

Investigation Of The Effects Of A 6-Week Circuit Training Program On Selected Performance Parameters In Futsal Players*

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ABSTRACT

Purpose: The purpose of this study was to investigate the effects of a 6-week circuit training program on selected performance parameters in male futsal players aged 14–16 years.

Method: A total of 20 male amateur futsal players (age: 14.55 ± 0.60 years; height: 170.10 ± 9.18 cm; body mass: 56.95 ± 8.41 kg; training age: 3.65 ± 0.81 years) participated in the study and underwent a 1-week general familiarization period. Following the familiarization period and baseline measurements, the players were randomly assigned to either an experimental group (EG, $n = 10$; age: 14.70 ± 0.48 years; height: 165.40 ± 7.67 cm; body mass: 51.60 ± 3.77 kg; training age: 3.70 ± 0.82 years) or a control group (CG, $n = 10$; age: 14.40 ± 0.69 years; height: 174.80 ± 8.36 cm; body mass: 62.30 ± 8.45 kg; training age: 3.60 ± 0.84 years). While both groups continued their regular futsal training, the experimental group additionally performed circuit training three days per week for six weeks. Performance assessments, including the 20-m sprint test, vertical jump test, and Illinois agility test, were conducted before (pre-test) and after (post-test) the 6-week training period.

Results: The normality of the obtained data was examined using the Shapiro-Wilk test, and it was determined that the data showed a normal distribution ($p > 0.05$). Pre-test and post-test results within groups were analyzed using the dependent groups t-test, while comparisons between groups were analyzed using the independent groups t-test. Statistical significance was accepted at $p < 0.05$. Significant differences were found within and between groups in the parameters of speed and vertical jump ($p < 0.05$). However, in the agility parameter, a significant difference was found within the group ($p < 0.05$), while no significant difference was found between the groups ($p > 0.05$).

Conclusion: The results indicate that a 6-week circuit training program has positive effects on performance parameters. Accordingly, circuit training may be integrated into training programs in a planned and controlled manner to support performance development in young futsal players.

Keywords: Futsal, Circuit Training, Agility, Anaerobic Power, Speed.

ÖZET

6 Haftalık Dairesel Antrenmanların Futsalcılarda Bazı Performans Parametreleri Üzerine Etkisinin İncelenmesi

Amaç: Bu çalışmanın amacı, 14-16 yaş arası erkek futsalcılarda 6 haftalık dairesel antrenmanların bazı performans parametrelerine olan etkilerini incelemektir.

Yöntem: Araştırmaya dâhil edilen 20 erkek amatör futsalcı (yaş: 14.55 ± 0.6 yıl; boy: 170.10 ± 9.18 cm; vücut ağırlığı: 56.95 ± 8.41 kg, antrenman yaşı: 3.65 ± 0.81 yıl) 1 haftalık genel uyum sürecine dâhil olmuştur. Genel uyum sürecinden sonra sporcuların ölçümleri alındıktan sonra, yansız atama yöntemiyle Deney grubu (DG, $n:10$; yaş: 14.70 ± 0.48 yıl; boy: 165.40 ± 7.67 cm; vücut ağırlığı: 51.60 ± 3.77 kg; antrenman yaşı: 3.70 ± 0.82 yıl) ve Kontrol grubu (KG, $n:10$; yaş: 14.40 ± 0.69 yıl; boy: 174.80 ± 8.36 cm; vücut ağırlığı: 62.30 ± 8.45 kg; Antrenman yaşı: 3.60 ± 0.84 yıl) olmak üzere 2 gruba ayrılmıştır. Her iki grup da düzenli futsal antrenmanlarına katılırken, deney grubuna ek olarak 6 hafta boyunca haftada 3 gün dairesel antrenmanlar uygulanmıştır. Çalışmada, 20 metre sürat testi, dikey sıçrama testi ve illinois çeviklik testi ölçümleri 6 haftalık çalışma öncesinde (ön test) ve sonrasında (son test) gerçekleştirilmiştir.

Bulgular: Elde edilen verilerin normallik analizi Shapiro-Wilk testi ile incelenmiş ve verilerin normal dağılım gösterdiği belirlenmiştir ($p > 0.05$). Değişkenlerin, grup içi ön test ve son test sonuçları bağımlı

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gruplar t testi ile gruplar arası karşılaştırmaları ise bağımsız gruplar t testi ile analiz edilmiştir. İstatistiksel anlamlılık $p < 0,05$ olarak kabul edilmiştir. Sürat ve dikey sıçrama parametrelerinde gruplar içinde ve gruplar arasında anlamlı farklılıklar bulunmuştur. Bununla birlikte, çeviklik parametresi için grup içinde anlamlı bir fark bulunurken ($p < 0,05$), gruplar arasında anlamlı bir fark bulunmamıştır ($p > 0,05$).

Sonuç: 6 haftalık dairesel antrenmanların performans parametreleri üzerinde olumlu etkiler yarattığı tespit edilmiştir. Bu doğrultuda, dairesel antrenmanların genç futsalcuların performans gelişimini desteklemek amacıyla antrenman programlarına planlı ve kontrollü bir şekilde entegre edilebileceği düşünülmektedir.

Anahtar Kelimeler: Futsal, Dairesel Antrenman, Çeviklik, Anaerobik Güç, Sürat.

INTRODUCTION

Futsal is an internationally recognised sport by UEFA and FIFA and is known as indoor football (Alvarez et al., 2009). Widely practised at a professional level worldwide, this sport stands out as one of the major sports disciplines (Ocak and Buğdaycı, 2012; Sert, 2015). In futsal, compared to football, the reduction in the number of players, the narrowing of the playing area, and the shortening of the duration have made it necessary for players to be more active and constantly involved in the game (Hermans and Engler, 2010). The fact that the game is played in a limited area requires athletes to run more to get into the right position, change places frequently, move quickly and make quick decisions, and be effective in one-on-one battles (FIFA. Fifa Futsal Rules 2015). In addition, the ability to skilfully apply attacking and defensive principles such as passing and support, creating space, width, depth, layering-support, intensity, balance, communication, mobility, and changing position, as well as creativity and high-level game intelligence, are considered fundamental characteristics of futsal players (Ocak and Buğdaycı, 2012).

Considering this game structure, it is evident that physical characteristics such as speed and agility are of critical importance for futsal players to perform optimally (Matos et al., 2008). In particular, repeated sprints over short distances, sudden acceleration and deceleration, and the need to change direction necessitate the development of these characteristics through training (Alvarez et al., 2009). The literature reports that training approaches targeting speed and agility development in futsal players have positive effects on performance (Göral, 2014; Moore et al., 2014). It is believed that improving these skills in athletes will increase the quality of the game. However, there is no consensus on how to maximize an athlete's performance in a more economical way (Ferioli et al., 2021; Gonsi, 2024; Alcaraz et al., 2011).

The circuit training method, which allows for the simultaneous development of multiple motor skills, is considered an effective training approach for high-tempo sports such as futsal (Koç, 2019). Circuit training consists of structured exercise sequences comprising different stations that aim to improve the performance of sport-specific skills as well as basic motor skills

(Brody & Hall, 2011; Mcardle et al., 2010). This method is widely preferred in sports science because it allows for the alternating training of muscle groups and ensures the efficient use of training time. In addition to the effects of circuit training on motor development, it has been reported that it also has positive contributions to athletes' motivation and training compliance (Muratlı et al., 2011). The vast majority of studies in the literature examining the effects of circuit training on performance have employed training programmes lasting 8–12 weeks (Koç, 2019). However, factors such as season planning, academic workload and time constraints, particularly among grassroots and amateur athletes, increase the need for shorter and more effective training programmes. Therefore, examining the effects of shorter interventions on performance is important in terms of training planning (Koç, 2019).

The aim of this study is to examine the effects of a 6-week circuit training programme on specific performance parameters in male futsal players aged 14–16. The potential contribution of this study to the literature is that it demonstrates that a relatively short-term training intervention can lead to significant improvements in some performance indicators. Considering that the vast majority of previous studies examining the effects of circuit training preferred application periods of 8–12 weeks, the fact that the 6-week programme applied in this study can provide similar physiological and physical adaptations can be considered a noteworthy finding in terms of the literature. In this context, it is thought that the results obtained may offer practical and applicable insights for training plans with time constraints, particularly for amateur futsal players.

METHODS

Research Design

A quantitative method was used in the study, and the pre-test - post-test control group design was preferred from among actual experimental research models. In this research model, measurements were taken before and after the experiment under equal conditions in groups formed by random assignment. The study was conducted with the written permission of the Scientific Research and Publication Ethics Committee of Iğdır University, numbered 2024/35.

Participants

The population of this study consists of amateur futsal players, while the sample comprises 20 male futsal players aged 14–16 residing in the province of Iğdır. To determine the minimum sample size for this study, a G*Power analysis was performed, referencing the work by Hermassi et al. (2020) (5% margin of error, 95% power), and the sample size was determined to be at least 9 individuals per group, totalling at least 18 individuals for both

groups. The study included athletes who competed in licensed futsal competitions as part of school sports during the 2024-2025 season, had not experienced any cardiovascular disorders in the last 6 months, and had no sports injuries. Participants were randomly assigned to experimental and control groups of 10 players each using a random assignment method; a total of 20 futsal players participated in the study. Assignments to the groups were made using the random assignment program random.org. Athletes participated in the study on a voluntary basis.

Data Collection Methods and Tools

Antropometrics Measurements

The athletes' body weight measurements were taken using a mechanical scale with 0.01 precision, and their height measurements were taken using a wall-mounted stadiometer. During the measurements, the athletes removed their shoes and were measured wearing shorts, T-shirts and socks.

Vertical Jump Test

The vertical jump test was measured using a flat wall. The vertical jump test measures the difference between the height a person can reach while standing still and the height they can reach by jumping. The participant approaches a predetermined wall and leans their shoulder against it. Their hands are chalked, and their feet are positioned shoulder-width apart. Before jumping, the participant marks the highest point they can reach with their hand. They then jump without taking a step and attempt to touch the highest point they can reach with their chalk-covered hand. The point they touch is recorded. Each participant performs two jump attempts, and their best score is evaluated (Yavuz et al., 2023; Alkan et al., 2022; Günay et al., 2013).

20 Meter Sprint Test

A 20-metre sprint test was used to measure sprint performance. Participants' test results were measured using an electronic photocell device (DolunayLED DK-386, Turkey). Each athlete started running from 0.5 metres behind the starting line without waiting for any starting command when they felt ready and completed the test by covering the 20-metre distance. Participants were asked to run at maximum speed and were given two attempts. The best result was evaluated. During the test, athletes wore a T-shirt, shorts, and indoor shoes (Apriantono et al., 2023; Cinthuja et al., 2015; Nakamura et al 2015).

Illinois Agility Test

This test consists of a slalom run between 40 metres of straight track and 20 metres of cones, along with five full 180-degree turns and six incomplete turns between cones. Athletes were required to start 0.5 metres behind the starting line and complete the test at maximum

speed. Each athlete was given two attempts with a 30-second rest interval between them, and their best scores were recorded (Selin et al., 2024; Hazır et al., 2010).

Training Program

During the 6-week study period, the control group underwent only futsal training, while the experimental group underwent a circuit training programme in addition to futsal training after warming up. The training programme was implemented at the Iğdır 15 July Martyrs Anatolian High School sports hall for 6 weeks, 3 days a week (Monday, Wednesday and Friday). The training programme was conducted at 75% of the participants' maximum number of repetitions at each station. To determine this ratio, participants were asked to perform the movements at the stations for 15 seconds, using their maximum number of repetitions. The number of repetitions achieved was accepted as the maximum number of repetitions for each participant for the movement at the relevant station. Subsequently, 75% of these values were calculated to determine the number of repetitions participants would perform during training. These calculations were performed separately for all stations and all participants. Participants were informed in advance of the number of repetitions they would perform at each station. A rest period of 40 to 60 seconds was applied between stations. Eight stations were considered one series. The training programme was carried out in a total of 3 series, with a 10-minute active rest period between series. Participants did not use any additional weights during the training. The stations were numbered and named; participants moved between stations in order during the circuit training.

Stations for Circuit Training

First Station, Jump Rope: At first, the subject may draw large circles and hop backwards with their feet to prevent the rope from tangling around their feet. If the subject consciously tries to achieve the ideal form while jumping rope, they will succeed in a short time. Second Station, Sit-ups: The subject can perform this exercise on the floor. The participant lies on their back on the floor with their knees bent at approximately 70 degrees and their hands crossed over their chest. Third Station, Hurdle Jump: The subject stands next to a 30 cm high hurdle on a flat surface. Upon command, they jump to the right and left with both feet. Fourth Station, Push-ups: The subject lies face down on the floor and then extends their arms. The body is supported with the hands flat on the floor and the toes on the floor. The back is straight and the head is positioned facing the participant. The hands are placed slightly in front of the body, shoulder-width apart or slightly wider, directly under the shoulders. The wider the hands, the more the chest is engaged and the less the back of the upper arms. Keeping the back straight, the participant lowers their body in a controlled manner by bending their elbows until their

chest touches the ground. The participant then raises their body back to the starting position. Fifth Station, Jack-Knife: The subject lies on their back on the floor. Their feet are turned out and their arms are at their sides. On command, they bring their arms and legs towards each other. Sixth Station, Jump Squat: The subject begins the exercise standing (arms may hang at their sides). The body and head are upright. The subject then bends their knees and lowers their hands towards their feet, then jumps up high. They then assume a squatting position and repeat. In this exercise, the subject uses their body weight. Seventh Station, Reverse Sit-Up (Superhero): The subject lies face down on the floor with their arms in front of their body. No partner is needed to hold the legs. The lifter quickly lifts their head, shoulders, chest, and legs off the ground at the same time. With their arms in the air and in front of their body, the exerciser looks like a flying superhero. Eighth Station, Commando Dance: The subject positions themselves with one leg forward and the other leg back, standing on a straight line. The distance between the two legs is approximately 50 cm. The hands are tied behind the head. Upon command, the subject jumps, switching the position of their legs back and forth. The leg in the front position is bent at a 90-degree angle.

Data Collection Process

In this study, participants underwent anthropometric measurements (age, height, body weight) and physical performance tests (20 m sprint test, vertical jump test, and Illinois agility test). One week prior to the start of the study, all participants underwent adaptation training (3 sessions) to ensure a proper understanding of the performance tests and strength training exercises, eliminate the learning effect, and identify any injury conditions. Following the adaptation training, the participants' anthropometric measurements (age, height, body weight) were taken first, followed by pre-tests for physical performance tests (20 m sprint test, vertical jump test, and Illinois agility test). After the pre-tests were completed, participants were assigned to the experimental and control groups using a random assignment programme (random.org). Statistical analysis was performed to determine whether there were any differences between the groups at baseline, and no differences were found between the pre-tests. Following random assignment, participants underwent a 6-week circuit training programme. After completing the 6-week programme, post-tests (physical performance tests) were administered under the same conditions as the pre-tests. The 6-week training programme and physical performance tests were conducted at the same time of day (15:00-17:00) to ensure that participants' circadian rhythms did not affect their performance. Participants were instructed to wear the same shoes for the pre-test and post-test. They were also asked to maintain their usual diet and sleep patterns.

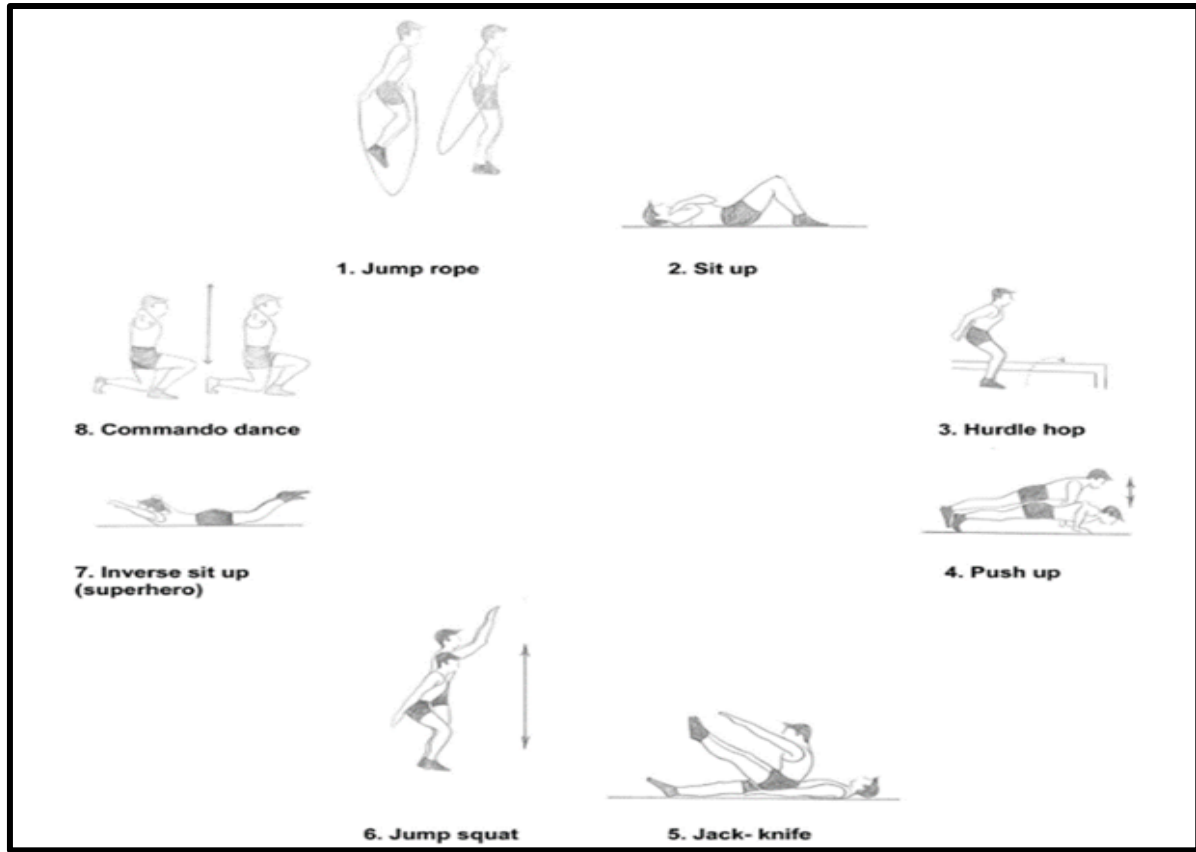


Figure 1. Circuit Training Stations (Taşkın, 2009).

Data Analysis

Data analysis was performed using the SPSS (Statistical Package for the Social Sciences) statistical programme. First, the Shapiro-Wilk test was applied to determine whether the data showed a normal distribution. According to the analysis results, since it was determined that the data followed a normal distribution, parametric tests were used. The T-test for dependent groups (Paired samples t-test) was used to examine the difference between the pre-test and post-test values within the group, while the t-test for independent groups (Independent samples t-test) was used to compare the pre-test and post-test values between groups. The percentage change over time for each variable was calculated using the formula ' $\% \Delta = (\text{Post-test} - \text{Pre-test}) / \text{Pre-test} * 100$ '. Effect sizes were calculated as Cohen's d to evaluate the changes between the pre-test and post-test in each group. Cohen's d values were interpreted as small (0.2), medium (0.5), and large (0.8), respectively (Cohen, 1988). The statistical significance level was set at $p < 0.05$ for all analyses.

RESULTS

Table 1. Descriptive statistics of participants by group

Anthropometric Characteristics	Groups	N	($\bar{X}\pm SS$)
Age (Years)	EG	10	14,70±0,48
	CG	10	14,40±0,69
	TOTAL	20	14,55±0,60
Height (cm)	EG	10	165,40±7,67
	CG	10	174,80±8,36
	TOTAL	20	170,10±9,18
Body Weight (kg)	EG	10	51,60±3,77
	CG	10	62,30±8,45
	TOTAL	20	56,95±8,41
Training Age (years)	EG	10	3,70±0,82
	CG	10	3,60±0,84
	TOTAL	20	3,65±0,81

CG: Control Group, EG: Experimental Group

Table 1 presents the anthropometric characteristics of futsal players in the experimental and control groups, including age (years), height (cm), body weight (kg), and training age (years). The mean age of participants in the experimental group (n=10) was 14.70±0.48 years, the mean height was 165.4±7.67 cm, the mean body weight was 51.60±3.77 kg, and the mean training age was 3.70±0.82 years. The mean age of participants in the control group (n=10) was 14.40±69 years, the mean height was 174.80±8.36 cm, the mean body weight was 62.30±8.45 kg, and the mean training age was 3.60±0.84 years.

Table 2. Pre-test and Post-test Speed Comparisons Within the Experimental and Control Groups

Groups	N	Pre Test ($\bar{X}\pm SS$)	Post Test ($\bar{X}\pm SS$)	t	df	$\Delta\%$	ES	p
CG	10	3,69 ± 0,25	3,68 ± 0,21	0,35	9	-0,27	0,11	0,73
EG	10	3,68 ± 0,25	3,37 ± 0,27	6,57	9	-8,42	2,08	0,001*

*p<0,05; CG: Control Group, EG: Experimental Group; ES: Effect Size

When examining the pre-test and post-test comparisons within groups in Table 2, a statistically significant difference was found in the pre-test and post-test speed values of the

experimental group (t: 6.57; p: 0.001; ES: 2.08, large; p<0.05), no statistically significant difference was found in the pre-test and post-test speed values of the control group (p>0.05).

Table 3. Pre-test and Post-test Comparisons of Vertical Jump Within the Experimental and Control Groups

Groups	N	Pre Test ($\bar{X}\pm SS$)	Post Test ($\bar{X}\pm SS$)	t	df	$\Delta\%$	ES	p
CG	10	33,10±4,20	33,10±4,95	0	9	0	0	1
EG	10	36,10±8,58	42,10±9,06	-5,8	9	16,6	-1,85	0,001*

*p<0,05; CG: Control Group; EG: Experimental Group, ES: Effect Size

Table 3 shows that when comparing the pre-test and post-test vertical jump values within the group, a statistically significant difference was found in the pre-test and post-test vertical jump values of the experimental group (t: -5.8; p: 0.001; ES: -1.85, large; p<0.05), no statistically significant difference was found in the pre-test and post-test vertical jump values of the control group (p>0.05).

Table 4. Pre-test and Post-test Agility Comparisons Within the Experimental and Control Groups

Groups	N	Pre Test ($\bar{X}\pm SS$)	Post Test ($\bar{X}\pm SS$)	t	df	$\Delta\%$	ES	p
CG	10	19,35±1,25	19,45±1,21	-,83	9	0,51	-,26	,42
EG	10	19,60±1,62	18,69±1,45	4,54	9	-4,64	1,43	0,001*

*p<0,05; CG: Control Group; EG: Experimental Group; ES: Effect Size.

When examining the pre-test and post-test comparisons of intra-group agility in Table 4, a statistically significant difference was found in the pre-test and post-test agility values of the experimental group (t: 4.54; p: 0.001; ES: 1.43, large; p<0.05), no statistically significant difference was found in the agility pre-test and post-test values of the control group (p>0.05).

Table 5. Pre-test and Post-test Comparisons of Speed Between the Experimental and Control Groups

Groups	N	CG ($\bar{X}\pm SS$)	EG ($\bar{X}\pm SS$)	t	df	ES	p
Pre Test	10	3,69 ± 0,25	3,68 ± 0,25	-,08	18	-0,03	0,93
Post Test	10	3,68 ± 0,21	3,37 ± 0,27	-2,73	18	-1,22	0,01*

*p<0,05; CG: Control Group; EG: Experimental Group; ES: Effect Size.

Table 5 shows that when comparing the pre-test and post-test speed values between groups, no statistically significant difference was found between the experimental and control groups in the pre-test speed values (p>0.05), while a statistically significant difference was found between the experimental and control groups in the post-test speed values (t: -2.73; p: 0.01; ES: -1.22, large; p<0.05).

Table 6. Pre-test and Post-test Comparisons of Vertical Jump Between the Experimental and Control Groups

Groups	N	CG ($\bar{X}\pm SS$)	EG ($\bar{X}\pm SS$)	t	df	ES	p
Pre Test	10	33,10 \pm 4,20	36,10 \pm 8,58	0,99	18	0,44	0,33
Post Test	10	33,10 \pm 4,95	42,10 \pm 9,06	2,75	18	1,23	0,013*

*p<0,05; CG: Control Group; EG: Experimental Group; ES: Effect Size.

Table 6 shows that when comparing the pre-test and post-test vertical jump values between groups, no statistically significant difference was found between the experimental and control groups in the pre-test vertical jump values ($p>0.05$), whereas a statistically significant difference was found between the experimental and control groups in the post-test vertical jump values ($t: 2.75$; $p: 0.013$; $ES: 1.23$, large; $p<0.05$).

Table 7. Pre-test and Post-test Comparisons of Agility Between the Experimental and Control Groups

Groups	N	CG ($\bar{X}\pm SS$)	EG ($\bar{X}\pm SS$)	t	df	ES	p
Pre Test	10	19,35 \pm 1,25	19,60 \pm 1,62	0,37	18	0,17	0,70
Post Test	10	19,45 \pm 1,21	18,69 \pm 1,45	-1,27	18	-0,57	0,21

*p<0,05; CG: Control Group; EG: Experimental Group; ES: Effect Size.

When examining the pre-test and post-test comparisons of agility between groups in Table 7, no statistically significant difference was found between the experimental and control groups in the pre-test and post-test agility values ($t: -1.27$; $p: 0.21$; $t: -0.57$, large; $p>0.05$).

DISCUSSION and CONCLUSION

This study aimed to investigate the effects of circuit training on physical performance parameters (speed, vertical jump, and agility) in futsal players. This study found significant differences in speed and vertical jump parameters within and between groups after 6 weeks of circuit training. However, while a significant difference was found within the group for the agility parameter ($p<0.05$), no significant difference was found between groups ($p>0.05$).

Effects of Circuit Training on Speed Performance

In this study, statistically significant improvement was observed in the 20 m speed test final test values of the experimental group participating in the circuit training programme compared to the control group ($p<0.05$). The absence of a significant difference in the pre-test data indicates that the improvement achieved can be attributed to the training programme. This finding supports the notion that circuit training can have positive effects on speed performance.

A review of the literature reveals that the findings obtained are largely consistent with previous studies. In this study, Adalı (2019) investigated the effect of an 8-week speed training programme on positive acceleration in male footballers. As a result of the 8-week circuit speed training programme applied to the athletes participating in the study, a significant improvement in the athletes' speed skills was observed in the 10-metre and 15-metre sprint tests. Kaur and Goswami (2019) reported that 12 weeks of circuit training resulted in significant improvements in students' speed performance. Similarly, a study by Koç (2019) demonstrated that high-intensity circuit training increased sprint performance. A study conducted by Taşkın (2009) examined the effects of an 8-station high-intensity circuit training programme, applied three days a week for 10 weeks, on the speed performance of 32 male university students. The study found a significant improvement in sprint performance in the experimental group. A study by Chaudhary and Jadon (2017) examined the effect of a 12-week circuit training programme on the speed performance of university students. The study found a statistically significant increase in the speed levels of individuals as a result of the circuit training programme applied to the experimental group. The physiological explanation for this increase in speed development can be attributed to the structure of circuit training, which involves multi-joint and functional movements. In a study by Akkaya et al. (2022), a circuit training programme was applied to female tennis players three days a week for 8 weeks. Statistically significant improvements in the performance of the experimental group were observed in the 5-metre and 10-metre sprint tests conducted after the training programme. Sonchan et al. (2017) and Ravi and Divya (2024) reported that 6–8-week programmes, in particular, optimise speed increases in young individuals. In this context, short-term circuit training can be considered a practical and effective method for improving speed in young futsal players. However, there are also studies in the literature that report no statistically significant improvement in speed performance following circuit or resistance-based training protocols. Jung and Lee (2017), in their 8-week high-intensity circuit training programme with university students, found significant improvements in muscle endurance and aerobic capacity, but did not find a statistically significant change in the 20-metre sprint test. Similarly, a systematic review and meta-analysis conducted by Ramos-Campo et al. (2021) reported that resistance circuit training has positive effects on body composition and cardiorespiratory fitness; however, subgroup analyses did not reveal any significant improvement in speed performance. Koç (2019). This finding suggests that the specific neuromuscular adaptations required for the development of sprint performance may not have been sufficiently stimulated by the general strength-based circuit training used in the study. Sprint performance relies not only on strength but also on multifaceted components

such as technical skill, reaction time, neuromuscular coordination, and explosive power. Therefore, training that does not target these multifaceted elements may be limited in terms of sprint development.

Effects of Circuit Training on Vertical Jump Performance

In this study, while no significant difference was observed between the pre-test vertical jump values of the experimental and control groups, a statistically significant improvement in favour of the experimental group was recorded in the post-test measurements ($p < 0.05$). The similarity of the pre-test values indicates that the difference in the post-test is attributable to the circuit training programme implemented. A review of the literature reveals that these findings are largely consistent with previous studies. Alcaraz et al. (2011), in their study comparing high-resistance circuit training with traditional strength training, found significant increases in vertical jump performance after 8 weeks of training. Similarly, Hermassi et al. (2020) reported in their study with elite handball players that a 12-week circuit strength training programme significantly improved vertical jump performance. In a study by Haliq (2015), low-intensity circuit training consisting of 6 stations, twice a week for 8 weeks, was implemented, and a significant improvement in vertical jump performance was observed. Kaur and Goswami (2019) demonstrated that a 12-week circuit training programme significantly increased explosive power parameters in school-aged individuals. Yuliandra et al. (2020) observed a statistically significant improvement ($p = 0.008$) in vertical jump performance in their 12-person experimental group who worked with a 4-station circuit training protocol.

Such training increases the strength, power, and endurance capacity of the lower limb muscles and improves the efficiency of fast-twitch motor units and motor unit synchronisation through multi-joint, functional, and high-intensity exercise content. Furthermore, it improves jumping performance by supporting neuromuscular adaptations that play a role in explosive power production. Similarly, in our study, the circuit training programme, applied three days a week for six weeks, significantly increased the lower limb explosive power of young individuals. At this point, the original contribution of our study to the literature is that meaningful development was achieved with a shorter programme (6 weeks). Compared to the 8–12-week programmes frequently encountered in the literature, the fact that our study achieved similar physiological adaptations in a shorter period can be considered a practical outcome that could offer flexibility in training planning.

Effects of Circuit Training on Agility Performance

In this study, a statistically significant difference was observed in the within-group (pre-test-post-test) comparison of the experimental group ($p < 0.05$), while no significant difference was observed in the within-group (pre-test-post-test) comparison of the control group ($p > 0.05$). It was determined that the difference observed in the experimental group was in favour of the post-test and that the participants' agility performance improved after 6 weeks. Furthermore, the study found no statistically significant difference in the participants' agility performance in the between-group (post-test) comparison ($p > 0.05$).

A review of the literature shows that the findings are largely consistent with previous studies. Ferioli et al. (2021) reported that an 8-week circuit strength training programme conducted twice a week on futsal players significantly improved agility performance. Similarly, Gonsi (2024) recorded statistically significant improvements in agility tests as a result of a 10-week circuit training protocol conducted three days a week. Adalı (2019) investigated the effect of an 8-week agility training programme on positive acceleration in male footballers. The 8-week circuit agility training programme administered to the participating athletes resulted in a significant improvement in agility skills. Rajković et al. (2014) demonstrated that 6-week training programmes improved agility performance in footballers. Taşkın (2009) observed significant improvements in agility performance with a high-intensity 8-station circuit training programme applied to 32 male university students. Similarly, Akkaya et al. (2022) recorded significant improvements in agility tests after 8 weeks of circuit training in a study conducted with tennis players aged 8-10 years.

Circuit training can directly contribute to agility performance by improving neuromuscular coordination, balance, and the ability to change direction, as it involves multi-directional movement patterns (e.g., burpees, lateral shuffles, squat jumps, direction change drills, etc.). It is known that short-term, high-intensity applications support the sudden acceleration and deceleration movements required for agility performance by increasing the activation of fast-twitch motor units. In line with this, the study presented statistically significant improvements in agility performance, similar to previous studies. However, unlike the 8–12 week programmes frequently encountered in the literature, the fact that statistically significant improvements in agility were achieved in this study with only a 6-week period increases the practical applicability of the study and provides a valuable contribution in terms of training planning. However, there are also studies in the literature that report no statistically significant improvement in agility performance following circuit training protocols. Similarly,

Chaudhary and Jadon (2017) implemented a circuit training programme consisting of 8 stations, 3 days a week for 12 weeks for university students; however, no significant improvement in agility performance was achieved in the experimental group. When the findings of this study are evaluated together, it is seen that circuit training protocols do not provide systematic and statistically significant improvement in agility performance. The main reason for this is that the concept of agility is a complex motor skill that requires not only the ability to change direction but also the multi-planar and high-speed use of explosive strength.

Consequently, based on the pre-test and post-test results, it was determined that 6 weeks of circuit training provided positive contributions to speed, vertical jump, and agility parameters in futsal players. These results emphasise that circuit training can be effective in developing fundamental motor skills such as speed, agility, and vertical jump, even in short-term applications. Based on the data obtained, it was concluded that the circuit training method could be used as an alternative training model to improve the physical performance of young futsal players in their developmental stage. In this context, there is a need for applied research to be conducted in future studies with longer durations and larger sample groups. It would be beneficial to conduct comparative studies by applying circuit training to different age groups, genders, and sports disciplines in order to evaluate its effects more comprehensively.

Suggestions

It is recommended that future studies in this field be conducted as applied research with longer durations and larger sample groups. It is thought that comparative studies would be beneficial, applying circuit training to different age groups, genders, and sports disciplines in order to evaluate its effects more comprehensively.

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