectual disability . It has been stated that the life quality of individuals with DS may be poor because of their hypotenuse muscular nature. This hypotenuse muscular nature has been reported to affect DS individuals' self-care and academic skills negatively (Agiovlasitis et al., 2009; Carmeli et al., 2002; Pitetti et al., 1992). DS adults' muscular strength, endurance and dynamic stability have been considered very significant for a good quality of life and functional independence (Carmeli et al., 2002). In line with this, Mendonca et al. (2010)'s study on individuals with DS has put forward that leg strength is connected with aerobic and physical conditioning capacity. When related studies in the literature are examined, there are various exercise programs intended for the development of DS individuals' muscular tonus. Specifically, it has been detected that progressive resistance training has been utilized to develop DS individuals' muscular strength in general (Cowley et al., 2011; Shields et al., 2013; Shields et al., 2010; Shields et al., 2008). However, there are some studies in the literature which have pointed out that this training method increases the risk of disability (Kolber et al., 2010; Phadke et al., 2009). In line with this, it has been claimed that resilient cyclical training leads to the growth of low-grade systemic inflammation in DS sedentary male individuals (Rosety-Rodriguez et al., 2013). In this regard, using different training methods aimed at muscular strength and other features have been suggested in normal (Biçer et al., 2015; Özdal, 2016a; Özdal, 2016b) and disabled persons (Karakoc, 2016; Mayda et al., 2016; Shields et al., 2013; Tsimaras and Fotiadou, 2004). In their study, Worrell et al (1994) have stated that the fact of static stretching practices' effectiveness on the development of muscular strength is not a new notion. In addition to this, the study has put forward that utilizing static stretching practices 5 days a week through 3 weeks enhances eccentric torque strength at the rate of 8.5 % and concentric torque strength of 11.2% (Worrell et al., 1994). Regarding this finding, Rubini et al. (2007) lay emphasis on the positive effect of 3-week static stretching practices on the development of muscular strength.

Stauber et al. (1994) conducted a study implementing a 4-week long (3 times a week) stretching exercise on mice's soleus muscles and it was concluded that there was a significant increase in the muscle mass at the rate of 13% and the muscle tendons as a rate of 30%. Similarly, Coutinho et al. (2004) held a study involving a 3-week long stretching exercise (40 minutes 3 days a week) on mice's soleus muscles and revealed that a 16% increase in the soleus muscle tendons was observed. Ball-handling is an important personal offence skill for various basketball positions, such as self-defence, dribbling the ball and playing the game (Franciosi et al., 2012). It is highlighted that an athlete who can perform Ball-handling movements well can also perform his/her movements with the ball compatibly and also ball control very well (Kocić et al., 2016). In Ball-handling training programs, when the muscles in low extremity are considered to be working in static condition especially in stance position, the discussion about whether this situation has an effect on DS individuals' muscular tonus or not emerges. In addition to this argument, another concern is whether upper extremity muscles are affected or not during technical movements, such as bouncing the ball, lobbing it and turning it around the head, waist and knees. When the related literature is examined, there is a limited number of studies on (Kocić et al., 2016; Belkacem et al.,2016; Monfort et al., 2015; Zeller et al., 2015; Hamamioğlu et al., 2011). In general, whether there is an effect of ball-handling exercises or not on athletes' performance efficiency in basketball and football technical training has been investigated. Nevertheless, no studies on ball-handling regarding DS individuals have been come across in the literature. Therefore, this study seeks to find out the effect of 8-week Ball-handling Traning Program (BTP) on DS individuals' upper and lower muscular strength.

## 2. Materials and Methods

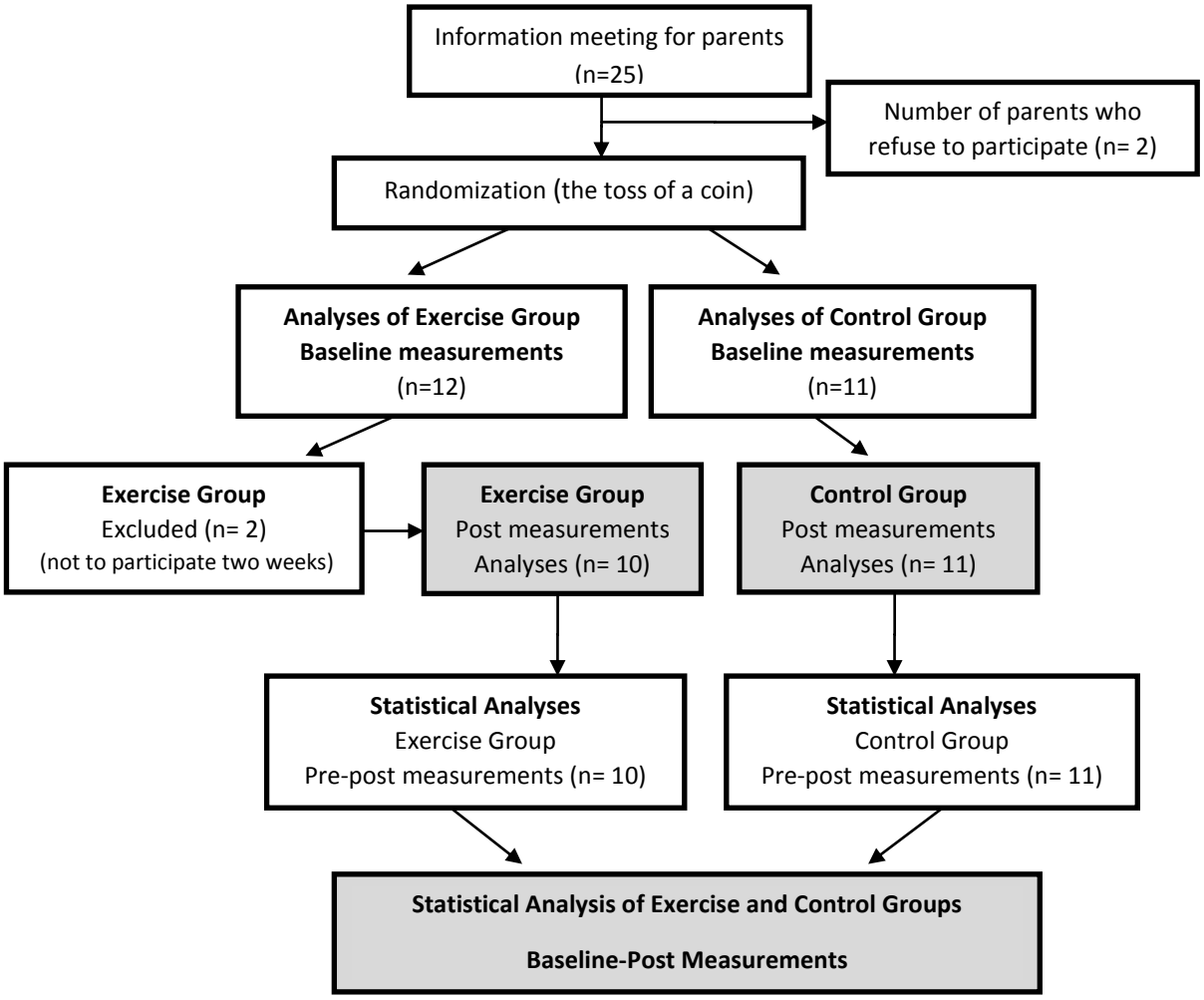
### 2.1. Participants and Design

As a first step of our study, a contact meeting was arranged and 25 DS individuals (twenty five people who had been medically diagnosed with trisomy DS), who attend to special education and rehabilitation centres and have been found appropriate according to our study participation criteria, attended the meeting. Two out of 25 families having DS children refused to participate in the study. Twenty three DS individuals have been divided into two groups with random method sampling **(**Clark and Westerberg, 2009); namely Exercise Group (EG-12 individuals) and Control Group (CG-11 individuals). However, 2 DS participants in EG did not attend the study regularly and so those participants were excluded from the study. In summarize, the

study was conducted on 21 DS participants [10 people EG (4 male, 6 female), 11 people CG (6 male, 5 female)].

Study Participation Criteria (Rosety-Rodriguez et al., 2013); Study participation criteria selects for individuals who do not have atlantoaxial instability, thyroid disease, orthopaedic problems, attend a sportive activity for at least 6 months, smoking and drinking habits, congenital heart disease, but the individuals who would attend the study should have mildly intellectual disability (IQ=50-70) level reported by specialists in the hospital report.

**Figure 1:** Participant Flow Chart




BTP program including warm-up (10 minutes), main period (40 minutes) and cool-down (10 minutes) sections, 60 minutes in total each day was applied to the Exercise Group 2 days a week throughout 8 weeks. On the other hand, the Control group did not attend any activities regularly throughout 8 weeks. At the end of the study, the DS participants in the Control Group were taken to ball-handling exercises.

At the pre-training and post-training periods of the 8-week training, all DS participants' upper and lower extremity muscular strengths were measured. In order to measure lower extremity muscular strength, wall squat test, Takei leg dynamometer, leg strength, standing long jump and vertical jump were utilized. On the other hand, Takei hand grip test was used to measure upper extremity muscular strength. At the beginning of the study, all participants were informed about the study and signed an informed consent form, which was approved by the Human Ethics Committee of Cukurova University numbered 07-03-2014/29. Besides, a questionnaire involving demographic features of Down syndrome individuals was formed and administered to the participant families.

**Table 1: BTP Including Participants with DS in Exercise Group**

(Ince et al., 2006; Krause et al., 1999)

<table>
<tr><th>WARM-UP<br>5min. jogging<br>5min.<br>stretching<br>exercises</th><th colspan="2">MAIN PERIOD<br>40min.<br>Ball-handling movements</th><th>COOL-DOWN<br>5min. jogging<br>5min. stretching<br>exercises</th></tr>
<tr><td rowspan="15">**a.** Jogging<br>**b**. Stretching<br><br>**<u>Stretching exercises</u>**<br><br>1. Forward and backward head stretch<br>2. Sideways head stretch<br>3. Chest and shoulders stretch<br>4. Deltoid muscle stretch<br>5. Triceps muscle stretch<br>6. Overhead stretch<br>7. Lateral trunk muscle stretch<br>8. Arched back</td><td>FIGURES</td><td>EXPLANATIONS</td><td rowspan="15">**a.** Jogging<br>**b.** Stretching<br><br>**<u>Stretching exercises</u>**<br><br>1. Forward and backward head stretch<br>2. Sideways head stretch<br>3. Chest and shoulders stretch<br>4. Deltoid muscle stretch<br>5. Triceps muscle stretch<br>6. Overhead stretch<br>7. Lateral trunk muscle stretch<br>8. Arched back stretch<br>9. Leg extensor and</td></tr>
<tr><td>Figure I.</td><td>Throwing the ball into the air with two hands and catching it again. Then, bouncing it in front of the body with two hands.</td></tr>
<tr><td>Figure II.</td><td>Turning the ball around legs on the ground.</td></tr>
<tr><td>Figure III.</td><td>Drifting the ball by figuring 8 around legs.</td></tr>
<tr><td>Figure IV.</td><td>Turning the ball around the head.</td></tr>
<tr><td>Figure V.</td><td>Bouncing and catching the ball with two hands on the left hand side strongly.</td></tr>
<tr><td>Figure VI.</td><td>Bouncing and catching the ball with two hands in front of the body strongly.</td></tr>
<tr><td>Figure VII.</td><td>Bouncing and catching the ball with two hands on the right hand side strongly.</td></tr>
<tr><td>Figure VIII.</td><td>Turning the ball around waist.</td></tr>
<tr><td>Figure IX.</td><td>Turning the ball around the ankle of the juxtaposed feet.</td></tr>
<tr><td>Figure X.</td><td>Taking the ball from the bottom to the top of the body while turning it. .</td></tr>
<tr><td>Figure XI.</td><td>Throwing and catching the ball to the right and left by tapping the fingers on the head.</td></tr>
<tr><td>Figure XII.</td><td>Throwing and catching the ball with finger tips in the chest position.</td></tr>
<tr><td>Figure XIII.</td><td>Throwing and catching the ball with finger tips in knee line.</td></tr>
</table>

| | | | |
|---|---|---|---|
| stretch<br>9. Leg extensor and pelvic flexor stretch<br>10. Spinal twist stretch<br>11. Paravertebral muscle stretch<br>12. Loosen-up stretch<br>13. Upper back prayer<br>14. Double knee-to-chest stretch | **Figure IX.** | High pounding with left hand on the left side in basic position. | pelvic flexor stretch<br>10. Spinal twist stretch<br>11. Paravertebral muscle stretch<br>12. Loosen-up stretch<br>13. Upper back prayer<br>14.Double knee-to-chest stretch |
| | **Figure XV.** | High pounding with right hand on the right side in basic position. | |
| | **Figure XVI.** | In basic position, pounding the ball with the right and left hand from right to left. | |
| | **Figure XVII.** | In basic position, throwing the ball into the air with right hand and catching it again. | |
| | **Figure XVIII.** | In basic position, throwing the ball into the air with left hand and catching it again. | |
| | **Figure IXX.** | In basic position, throwing the ball into the air with two hands and catching it again. | |
| | **Figure XX.** | In basic position, throwing the ball into the air with two hands and clapping your hand and catching it again. | |
| | **Figure XXI.** | In basic position, drifting the ball around the left leg. | |
| | **Figure XXII.** | In basic position, drifting the ball around the right leg. | |
| | **Figure XXIII.** | In basic position, pounding the ball low with two hands on the right side. | |
| | **Figure IVXX.** | In basic position, pounding the ball low with two hands on the left side. | |

### 2.2. Instruments

**2.2.1. Takei hand dynamometer test:** While the individual was standing, dominant and non-dominant hand measurement were held by adjusting the instrument to the individual's wrist and by placing it to $45^0$ abduction. During the measurement, the arm was stretched (MacDonncha et al., 1999; España-Romero et al., 2010; Roberts et al., 2011; Mayda et al., 2016).

**2.2.2. Takei leg dynamometer test:** The participants were positioned on the dynamometer after each movement was demonstrated on the dynamometer. In the upright position, the dynamometer chain was adjusted according to the participant's knee level. In the stance position in basketball, while the participant was looking across and also his/her back was upright, he/she was asked to lift up the dynamometer chain by relying on his/her legs strength. The value measured was recorded as kg (Biçer et al., 2015; Karakoc, 2016; Mayda et al., 2016; Bilgiç et al., 2016a).

**2.2.3. Vertical jump test:** Takei jump meter instrument was used to measure vertical jump. The individual jumped upwards with his/her all power without bounding and taking a step on a time and distance scaled soft floor and the distance he/she jumped

was recorded as centimetre degree on the instrument (Bilgiç et al., 2016b; Milliken et al. 2008; Giagazoglou et al., 2013, Juneja et al., 2010).

**2.2.4. Standing broad jump test:** The individual performed the standing broad jump from the back of marked line with his/her feet to the best of his/her ability. The distance was measured in the form of meter by detecting the distance between the marked line and the closest trace the participant had (Wang and Ju, 2002; Guidetti et al., 2010, Juneja et al., 2010).

**2.2.5. Wall squat test:** During this test, the participant was asked to wait in half-done squat position. In this position, the participant's back was against a smooth vertical wall, his/her arms were in parallel extension towards the floor facing front of the body and in the leg-shoulder width apart position (http://www.topendsports.com/testing/tests/wall-sit.htm, [Accessed; 24/02/2017]; Mclntosh et al., 1998**)**. When the participant was positioned in half-done squat, the chronometer was started. The timing started when one foot was lifted off the ground and was stopped when the participant could not maintain the position, the chronometer was stopped and the value detected was recorded. After a period, the other leg was tested in the same way. All measurements were carried out twice and the best value from two measurements was used.

### 2.3. Statistical analyses

All statistical analyses were conducted using the SPSS package program, version 21.0 (SPSS, Inc., Chicago, IL). Descriptive statistics were used for the means and standard deviations. Shapiro-Wilk test was used for normality distribution of the data. Non-parametric tests were made since the exercise and control groups did not show normal distribution ($p<0.05$). While comparing paired groups, Wilcoxon signed rank test was performed and to compare independent groups Mann-Whitney U test was used.

## 3. Results

**Table 2:** Comparing exercise group and control group by demographic characteristics

| Characteristics | Groups | n | Mean | S.D. | Mean Rank | Z | p |
|---|---|---|---|---|---|---|---|
| **Age** | Exercise | 10 | 22.50 | 5.25 | 13.00 | -1.414 | .157 |
| | Control | 11 | 19.36 | 6.28 | 9.18 | | |
| | **Total** | **21** | **20.86** | **5.89** | | | |
| **Height** | Exercise | 10 | 153.10 | 7.71 | 12.50 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Control | 11 | 150.09 | 7.20 | 9.64 | -1.059 | .290 |
| | **Total** | **21** | **151.52** | **7.42** | | | |
| **Body Weight** | Exercise | 10 | 61.41 | 15.22 | 10.90 | -.071 | .944 |
| | Control | 11 | 60.44 | 14.17 | 11.09 | | |
| | **Total** | **21** | **60.90** | **14.32** | | | |

The mean values of DS participants' age, height and weight features are demonstrated in the order respectively (20.86±5.89 year old; 151.52±7.42 cm; 60.90±14.32 kg). Demographic characteristics of exercise and control groups were compared and we did not find any significant differences between them (p>0.05).

**Table 3:** Comparing the results of pre- and post-tests in Exercise Group

| **Strength Tests of Upper and Lower Extremities** | **n** | **Mean** | **S.D.** | **Rank** | **Mean Rank** | **z** | **p** |
|---|---|---|---|---|---|---|---|
| **Leg Strength (Pre-test)** | 10 | 22.47 | 13.12 | **negative ranks** | .00 | -2.80 | **.005*** |
| **Leg Strength (Post-test)** | 10 | 30.90 | 19.16 | **positive ranks** | 5.50 | | |
| **Vertical Jump (Pre-test)** | 10 | 13.60 | 7.03 | **negative ranks** | 3.17 | -1.56 | .119 |
| **Vertical Jump (Post-test)** | 10 | 15.20 | 7.15 | **positive ranks** | 5.92 | | |
| **Standing Broad Jump (Pre-test)** | 10 | 66.70 | 34.63 | **negative ranks** | 2.50 | -1.13 | .260 |
| **Standing Broad Jump (Post-test)** | 10 | 75.00 | 43.06 | **positive ranks** | 6.50 | | |
| **Wall Squat (Pre-test)** | 10 | 23.55 | 10.95 | **negative ranks** | .00 | -2.80 | **.005*** |
| **Wall Squat (Post-test)** | 10 | 30.92 | 13.87 | **positive ranks** | 5.50 | | |
| **Hand Grip Dominant (Pre-test)** | 10 | 11.35 | 5.74 | **negative ranks** | 3.50 | -2.26 | **.024*** |
| **Hand Grip Dominant (Post-test)** | 10 | 14.55 | 7.18 | **positive ranks** | 5.19 | | |
| **Hand Grip Non-Dominant (Pre-test)** | 10 | 11.10 | 6.29 | **negative ranks** | 4.50 | -1.89 | .059 |
| **Hand Grip Non-Dominant (Post-test)** | 10 | 14.10 | 6.37 | **positive ranks** | 5.75 | | |

*p<0.05

The means of measurements after 8 weeks of leg strength test (baseline: 22.47±13.12; after 8 weeks: 30.90±13.87) wall squat test (baseline: 23.55±10.95; after 8 weeks: 30.92±13.87) and dominant hand grip strength (baseline: 11.35±5.74; after 8 weeks: 14.55±7.18) in exercise group were found higher than the means of pre-test. Hence, regarding exercise group, statistically significant differences between pre- and post-training were found respectively (p=.005; p=.005; p=.024).

**Table 4:** Comparing pre-and post-test results regarding control group

| Strength Tests of Upper and Lower Extremities | n | Mean | S.D. | Rank | Mean Rank | z | p |
|---|---|---|---|---|---|---|---|
| **Leg Strength (Pre-test)** | 11 | 25.36 | 12.56 | **negative ranks** | 4.50 | -2.205 | **.03** |
| **Leg Strength (Post-test)** | 11 | 25.13 | 12.62 | **positive ranks** | 1.00 | | |
| **Vertical Jump (Pre-test)** | 11 | 14.45 | 4.63 | **negative ranks** | 5.14 | -1.732 | .08 |
| **Vertical Jump (Post-test)** | 11 | 13.91 | 4.78 | **positive ranks** | 4.50 | | |
| **Standing Broad Jump (Pre-test)** | 11 | 65.18 | 21.27 | **negative ranks** | 4.08 | -1.897 | .06 |
| **Standing Broad Jump (Post-test)** | 11 | 64.55 | 21.00 | **positive ranks** | 3.50 | | |
| **Wall Squat (Pre-test)** | 11 | 21.27 | 9.13 | **negative ranks** | 4.08 | -1.897 | .06 |
| **Wall Squat (Post-test)** | 11 | 20.73 | 9.18 | **positive ranks** | 3.50 | | |
| **Hand Grip Dominant (Pre-test)** | 11 | 15.45 | 5.56 | **negative ranks** | 3.00 | .000 | 1.00 |
| **Hand Grip Dominant (Post-test)** | 11 | 15.44 | 5.67 | **positive ranks** | 1.50 | | |
| **Hand Grip Non-Dominant (Pre-test)** | 11 | 14.91 | 6.09 | **negative ranks** | 2.50 | -1.069 | .29 |
| **Hand Grip Non-Dominant (Post-test)** | 11 | 14.83 | 6.09 | **positive ranks** | 1.00 | | |

*p<0.05

After 8-week training, the means of leg strength test (pre-test: 25.36±12.56; post-test: 25.13±12.62) in control group were found lower than the means of pre-test. So, statistically significant differences were detected between pre-training period and post-training period (p=.003).

**Table 5:** Comparing pre-test and post test results of exercise and control groups

| Strength Tests of Upper and Lower Extremities | Groups | n | Mean | S.D. | Mean rank | z | p |
|---|---|---|---|---|---|---|---|
| **Leg Strength (Pre-test)** | **Exercise** | 10 | 22.47 | 13.12 | 10.40 | -.423 | .672 |
| | **Control** | 11 | 25.36 | 12.56 | 11.55 | | |
| **Leg Strength (Post-test)** | **Exercise** | 10 | 30.90 | 19.16 | 11.90 | -.634 | .526 |
| | **Control** | 11 | 25.13 | 12.62 | 10.18 | | |
| **Vertical Jump (Pre-test)** | **Exercise** | 10 | 13.60 | 7.03 | 10.60 | -.282 | .778 |
| | **Control** | 11 | 14.45 | 4.63 | 11.36 | | |
| **Vertical Jump (Post-test)** | **Exercise** | 10 | 15.20 | 7.15 | 11.45 | -.318 | .750 |
| | **Control** | 11 | 13.91 | 4.78 | 10.59 | | |
| **Standing Broad Jump (Pre-test)** | **Exercise** | 10 | 66.70 | 34.63 | 11.40 | -.282 | .778 |
| | **Control** | 11 | 65.18 | 21.27 | 10.64 | | |
| **Standing Broad Jump (Post-test)** | **Exercise** | 10 | 75.00 | 43.06 | 11.80 | -.563 | .573 |
| | **Control** | 11 | 64.55 | 21.00 | 10.27 | | |
| **Wall Squat (Pre-test)** | **Exercise** | 10 | 23.55 | 10.95 | 11.60 | -.423 | .672 |
| | **Control** | 11 | 21.27 | 9.13 | 10.45 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Wall Squat (Post-test)** | **Exercise** | 10 | 30.92 | 13.87 | 13.70 | -1.903 | .057 |
| | **Control** | 11 | 20.73 | 9.18 | 8.55 | | |
| **Hand Grip Dominant (Pre-test)** | **Exercise** | 10 | 11.35 | 5.74 | 8.95 | -1.447 | .148 |
| | **Control** | 11 | 15.45 | 5.56 | 12.86 | | |
| **Hand Grip Dominant (Post-test)** | **Exercise** | 10 | 14.55 | 7.18 | 10.60 | -.282 | .778 |
| | **Control** | 11 | 15.44 | 5.67 | 11.36 | | |
| **Hand Grip Non-Dominant (Pre-test)** | **Exercise** | 10 | 11.10 | 6.29 | 9.25 | -1.236 | .216 |
| | **Control** | 11 | 14.91 | 6.09 | 12.59 | | |
| **Hand Grip Non-Dominant (Post-test)** | **Exercise** | 10 | 14.10 | 6.37 | 10.65 | -.247 | .805 |
| | **Control** | 11 | 14.83 | 6.09 | 11.32 | | |

No significant differences were found between exercise and control groups regarding all parameters (pre-test and post-test) ($p>0.05$).

## 4. Discussion

Intellectually disabled individuals' physical fitness components' (strength, velocity, endurance, flexibility and so on.) being low shows that those individuals have low level of physical activities. Furthermore, the related literature points out that this low physical fitness may affect not only their social involvement, but also their health problems negatively (Salaun et al., 2012). In DS individuals, muscular strength has been considered as the most significant physical fitness parameter since DS individuals have hypotenuse nature because this condition has been reported to affect those individuals' daily life skills negatively (Agiovlasitis et al., 2009). Several studies in the literature state that there is a strong relationship between DS individuals' muscle hypotonus and muscle strength (Sharav and Bowman, 1992; Pitetti et al., 1992; Priosti et al., 2013). In their study, John et al. (2016) emphasized that DS individuals' muscular strength may be affected negatively because of their joint laxity and hypotonus muscles.

In another study, Cameli et al. (2002) compared the muscular strength of individuals with Mental Retardation (MR) disability and the individuals with Down Syndrome+Mental Retardation (DSMR). Cameli et al. (2002) found out that the muscular strength of individuals with Down syndrome + Mental Retardation (DSMR) was lower than the muscular strength of individuals with Mental Retardation (MR). In line with that, upper and lower extremity muscular strength of DS individuals was found to have 50% lower strength when compared to their mentally retarded peers without DS (Pitetti et al., 1992; Croce et al., 1996). This finding points out that it is essential to develop DS individuals' muscular strength.

In our study, after 8-week training the means of measurements were found higher than the means of baseline in exercise group; such as leg strength test (baseline:

22.47±13.12; after 8 weeks: 30.90±13.87), wall squat test (baseline: 23.55±10.95; after 8 weeks: 30.92±13.87) and dominant hand grip strength (baseline: 11.35±5.74; after 8 weeks: 14.55±7.18). Therefore, in the exercise group significant differences were found between baseline and after 8-week treatment respectively (p=.005; p=.005; p=.024). Mendonca et al. (2010) signify the importance of lower part body development because they suggest that leg strength is closely related to aerobic and physical exercise capacity. In addition, 10-week progressive resistance training program administered to DS individuals (17 male, 6 female, age: 15.6±1.6 year) was reported to develop low extremity strength. However, it was stated that upper extremity strength was not developed (Shields and Taylor, 2010). In our study, this is an important finding although our training lasted 8 weeks, which took shorter duration than the training in Shields and Taylor's study. Nevertheless, a development was observed between pre-post upper and lower extremity strengths in the exercise group. This situation might have stemmed from DS individuals' easy orientation to ball-handling training and in the first weeks unexperienced minor situations, such as aches which are mostly seen in progressive resistance training program. However, any adverse events that occurred during training (including minor events such as delayed onset muscle soreness) were recorded by the student mentor during the participant's exercise.

In some studies in the related literature, it was stated that a significant development takes place in upper and lower extremity muscular strengths when exercise programs devoted to major muscle groups are put into use 2-3 days a week, 10-12 weeks in total for individuals with DS (Cowley et.al., 2011, Shields et.al., 2008, Tsimaras and Fotiadou, 2004). In another study, Oxyzoglou et al. (2007) conducted a comparative study to examine pre-post jumping and strength skills between two different groups including 121 adults in total; namely, the Handball Group (51 individuals, average age mean 13.7±1.5) and the physical education group (70 individuals, average age mean 13.5±96). The participants in the handball group were trained 3 days a week, 60 minutes a day doing handball ball-handling drills, horizontal-vertical jumping rounds, fast offense practices and various defencing drills. On the other hand, some exercises oriented to sport techniques were administered to the Physical Education group. In both groups, the participants' jumping and strength skills were compared before and after the training sessions.

The findings of the study revealed that the participants' horizontal-vertical jumping skills and right hand grip in the handball group developed more than the participants in the physical education group. However, it was pointed out that no significant difference existed in left hand grip strength (Oxyzoglou et al., 2007). Similarly, we can state that the reason for the positive development of EG dominant

hand statistically may stem from using dominant hand actively during BTP. In our study, EG pre-post test results revealed that the horizontal and vertical jumping mean values showed a positive development but not found as statistically significant ($p>0.05$). It can be said that BTP was ineffective on the development of DS individuals' jumping skills. However, in Hamamioğlu and Çakmakçı's (2011) study, 40 male participants aged between 9-14 were divided into two groups, namely, the exercise group (20 participants) and the control group (20 participants); and the participants in the exercise group were trained for about 1.5 hours a day by implementing ball handling, pass techniques and drippling throughout 12 weeks involving 2 days a week to compare their skills in jumping (horizontal-vertical), flexibility, speed with the participants in the control group (20 individuals). During that period, the control group went on doing Physical education lessons. When pre-test and post-test results were examined, no significant difference was found between the groups regarding vertical jumping. However, horizontal jumping feature was found to have developed in the exercise group while it remained the same in the control group (Hamamioğlu and Çakmakçı, 2011). In addition to ball-handling exercises, we suggest that using pass techniques and drippling exercises may be effective in developing horizontal jumping feature. In another study, Kokkonen et al. (2007) carried out a research involving 38 university students. 38 participants were also divided into two groups; the exercise group (8 male, 11 female) and the control group (8 male, 11 female). The exercise group participants were made work out static stretching exercises directed for extremity major muscle groups. However, the control group (8 male, 11 female) did not attend any regular activity. The results of the study showed that in some skills, such as standing broad jump (2.3%), vertical jumping (6.7%) strength [knee flexion (15.3%) and extension (32.4%) one repetition maximum (1 RM] and maintenance in strength [1RM 60 % knee flexion (30.4%) and the number of extension (28.5%)]; the values obtained in the exercise group were much better than the control group revealing a significant difference between the two groups (Kokkonen et al., 2007). Considering two separate studies conducted by Hamamioğlu (2011) and Kokkonen et al. (2007), since the two studies' training periods (10-12 weeks) lasted much more time than the training sessions in our study we can state that long training periods may have affected DS individuals' horizontal and vertical jumping skills negatively.

In our study, EG pre and post-tests dominant hand grip strength was observed to have developed in a positive way ($p=.024$) although no significant difference was found out in CG ($p>0.05$). It was noted that there was a positive and high correlation between hand grip strength and functional performance, especially in self-care skills (Souza et al., 2012). Sensorial and motor tasks realized by hand individuals'

performance for survival in daily life (Priosti et al., 2013). Therefore, we can state that hand strength has a significant place to fulfil daily life activities. John et al. (2016) suggest hand grip and finger exercise programs for individuals with DS because of their joint laxity and hypotenuse muscular feature.

In our study, when CG pre-post test results on leg strength were examined, a decrease was observed in the mean values of leg strength test (p=.003) while no significant difference was found out after 8 weeks of training (p>0.05). After 8 weeks, the means of leg strength test (baseline: 25.36±12.56; after 8 weeks: 25.13±12.62) in the control group were found lower than the means of baseline. Therefore, a significant difference was found between pre-and post-tests in the control group (p=.003). The other parameters did not seen significant differences between pre-tests and post-tests in control group.

Regarding pre-and post-test leg strength test results of the exercise group, it can be said that there has been a development in the participants' leg strength. In this regard, we can conclude that ball-handling training programs may develop DS participants' low extremity strength.

Based on the comparison regarding pre- and post-training results of the exercise group, it can be stated that there has been a positive development; however, no significant difference has been come across between the control group and the post-test results. We consider that the reason for this situation may have occurred because of the different pre-test values numerically between the control and exercise group although no statistically significant difference was found (p>0.05). In this respect, we can note that extending training period may create a change on the results.

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