# AYAK ÇALIŞMALARININ BADMİNTON OYUNCULARININ KUVVET VE ÇEVİKLİK PARAMETRELERİ ÜZERİNDEKİ ETKİSİNİN ARAŞTIRILMASI

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## ÖZ

Bu araştırmanın amacı, 8-10 yaş grubu çocuklarda 12 haftalık badmintona özgü ayak çalışmalarının kuvvet ve çeviklik parametreleri üzerine etkilerini araştırmaktır. Araştırma grubunu oluşturan katılımcılar, ayak çalışmaları antrenman grubu (BF, n=35 17 erkek-18 kız), klasik badminton antrenman grubu (BC, n=34 19 erkek-15 kız) ve çalışma süresince herhangi bir fiziksel aktivitede bulunmayan kontrol grubu (KG, n=32 15 erkek-17 kız) şeklinde 3 gruba bölünmüş ve toplam 101 katılımcı üzerinde gerçekleştirilmiştir. BF ve BC gruplarına hazırlık ve temel antrenmanlar dönemi şeklinde toplam 16 hafta ve haftada 4 gün süre ile antrenman yaptırılmıştır. 4 haftalık hazırlık çalışmalarından sonra tüm grupların ön testleri gerçekleştirilmiştir. Ön testlerden sonra BC antrenman grubuna 12 hafta süre ile haftada 4 gün klasik badminton antrenman programı, BF antrenman grubuna da12 hafta ve haftada 4 günlük antrenman sürecinde, haftada 2 gün klasik badminton antrenmanı 2 gün de badmintona özgü ayak çalışmaları uygulanmıştır. Temel antrenman döneminde 8 hafta sonunda ara testler ve 12 hafta sonunda ise son testler gerçekleştirilmiştir. Verilerin değerlendirilmesinde SPSS 18.0 istatistik paket programı kullanılmıştır. Ön, ara ve son test ölçümleri arasında anlamlı bir fark olup olmadığını belirlemek için ANOVA (ReAnova) kullanılmıştır. Anlamlılık düzeyi ($p < 0.05$) olarak kabul edilmiştir. Çalışma sonucunda, her iki antrenman grubunu (BF-BC) oluşturan katılımcıların, kuvvet ve çeviklik parametrelerinde gelişme olduğu tespit edilmiştir. Bununla birlikte BF grubunu oluşturan katılımcıların BC grubuna göre dikey sıçrama, anaerobik güç, sırt kuvveti, 30 sn mekik çekme, illinois çeviklik, yanlara çeviklik (saha testi), 4 köşe çeviklik (saha testi) parametrelerinde istatistiki olarak anlamlı farklılıklar bulunmuştur. Sonuç olarak, badmintona özgü ayak çalışmalarının 8-10 yaş grubundaki çocuklarda kuvvet ve çeviklik performans parametreleri üzerinde olumlu etkileri olduğu söylenebilir.
**Anahtar Kelimeler:** Badminton, Ayak Çalışmaları, Kuvvet, Çeviklik

# INVESTIGATION THE EFFECT OF FOOTWORK ON STRENGTH AND AGILITY PARAMETERS OF BADMINTON PLAYERS

## ABSTRACT

The purpose of this study is to research the effects of 12-week footwork badminton trainings on strength and agility parameters of 8-10 age groups of children. Subjects of the research group have been divided into 3 groups as footwork badminton training group (BF, n=17 boys-18 girls), classical badminton training group (BC, n=19 boys-15 girls) and control group (CG, n=15 boys-17 girls), and it has been carried out on 101 subjects. BF and BC groups were trained 4 days a week for 16 weeks and as preparation and basic trainings period. After 4 weeks of preparation works, preliminary tests of all groups were carried out. After the preliminary tests, subjects of BC training group were applied classical badminton training program 4 days a week for 12 weeks, subjects of BF training group were applied 2 days classical badminton training and 2 days shadow badminton trainings in a week as during 12 weeks and 4-day training in a week. After 8 weeks, mid-term tests and after 12 weeks final tests were applied during basic training period. SPSS 18.0 statistical package program was used to evaluate the data. ANOVA (ReAnova) was used to determine whether there was a significant difference between pre-, middle- and post-test measurements. Significance level was admitted as ($p<0.05$). At the end of the study, statistically significant differences were found in the parameters of the subjects of BF group in terms of vertical jump, anaerobic power, back strength, 30 sec sit-up, Illinois agility, side to side agility, 4-corner agility. As a result, it can be said that badminton footwork training has positive effects on strength and agility performance parameters in children aged 8-10 years.
**Keywords:** Agility, Badminton, Footwork, Strength

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# INTRODUCTION

With a long history and now part of the modern Olympic Games, badminton is a contact-free racket sport that requires jumps, direction changes and fast arm movements that can be played by two or four people on a rectangular court[1,2]. In badminton there is a well-known maxim: If the athlete's foot movement is fast, regular, rhythmic and harmonious he will be successful[3].

In very short rallies in badminton, reaching each zone of the court and returning to the center is a very important factor. Testing the ability of the athlete to accomplish this is also possible through stepping exercises and biomotor studies on the feet. Kale (2011) reports that from time to time, exercise and stroke techniques must be applied alternately in the exercise forms related to learning the technique[3]. The stepping, in the form of shifting the body from one place to the other with leg movements within a certain rhythm, is indispensable for the most effective application of the athlete's stroke techniques during the period between the start of the basic center position and the return to the basic center position during badminton play[3,4]. In a study of competition analysis, it was reported that the ball returned after 0.93 seconds from a stroke in the rally[5]. In other research, it was identified that the maximum speed of the badminton ball was measured at 421 km/h, the fastest ball in the world[6,7]. These values show how a hit is made in almost a second in rallies and how fast the game is played, which reveals the importance of badminton-specific foot movements and work in badminton sports. Although it has been indicated by some sources that the pacing exercises of footwork are used in foot exercises and constitute a considerable part of them[8,9], there is very little in the literature about special foot practice[10,11].

There are two purposes of this research. The main purpose of the study was to investigate the effects of a 12-week footwork badminton training course on the strength and agility performance parameters in children aged 8-10 years. In addition, the other objective was to compare the practice of footwork badminton with classic badminton practice to determine the frequency and duration of footwork badminton training in beginners at the sport.

# MATERIALS AND METHODS

## Participants

The research was conducted on students in the 8-10 age group. 101 students (50 girls and 51 boys) participated in the research, including the badminton footwork training group (BF, n=35, 17 boys and 18 girls), the classic badminton training group (BC, n= 34, 19 boys and 15 girls) and the control group (CG, n=32, 15 boys and 17 girls), that was not included in any physical activity during the research. The average age of the badminton foot training group (BF) was 9.64, the classical badminton training group (BC) was 8.70 and the control group (CG) was 9.52.

## Ethical Scope

Written permit for the study was obtained from “Necmettin Erbakan University, Meram Medical Faculty, Ethics Committee of non-Pharmaceuticals and non-Medical Device Researches” with the decision dated 2015 and numbered 2015/222.

**Procedures**

The study consisted of four days a week for 16 weeks of preparation and basic training periods. For four weeks, the badminton footwork training group and students in the classic badminton training group (n = 69) studied game rules and field knowledge and prepared for the transition to the basic techniques used in badminton and the in situ posture positions.

Pre-test was applied to all groups after four weeks of preparatory work. The classic badminton training program was applied to subjects of the classic badminton training group for 12 weeks. The classic badminton training program was applied to subjects of the footwork badminton training group for 12 weeks with four days of training per week, classic badminton training for two days and footwork badminton-training program for two days. The daily and weekly training intensity was assessed according to the athlete's training adaptation process and the relative intensity was increased. Intermediate tests were performed at the end of eight weeks and final tests were performed at the end of 12 weeks in the basic training period. A 15 min warm-up period was given before the tests started. With the exception of the 30 sec sit-up test, two measurements were made with 5-10 minutes rest intervals on each test battery and the best ratings were recorded.

**Applied Tests**

**Leg Strength:** A Takei brand dynamometer was used to determine leg strength. After the subjects placed their legs on the dynamometer stand in a twisted position with their knees bent, they were asked to pull the dynamometer bar vertically with their hands using their maximum strength while the arms were stretched, the back straight and the body inclined slightly forward. The value after the traction was read and recorded in kg[12].

**Back Strength:** A Takei brand dynamometer was used to determine back strength. After the subjects placed their legs on the dynamometer stand with the knees in a stretched position, they pulled the dynamometer bar vertically upwards to the maximum position, with the arms stretched, the back straight and the body slightly forward. The value after the traction was read and recorded in kg[12].

**30 sec Sit-Up Test:** The legs of the tines are attached to the crotch, the knees are twisted (90 degrees) in the length of the handles, and the body is seated in the upright position, allowing the legs to move by gripping the backs of the shoulders and hands with the help of the knees. For 30 seconds, the elbow was tied to the string and counted. The second trial was not done for this test[13].

**Vertical jump test:** Determined using the Takei brand vertical jumping gauge[14].

**Anaerobic power measurement:** Measurements of body weight with vertical jump distance (m) were determined by the Lewis formula using the resulting values[14].
(P=√4.9 * Body weight * √D) P= Anaerobic Power, D= Vertical jump distance (m).

**Side to Side Agility Test and 4-Corner Agility Test (Badminton field test):** Both tests were performed on the badminton courts to measure in-field agility. At the center of the badminton court (MN), participants stand in a ready position without a

racket in the hand. In the side to side agility test, subjects were desired to move on command quickly to the sides and to touch the points with the dominant hands mentioned above. The test was performed 10 times in total, five times each side.
In the 4-corner agility test, it is necessary to move quickly on command to the four corners of the court, and to touch specified points with the dominant hand. In both tests, the hand chronometer was started when the test began and stopped when the last point was again pressed to the center point. The resulting value was recorded in seconds[16].

**The Illinois Agility Test:** For the test carried out to determine agility, a track consisting of three rows arranged on a straight line with a width of 5 m, a length of 10 m and a width of 3.3 m in the middle section was established. With the subject in contact with the ground at the start of the course in the supine position and with the hand in the shoulder position, the command is given to rise from the ground and start running. The test scores of the subjects were measured with a New-Test 2000 photocell placed at the start and end points and recorded in seconds[15].

**Training Program**

Preparation Training Period (Weeks 1-4):
During this period, the same training program was applied to both training groups (BF and BC) for 60 minutes per day four days per week (Monday - Tuesday - Thursday - Friday). Necessary information about game features, the field and equipment is provided. The rules of the game are explained, and training for the development of the racket and ball is given. During these training sessions, children were prepared for badminton and played games for the workshops to be performed during the basic training period.

Training Period (Weeks 5-16):
Badminton footwork training program

| Days | | 1st day | 2nd day | 3rd day | 4th day |
|---|---|---|---|---|---|
| Time | | 60-65 minutes | 60-65 minutes | 60-65 minutes | 60-65 minutes |
| Aim | | Technical Exercise | Badminton Footwork+ Technical Exercise | Technical Exercise | Badminton Footwork + Technical Exercise |
| Badminton Footwork part | Total Time | 20 – 25 min. | | | |
| | Drill time | 10 sec. | | | |
| | Rest time between drills | 20 sec. | | | |
| | Set point | 2 - 4 | | | |
| | Rest time between sets | 1-2 min. | | | |
| Training Program | | --15' Warm-up run and gymnastic<br>-- 10' Serve exercises (short-long)<br>-- 10' Clear technical exercises<br>-- 10' Drop technical exercises<br>-- 10' free game + match<br>-- 3-5' cooling exercises | --15' Warm-up run and gymnastic<br>-- 10' Drive technical exercises<br>-- 20-25' badminton footwork training practice<br>According to running directions<br>• to the numbers 1-3, 1-4, 1-5, 3-4, 3-5 step exercises<br>-- 5-10' free game +match<br>-- 3-5' cooling exercises | --15' Warm-up run and gymnastic<br>-- 10' front of net-drop technical exercises<br>-- 10' front of net lob (lift) technical exercises<br>-- 10' repetition of technical exercises<br>-- 10' free game + match<br>-- 3-5' cooling exercises | --15' Warm-up run and gymnastic<br>-- 10' preliminary of smash exercises<br>-- 20-25' badminton footwork training practice<br>According to running directions<br>• to the numbers 4-5, 4-6, 4-8, 5-6, 5-8 step exercises<br>-- 5-10' free game +match<br>-- 3-5' cooling exercises |

**Statistical analysis**

SPSS 18.0 statistical package program was used to evaluate the data obtained within the scope of the research. Arithmetic mean and standard deviations were calculated and recorded. One-way analysis of variance was used for all age groups' averages. The ANOVA (ReAnova) was used to determine whether there was a significant difference between pre-, intermediate and post-test measurements according to the gender of the training groups and the control group and subjects. Significance level was taken as $p < 0.05$.

## FINDINGS

**Table 1.** Comparison of height, weight and body mass index results measured by gender of participants with training groups and control group

| Variables | | Badminton Footwork | | | Classic Badminton | | | Control Group | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Boy | Girl | Mean | Boy | Girl | Mean | Boy | Girl | Mean |
| Height (cm) | Beginning | 138,47 | 140,56 | 139,54 | 132,26 | 131,71 | 132,03 | 138,76 | 137,31 | 138,06 |
| | Week 8 | 139,65 | 141,44 | 140,57 | 133,05 | 132,79 | 132,94 | 139,47 | 139,38 | 139,42 |
| | Week 12 | 139,65 | 141,44 | 140,57 | 133,05 | 132,79 | 132,94 | 139,47 | 139,38 | 139,42 |
| Variables | | Badminton Footwork | | | Classic Badminton | | | Control Group | | |
| | | Boy | Girl | Mean | Boy | Girl | Mean | Boy | Girl | Mean |
| Weight (kg) | Beginning | 31,98 | 33,32 | 32,67 | 29,67 | 29,80 | 29,73 | 34,70 | 33,20 | 33,97 |
| | Week 8 | 33,31 | 34,33 | 33,84 | 30,57 | 30,74 | 30,65 | 35,72 | 33,79 | 34,78 |
| | Week 12 | 33,25 | 34,29 | 33,79 | 30,68 | 30,76 | 30,72 | 36,06 | 33,88 | 35,00 |
| Variables | | Badminton Footwork | | | Classic Badminton | | | Control Group | | |
| | | Boy | Girl | Mean | Boy | Girl | Mean | Boy | Girl | Mean |
| Body mass index ($kg/m^2$) | Beginning | 16,66 | 16,68 | 16,67 | 16,88 | 17,14 | 16,99 | 17,91 | 17,44 | 17,68 |
| | Week 8 | 17,02 | 16,90 | 16,96 | 17,22 | 17,37 | 17,29 | 18,19 | 17,23 | 17,73 |
| | Week 12 | 17,02 | 16,93 | 16,97 | 17,14 | 17,16 | 17,15 | 18,33 | 17,30 | 17,83 |

Table 1 shows the results of height, body weight and body mass index measured at the eighth week and $12^{th}$ week of the practice, before exercise according to the genders of the training groups and control groups and subjects. The results of the ANOVA for repeated measures of whether there is a significant difference between the measurement results are shown in Table 2.

**Table 2.** Descriptive statistics of the results of height, weight and body mass index measured by genders of participants with training groups and control group

| | Variance sources | Sum of squares | Std | Avrg of squares | F | p |
|---|---|---|---|---|---|---|
| Height | Measurements | 83,052 | 2 | 41,526 | 38,828 | 0,000* |
| | Between Groups | 3.284,032 | 2 | 1.642,016 | 12,468 | 0,000* |
| | Sex | 8,083 | 1 | 8,083 | 0,061 | 0,805 |
| | Group and Sex | 94,603 | 2 | 47,301 | 0,359 | 0,699 |
| Weight | Measurements | 67,392 | 2 | 33,696 | 88,269 | 0,000* |
| | Between Groups | 915,285 | 2 | 457,643 | 3,316 | 0,041* |
| | Sex | 3,142 | 1 | 3,142 | 0,023 | 0,880 |
| | Group and Sex | 118,357 | 2 | 59,178 | 0,429 | 0,653 |
| BMI | Measurements | 2,689 | 2 | 1,344 | 6,478 | 0,002* |
| | Between Groups | 39,467 | 2 | 19,734 | 0,929 | 0,398 |
| | Sex | 4,618 | 1 | 4,618 | 0,217 | 0,642 |
| | Group and Sex | 12,645 | 2 | 6,323 | 0,298 | 0,743 |

*p<.05

A significant difference was found between height, body weight and body mass index scores measured at three different time points ($p < 0.05$). There was no statistically significant difference between male and female children in terms of the gender factor of the classical badminton training group (BC) and the control group (CG) of footwork badminton training group (BF) participating in the study, while classical badminton was between length footwork badminton and control group, whereas in body weight, significant differences were found between classical badminton and the control group ($p < 0.05$).

**Table 3.** Comparison of strength and agility parameters measured by sex of training groups and control group

| Variables | | Badminton Footwork | | | Classic Badminton | | | Control Group | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Boy | Girl | Mean | Boy | Girl | Mean | Boy | Girl | Mean |
| Leg Strength (kg) | Beginning | 42,94 | 36,44 | 39,60 | 34,97 | 37,11 | 35,88 | 41,44 | 33,47 | 37,58 |
| | Week 8 | 47,50 | 40,17 | 43,73 | 40,21 | 38,71 | 39,58 | 41,35 | 34,56 | 38,06 |
| | Week 12 | 46,35 | 41,28 | 43,74 | 42,68 | 39,93 | 41,52 | 41,97 | 35,09 | 38,64 |
| | | Badminton Footwork | | | Classic Badminton | | | Control Group | | |
| | | Boy | Girl | Mean | Boy | Girl | Mean | Boy | Girl | Mean |
| Back Strength (kg) | Beginning | 35,21 | 30,08 | 32,57 | 28,29 | 29,61 | 28,85 | 34,38 | 27,78 | 31,18 |
| | Week 8 | 40,03 | 33,14 | 36,49 | 32,47 | 31,25 | 31,95 | 34,06 | 28,59 | 31,41 |
| | Week 12 | 39,65 | 34,00 | 36,74 | 34,71 | 32,07 | 33,59 | 34,12 | 28,81 | 31,55 |
| | | Badminton Footwork | | | Classic Badminton | | | Control Group | | |
| | | Boy | Girl | Mean | Boy | Girl | Mean | Boy | Girl | Mean |
| 30 sec Sit-Up Test | Beginning | 15,82 | 12,67 | 14,20 | 11,37 | 9,21 | 10,45 | 11,18 | 8,56 | 9,91 |
| | Week 8 | 17,41 | 15,22 | 16,29 | 12,16 | 10,00 | 11,24 | 11,00 | 9,13 | 10,09 |
| | Week 12 | 17,65 | 15,94 | 16,77 | 12,95 | 10,36 | 11,85 | 11,59 | 9,88 | 10,76 |
| | | Badminton footwork | | | Classic Badminton | | | Control Group | | |
| | | Boy | Girl | Mean | Boy | Girl | Mean | Boy | Girl | Mean |
| Vertical Jump (cm) | Beginning | 26,88 | 24,83 | 25,83 | 26,21 | 22,71 | 24,73 | 26,41 | 26,31 | 26,36 |
| | Week 8 | 30,00 | 27,72 | 28,83 | 27,16 | 23,14 | 25,45 | 26,29 | 26,25 | 26,27 |
| | Week 12 | 34,29 | 31,00 | 32,60 | 30,00 | 24,86 | 27,82 | 27,29 | 26,50 | 26,91 |
| | | Badminton Footwork | | | Classic Badminton | | | Control Group | | |
| | | Boy | Girl | Mean | Boy | Girl | Mean | Boy | Girl | Mean |
| Anaerobic power (kg-m/sec) | Beginning | 36,53 | 36,48 | 36,51 | 33,19 | 31,46 | 32,46 | 39,26 | 37,51 | 38,41 |
| | Week 8 | 40,12 | 39,84 | 39,98 | 34,70 | 32,76 | 33,87 | 40,22 | 38,08 | 39,18 |
| | Week 12 | 42,79 | 41,90 | 42,33 | 36,73 | 33,94 | 35,54 | 41,44 | 38,45 | 39,99 |
| | | Badminton Footwork | | | Classic Badminton | | | Control Group | | |
| | | Boy | Girl | Mean | Boy | Girl | Mean | Boy | Girl | Mean |
| The Illinois Agility Test (Sec) | Beginning | 21,37 | 22,42 | 21,91 | 21,98 | 23,40 | 22,58 | 22,15 | 23,09 | 22,60 |
| | Week 8 | 20,79 | 21,78 | 21,30 | 21,55 | 23,26 | 22,27 | 22,16 | 22,96 | 22,55 |
| | Week 12 | 20,61 | 21,42 | 21,03 | 21,37 | 22,97 | 22,04 | 21,89 | 22,83 | 22,35 |
| | | Badminton Footwork | | | Classic Badminton | | | Control Group | | |
| | | Boy | Girl | Mean | Boy | Girl | Mean | Boy | Girl | Mean |
| Side to Side Agility Test (field test) (Sec) | Beginning | 21,97 | 22,99 | 22,49 | 24,29 | 25,08 | 24,63 | 23,59 | 23,57 | 23,58 |
| | Week 8 | 20,79 | 21,26 | 21,03 | 22,94 | 24,38 | 23,55 | 23,65 | 23,44 | 23,55 |
| | Week 12 | 20,39 | 20,89 | 20,65 | 22,78 | 24,18 | 23,37 | 23,80 | 23,53 | 23,67 |
| | | Badminton Footwork | | | Classic Badminton | | | Control Group | | |
| | | Boy | Girl | Mean | Boy | Girl | Mean | Boy | Girl | Mean |
| 4 Corner Agility Test (field test) (Sec) | Beginning | 51,39 | 51,51 | 51,45 | 57,02 | 56,95 | 56,99 | 52,88 | 53,64 | 53,25 |
| | Week 8 | 49,29 | 49,30 | 49,29 | 54,12 | 55,31 | 54,62 | 52,86 | 53,41 | 53,13 |
| | Week 12 | 47,70 | 48,23 | 47,97 | 52,65 | 54,44 | 53,41 | 52,42 | 52,93 | 52,67 |

The results of leg strength, back strength, 30 snack pull, vertical jump, anaerobic power, Illinois agility, lateral agility, and 4-corner agility test results measured at the eighth and 12$^{th}$ weeks of practice are shown in Table 4 before exercise according to the gender of the training groups and control groups. The ANOVA for repeated measures was used to determine whether there was a significant difference between the measurement results and the values for the descriptive statistics are shown in Table 4.

**Table 4.** Descriptive statistics of strength and agility parameters measured by sex of participants with training groups and control groups

| | Variance sources | Sum of squares | Std | Average of squares | F | p |
|---|---|---|---|---|---|---|
| Leg Strength | Measurements | 668,375 | 2 | 334,188 | 72,432 | 0,000* |
| | Between Groups | 1.133,686 | 2 | 566,843 | 2,315 | 0,104 |
| | Sex | 1.686,446 | 1 | 1.686,446 | 6,887 | 0,010* |
| | Group and Sex | 608,435 | 2 | 304,218 | 1,242 | 0,293 |
| Back Strength | Measurements | 500,703 | 2 | 250,352 | 66,872 | 0,000* |
| | Between Groups | 1.096,341 | 2 | 548,171 | 3,758 | 0,027* |
| | Sex | 1.308,268 | 1 | 1.308,268 | 8,970 | 0,004* |
| | Group and Sex | 408,728 | 2 | 204,364 | 1,401 | 0,251 |
| 30 sec do sit-ups | Measurements | 129,968 | 2 | 64,984 | 58,367 | 0,000* |
| | Between Groups | 1.859,813 | 2 | 929,906 | 12,147 | 0,000* |
| | Sex | 376,325 | 1 | 376,325 | 4,916 | 0,029* |
| | Group and Sex | 1,141 | 2 | 0,571 | 0,007 | 0,993 |
| Vertical jump | Measurements | 606,338 | 2 | 303,169 | 62,120 | 0,000* |
| | Between Groups | 657,334 | 2 | 328,667 | 3,469 | 0,035* |
| | Sex | 416,916 | 1 | 416,916 | 4,401 | 0,039* |
| | Group and Sex | 187,987 | 2 | 93,993 | 0,992 | 0,375 |
| anaerobic power | Measurements | 603,353 | 2 | 301,677 | 96,962 | 0,000* |
| | Between Groups | 2.063,760 | 2 | 1.031,880 | 4,856 | 0,010* |
| | Sex | 196,564 | 1 | 196,564 | 0,925 | 0,339 |
| | Group and Sex | 56,461 | 2 | 28,230 | 0,133 | 0,876 |
| illinois agility | Measurements | 15,377 | 2 | 7,688 | 19,822 | 0,000* |
| | Between Groups | 97,45 | 1 | 97,45 | 15,76 | 0,000* |
| | Sex | 78,37 | 2 | 39,18 | 6,34 | 0,000* |
| | Group and Sex | 7,02 | 2 | 3,51 | 0,57 | 0,570 |
| side-to-side agility | Measurements | 56,717 | 2 | 28,358 | 90,206 | 0,000* |
| | Between Groups | 393,898 | 2 | 196,949 | 35,545 | 0,000* |
| | Sex | 24,375 | 1 | 24,375 | 4,399 | 0,039* |
| | Group and Sex | 23,675 | 2 | 11,838 | 2,136 | 0,124 |
| 4-corner agility | Measurements | 318,145 | 2 | 159,073 | 143,868 | 0,000* |
| | Between Groups | 1.571,30 | 2 | 785,653 | 12,669 | 0,000* |
| | Sex | 26,803 | 1 | 26,803 | 0,432 | 0,512 |
| | Group and Sex | 7,127 | 2 | 3,564 | 0,057 | 0,944 |

*p<.05

A significant difference was found between the results of leg strength test, back strength test, 30 sec do sit-ups test, vertical jump test, anaerobic power test, Illinois agility test, side agility test and 4-corner agility test results measured at three different times ($p < 0.05$). Leg strength test and 4-corner agility test results did not differ ($p > 0.05$), whereas back strength test, 30-sec do sit-ups test, vertical jump test, anaerobic power test, Illinois agility test and side agility test results were significantly different according to the gender of the subjects. Significant differences were found in the results of back strength, 30 sec do sit-ups test, Illinois agility test, side agility test, 4-corner agility test, vertical jump test and anaerobic power test ($p < 0.05$). In the results

of the anaerobic power measurement between the badminton footwork group and the classic badminton and control groups, the results of the classical badminton group and the badminton footwork and the control group were compared in the results of the differences, back strength test, 30 sec do sit-ups test, Illinois agility test, side-to-side agility test and 4-corner agility test results while in the vertical jump test it is between the classic badminton group and the footwork badminton group ($p < 0.05$).

## DISCUSSION

In the study, the effects of 12-week footwork badminton training on strength and agility performance parameters of 8-10 year old children were investigated. We also aimed to determine the frequency and duration of footwork badminton training for beginners by comparing badminton footwork weighted training with classical badminton training practices.

When the leg strength results were examined, there was no statistically significant difference in the results among all groups. In terms of the gender factor, it was observed that boys had higher values at statistically significant levels than girls. In addition, it was determined that the mean values of the leg strengths of the subjects constituting the training groups were increased and the values of the leg strengths were higher than those of the subjects constituting the CG. Karacabey and Derdin (2014) conducted a study on 200 boys and girls (11.1 years old) in order to determine the effects of physical development on exercise in summer sports school. The mean value of leg strength was 44.37 kg in the preliminary test and 51.20 kg at the end, a statistically significant improvement[17]. In another study, in which tennis athletes with a mean age of 10 were trained to move in groups and without a ball, the pre-test leg strength mean values were 49.07 kg and 45.73 kg respectively, while the 12-week post-test leg strength mean values were 53.08 kg and 47.73 kg[18]. The results of the research showed that the increase in leg strength values in children in both training groups was similar to that of children who regularly exercise their legs[19,20]. It was also determined that there was a similarity and a slight increase between the mean values in the measurements made at week eight and week 12 in the BF group. According to these results, it can be said that footwork badminton training for leg strength is effective in eight or 12 weeks of working time as well as training for longer periods if development is not at the desired level.

When the back strength results are examined, it can be seen that the mean value of the subjects in the BF group is higher at a statistically significant level than the girls in terms of the mean values of the subjects constituting the BC and CG, and the gender factor. In the research conducted on badminton players between the ages of 10 and 14, the average back strength of 44 badminton players, 22 boys and 22 girls, aged 10 years, was determined as 47.36 kg in boy badminton players and 39.43 kg in girls[21]. In another study conducted on the children who applied the exercise program within the scope of the summer sports school, the mean value of the back strength before the program was 45.52 kg and 52.44 kg at the end of the program and a statistically significant improvement was found[17]. In this study, it can be seen that the average values of back strength in the training groups increased, but they are slightly lower than the studies in the general literature. This can be explained by the fact that it may have been caused by minor age differences between the other studies and the study group. It was also determined that there was a similarity and a slight increase between

the mean values in the measurements made at week eight and week 12 in the BF group. According to these results, it can be said that badminton footwork training for back strength is significantly effective and may be sufficient in the eight week study period.

The abdominal strength of the subjects who participated in the study was determined by the 30 sec do sit-ups test. The gender factor was found to be significantly higher in boys compared to girls and the BF group was statistically higher than BC and CG. In a study conducted by children between the ages of 9 and 11 in Belgium, the average values of 30 sec of do sit-up were 25.3 in badminton players, 21.7 in tennis players, 22.6 in soccer players, 23.7 in swimmers, 22.9 in karate players, 19.8 in volleyball players, 22.1 in hockey athletes and 24.7 in gymnasts[22]. In another study of 1360 children aged 10 years, 680 girls and 680 boys, the mean value of 30 sec do sit-ups was reported as 14.6 in girls and 17.4 in boys[23]. In another similarly comprehensive study, Podstawski and Borysławski (2012) found that the average value of 30 sec do sit-ups of 1205 children, 621 girls and 584 boys in the age range 7-9, was 14.95 in girls and 15.42 in boys and that there was no significant difference between girls and boys[24]. Although the mean values obtained from the literature review are in agreement with the results of the research, it was determined that they are lower than the values obtained in some studies[25,26]. This may have been due to the lack of adequate abdominal strength training in the training programs of the children in the selected groups.

The explosive force characteristics of the subjects who participated in the study were determined by the vertical jump test, one of the performance indicators. When the literature is examined, it is reported that the mean value of the vertical jump is 17.27 cm in a study conducted on nine year old girls[27] and 18.03 cm in another survey on 1995 boys in the age range of 8-10 years[28]. The mean values of vertical jump were found to be 31.70 cm in the national badminton players and 27 cm in the badminton players at the amateur level in the study on male national and amateur badminton players with an average age of 11[29]. It can be seen that the subjects who constituted the CG in the study had similar results for all three measurements, while the average values of the subjects who formed the BF and the BC group were observed to increase. In addition, the fact that the average values of the vertical jump of the BF group subjects are higher than the BC group can be explained by the fact that footwork badminton exercises cause more explosive force increase in the leg muscles than classical badminton training.

When the anaerobic power results were examined, it was determined that the mean values of the BF group members were higher at a statistically significant level than the subjects forming the BC group. Although the mean values of anaerobic power of boys and girls are higher in favor of boys in terms of the gender factor, this difference is not statistically significant. In the study on athletes, the average anaerobic power was found to be 39.2 kg-m/sec in 10-year-old boy athletes and 35.6 kg-m/sec in girl athletes[30]. In another study on soccer players at provincial primary schools, the footballers who played in the teams that entered the first rank in the competition were statistically significantly higher compared to the footballers who played in the teams that were eliminated or in the last rank[31]. The anaerobic energy system in badminton sports is very important and it is observed that footwork badminton weighted training provides a significant increase in anaerobic power values during eight weeks of work.

However, 12 weeks of this training will have a positive effect on the performance development of the athletes.

When the results of the Illinois agility test are examined, it is seen that boys have higher values than girls at a statistically significant level in terms of the gender factor. When the literature is examined, it is reported that, in a study on badminton players, young national badminton players are more agile than amateur badminton players and agility performance may be an important determinant between elite and amateur badminton players[32]. In a study of 20 boys and 15 girls on a total of 35 subjects (11.1 years), the average Illinois agility test score was found to be 22.38 sec, indicating that muscle strength influenced agility positively[33]. In another study on young badminton players at the amateur level, the Illinois agility test average value was reported to be 20 sec in ladies and 17.9 sec in males[34]. It can be seen that these values in the literature review are lower (better) than the mean values obtained from our study. It can be considered that the values in this study were caused by differences in age and surplus during training. In addition, the fact that the average value of the Illinois agility test of subjects who formed the BF group is statistically significantly lower (better) than the mean values of subjects who constituted BC and CG may be a result of foot studies applied to subjects in footwork badminton training. It can be said that the increase in the results obtained as a result of the study may have been caused by the fact that the motorcycle characteristics of the badminton sport is a sporting event where the agility is in the forefront and this development is a natural result.

In-field agility performances were determined by badminton specific agility side to side and 4-corner agility tests. This test applied to Malaysian badminton players was evaluated both for validity and reliability and for convenience in practice. When the literature is examined, it can be seen that badminton is useful in determining in-field agility in sports but there are limited numbers of studies. Ooi et al. (2009) reported the mean values of the side to side agility tests as 15.3 sec and 15 sec, respectively and the 4-corner agility test of the same group as 32.4 sec and 32.9 sec, respectively, of the Malaysian elite and sub-elite male badminton players[16]. The mean test scores are much lower (better) than our study group. This can be explained by the fact that the Malaysian athletes were older and that they are competitors at the physical, physiologically high and International level. It can also be said that regular training has caused a significant increase in the athlete's side agility and 4-corner agility performances. Hazar (2005) conducted court cross-hitting and court cross-run tests to measure in-field agility in a study of girls and boys aged 10-13 years who were subjected to 14-week agility-weighted badminton and classical badminton practice. In the study, the mean values of the pre-test and post-test of the cross-hitting test dropped from 14.70 sec to 12.55 sec in the experimental group while it decreased from 15.8 sec to 14.05 sec in the control group. In the court cross-run test, pre-test and post-test mean values decreased from 17.37 sec to 13.74 sec in the experimental group and from 18.29 sec to 16.26 sec in the control group[11]. The study concluded that agility had significant effects on badminton performance, and that both in-field agility tests had significant and further significant relationships between the Illinois agility test and the shuttle running agility test (10*5 m). Similarly, Singh et al. (2011) stated that there is a significant relationship between agility and badminton performance[35]. The mean values of the subjects of the BF group on both in-field agility tests were statistically significantly higher than the mean values of the subjects of the BC and CG. This has also been seen in the Illinois agility test, and footwork badminton

training may be a result of footwork applied to subjects within training. According to the results of the Illinois agility test with both in-field agility the foot work in the BF group significantly increased the weighted training as an agility statistic and the trainers applied the footwork badminton exercises in their training programs to improve the agility feature, which is very important for badminton. It can be said that giving more prominence to such training could be beneficial.

## CONCLUSIONS

As a result of the study, it was found that the participants were at the age of development and that they continued regularly to the training and it was determined that the subjects forming both training groups (BF-BC) improved their strength and agility performance parameters. In addition, statistically significant differences were found in the vertical jump, anaerobic power, back strength, 30 sec do sit-ups, Illinois agility, side to side agility (field test) and 4-corner agility (field test) parameters of the BF group according to BC. When the gender factors of the subjects were evaluated, the average values of height, body weight, body mass index and 4-corner agility were similar between boys and girls. In addition, it was found that boys had better values in terms of anaerobic power and statistically significant differences than the girls in the average values of the leg strength, back strength, 30 sec do sit-up, vertical jump, Illinois agility, and side to side agility.

In addition to the technical training in badminton, we believe that the training of the athletes in foot movements and footwork badminton training practices is better than the classical badminton training of today. This is because, although it is necessary to have technical development in order to send the shuttlecock to the correct point in the game, it is necessary for the athlete to be in the right place and at the right time to be able to perform the appropriate technique. Considering the speed of the badminton ball, we also think that it is only possible to move continuously in the court with foot movements and especially with badminton foot working studies. As a result, it can be said that footwork badminton training has positive effects on the strength and agility performance parameters of 8-10 age group individuals.

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