INTERNATIONAL JOURNAL of IJSETS SPORT, EXERCISE & TRAINING SCIENCES

e-ISSN 2149-8229 **Vol** 8, **Issue** 3, 94–102, (2022) *Original Article*

http://dergipark.gov.tr/useeabd

The Effect of Isoinertial Training on Jumping Performance on Young Football Players*

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Abstract

Aim: Strength and power-related variables are essential mechanisms of performance that require jumping in football. Isoinertial training has been an important training method for improving power performance. The aim of the study is to observe the effect of eight-week isoinertial training on jumping in young football players.

Methods: Twenty-four volunteer male football players playing in the Turkish Football Federation (TFF) U19 Development League 1st League group were divided into two groups as training group (age: 16.91±0.72 years, height: 176.42±6.02 cm, body weight: 71.17±7.11 kg, BMI: 23.80±2.20 kg/m^2) and isoinertial group (age: 16.83±0.39 years, height: 176.17±6.13 cm, body weight: 68.28±5.69 kg, BMI: 22.02±1.77 kg/m^2). The training group performed exercises consisting of four sets, six repetitions, and five movements (squat, right/left lunge, right/left side lunge) with their body weight. The isoinertial group performed, same training with the isoinertial training device at 80% of the maximal intensity. The training groups performed the exercises two days a week for eight weeks, a total of sixteen training, during the training period. We measured the athletes' performance with a jump meter (Takai, Japan) device before and after the eight-week training. Paired simple t-test was used to compare the pre-test and post-test of the groups. Independent simple t-test analysis was used for comparisons between groups.

Results: The jumping grades of the group isoinertial training have increased ($p<0.05$). However, the jumping grades of the training group not have increased ($p>0.05$).

Conclusion: The result of the research showed that the eight-week isoinertial exercises that the young football players will do in addition to their training increase the jump height.

Keywords:
Young football player,
Isoinertial training,
Jump training.

Yayın Bilgisi
Received: 07.07.2022
Accepted: 26.09.2022
Online Published: 27.09.2022

DOI: 10.18826/useeabd.1141536

Genç Futbolcularda İzoinertial Antrenmanların Sıçrama Performansına Etkisi

Özet

Amaç: Kuvvet ve güçle ilgili değişkenler, futbolda sıçramayı gerektiren temel performans mekanizmalarıdır. İzoinertial antrenman, güç performansının iyileştirilmesi için önemli bir antrenman yöntemidir. Bu nedenle bu çalışmada genç futbolcularda sekiz haftalık izoinertial antrenmanının sıçramaya etkisini araştırılmıştır.

Materyal ve Metot: Türkiye Futbol Federasyonu (TFF) U19 Gelişim Ligi, 1. Lig grubunda oynayan, gönüllü Yirmi dört erkek futbolcu, antrenman grubu (yaş: 16.9±0.717 yıl, boy: 176.42±6.02 cm, vücut ağırlığı: 71.17±7.11 kg, VKİ: 23.80±2.20 kg/m^2) ve izoinertial grubu (yaş: 16.83±0.39 yıl, boy:176.17±6.13 cm, vücut ağırlığı: 68.28±5.69 kg, VKİ:22.02±1.77 kg/m^2) olmak üzere iki gruba ayrılmıştır. Antrenman grubu vücut ağırlıkları ile dört set, altı tekrar ve beş hareketten (squat, sağ/sol lunge, sağ/sol yan lunge) oluşan egzersizleri yapmıştır. İzoinertial grubu, antrenman grubunun egzersizlerine ek olarak, izoinertial antrenman cihazı ile maksimum şiddetin %80'inde antrenman yapmıştır. Antrenman grupları, sekiz haftalık antrenman süresi boyunca haftada iki gün toplam on altı uygulama yapmıştır. Sekiz haftalık antrenmandan önce ve sonra sporcuların performansları sıçrama ölçer (Takai, Japonya) cihaz ile ölçülmüştür. Grupların ön ve son testlerinin karşılaştırılmasında bağımlı gruplarda t test kullanıldı. Gruplar arası karşılaştırmalarda bağımsız gruplarda t test analizi kullanıldı.

Bulgular: İzoinertial antrenmanları yapan grubunun sıçramaları artmıştır ($p<0.05$). Ancak antrenman grubunun sıçramalarında gelişim olmamıştır ($p>0.05$).

Sonuç: Araştırmanın sonucu, futbolcuların antrenmanlarına ek olarak yapacakları sekiz haftalık izoinertial egzersizler futbolcuların sıçrama yüksekliğini arttırmıştır.

Anahtar Kelimeler:
Genç futbolcu,
İzoinertial antrenmanı,
Sıçrama antrenmanı.

Article Info
Gönderi Tarihi: 07.07.2022
Kabul Tarihi: 26.09.2022
Online Yayın Tarihi: 27.09.2022

DOI:10.18826/useeabd.1141536

INTRODUCTION

Football is an intermittent high-performing team game in which very intense actions that include short sprints, acceleration, deceleration, change of direction, and jumps are united with low-intensity

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* Produced from PhD Thesis of Halil Korkmaz, Marmara University, Institute of Health Science

movements (Morgans et al., 2014; Egesoy & Yapıcı Öksüzoğlu, 2020). Being successful in this branch depends on some factors such as physical fitness, techniques, and tactics applied with or without the ball (Sporis et al, 2009).

Football players make an average of 2.2-18.5 hitting the ball or airball fights per game (Rampinini et al., 2009; Dellal et al., 2011). However, the head kick rate among all goals in the 2010 World Cup (FIFA, 2010), UEFA EURO 2012 (UEFA, 2012), 2014 World Cup (FIFA, 2014), UEFA EURO 2016 (UEFA, 2016), and 2018 World Cup (FIFA, 2018) varies between 19% and 22%. This figures show that the head kick is a technique that directly affects the result of the match (Sarajärvi et al., 2020). Heading requires a complex skill that includes good jumping height and coordination for the football player (Vint et al., 1996).

The vertical jump height of the football player is an important performance indicator for a good head kick (Marcolin & Petrone, 2007; Paoli et al., 2012). Vertical jump performance depends on the build of the legs' muscles, intramuscular harmony, and intermuscular harmony (Paoli et al., 2012). The traditional proven strength training is widely used to increase vertical jump height (Teo et al., 2016; Comfort et al., 2018). However, isoinertial training methods have been increasing in popularity to improve athletes' strength (Petré et al., 2018) and skills.

The strength produced in the exercise using the isoinertial device is equal to or greater than the force obtained using the traditional strength training equipment for the same practice (Prieto-Mondragón et al., 2016). Athletes determine the load that emerges from the potential energy acquired by the displacement of the weights they use in traditional strength training as the training load. However, in isoinertial exercises, athletes use the weight released from the moment created by the cycle of the wheel (Madruga-Parera et al., 2020). In other words, isoinertial exercises help to improve strength and power development. These kinds of practices somewhat use kinetic energy transferred to a flywheel that enables eccentric overload and variable resistance throughout the movement (Petré et al., 2018).

While isoinertial training, the strength generated in the eccentric contraction phase is converted into elastic tension energy and released in the stretch-shortening cycle. Higher generation of this force results in better power development (Toumi et al., 2004; Karsten et al., 2016; Loturco et al., 2016; Beato et al., 2020). In the last few years, many studies supporting resistance training have been released to contribute to the physical development of young athletes (Beato et al., 2020; Fiorilli et al., 2020).

Henrik Petre et al. stated in their study (2018) said that isoinertial training for athletes for 4-24 weeks showed statistically significant increases in all strength directions. Also, their meta-analysis study indicated that seven out of twenty studies had positive results for the effect of isoinertial training on functional tests in the vertical direction such as squat jumping, counter-movement jumping, or fall jumping (Petré et al., 2018). Also, Kale et al. (2019) stated that isoinertial training had positive results on sprinting and vertical and horizontal jump (Kale et al., 2019). Gonzalez et al. (2020) said that in their study that some studies indicated that isoinertial exercises programs helped to improve athletes' vertical jump after the application of one session per week (Raya-González et al., 2021a). Giovanni et al. (2020) also asserted that the findings obtained from the research showed that isoinertial eccentric overload training in football training was more effective than traditional methods in terms of all variables examined (Fiorilli et al., 2020). In addition, Mondragon et al. (2014) stated the crucial effects of isoinertial training technologies in the prevention of sports injuries (Prieto-Mondragón et al., 2016).

However, Tous-Fajardo et al. (2016) observed that isoinertial training performed once a week in an 11-week period increased the jumping performance in a study in which 24 football players from 18 national football teams of Spain participated.

In line with the importance of jumping performance in football, it is aimed to investigate the effect of isoinertial exercises that will be performed by infrastructure football players in addition to their training on jump performance (Tous-Fajardo et al., 2016).

Our study aimed to investigate the effect of performing exercises consisting of five movements (squat, right/left lunge, right/left side lunge) using an isoinertial device, two days a week, for eight weeks, before football training, on the jumping performance of young football players.

METHODS

Twenty-four licensed and trained male footballers in Tuzla sports U19 and U17 teams one of the Turkish Football Federation Development League (TFF) 1 League group teams, were included in the research voluntarily participated. The footballers were divided randomly into two groups as IG (age:16.83±0.389 years, height:176.17±6.132 cm, body weight:68.28±5.694 kg, BMI:22.02±1.766 kg/m2) and TG (age:16.91±0.717 years, height:176.42±6.022 cm, body weight:71.17±7.109 kg, BMI:23.80±2.200 kg/m2).

We received ethical approval from the Marmara University, Faculty of Medicine Ethics Committee for our study (06.03.2020/ 09.2020.233). The researchers applied the study protocol in line with the Declaration of Helsinki in the investigation.

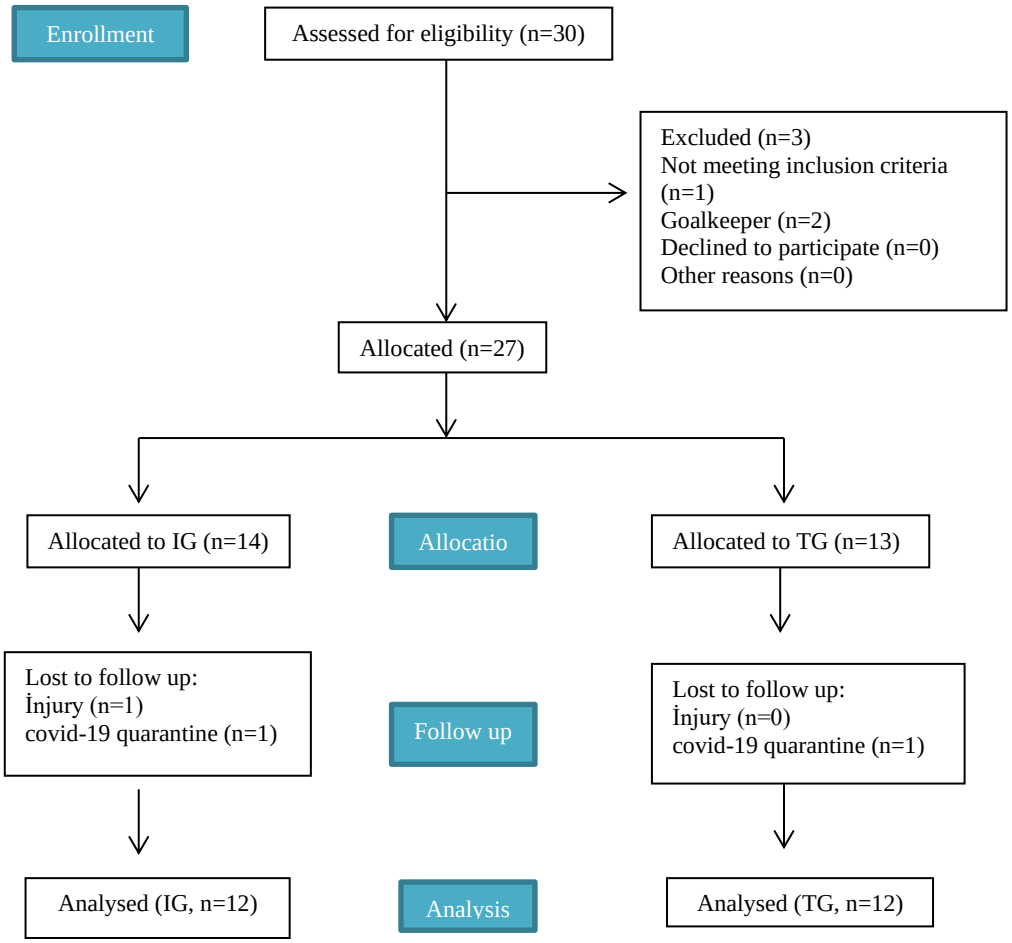

Figure 1. Consort diagram

IG = Isoinertial group TG = Training group

Design of the study

Trainings and measurements were made in Tuzla sports facility in Orhanlı. The first measurements were made on Tuesday, 23.02.2021. However, the first measurements were made again on Tuesday, 02.03.2021 due to the football players with positive Covid19 test results and the football players whose quarantine process was over. Pre-test and post-test measurements took 3 hours each. Athletes rested 48 hours before the measurements.

Young football players participating in the research were divided into two groups, isoinertial groups, and a training group. Before the applications started jump tests were conducted. Then, one repetition maximum of the isoinertial group in the isoinertial exercise device was determined. In addition

to their training, the isoinertial group performed exercises consisting of five movements (squat, right/left lunge, right/left side lunge) with the isoinertial device before training. The isointernal group performed one repetition with 80% of the maximal intensity as four sets, six repetitions, eight weeks, two days a week for sixteen exercises before the training. Besides their training, the training group performed exercises consisting of five movements (squat, right/left lunge, right/left side lunge) to be done with their body weight before training. The training group performed the exercises in four sets of six repetitions, two days a week for eight weeks, before training for sixteen. After finalizing eight weeks of practice, the young footballers completed the exercise by performing the jumping posttests. In addition, the below equation was used to calculate the vertical jump advancement difference of the players (Silva, 2019).

[Mpost – Mpre] / Mpre x 100

MON	TUE	WED	THU	FRI	SAT	SUN
	Warm-up: 10 min İsoinertial Training & body weight strength training: 30 min	REST		Warm-up: 10 min İsoinertial Training & body weight strength training: 30 min	REST	REST
Strength (90 min) Warm-up: 15 min Strength training: 40 min Small sided games: 25 min Cool-down: 10 min	Endurance (60 min) Large sided game: 25 min Simulated game: 25 min Cool-down: 10 min		Speed (60 min) Warm-up: 15 min Speed training: 35 min Cool-down: 10 min	Tactical (60 min) Positional games: 20 min Tactical drills: 20 min Strategy: 10 min Cool-down: 10 min		

Figure 2. Training program

Participation criteria

The players participating in the study have a football player license issued by the Turkish Football Federation. For this reason, health examinations are carried out regularly every year. Football players who experienced knee or muscle injury in the last six months and did not regularly attend the 8-week training plan were not included in the study. TFF allowed only U19 matches from development leagues to be played due to the Covid19 pandemic rules. The U17 team did not play the weekend games and only practiced. The players participating in the study consist of the U17 team and the U19 team players who were not included in the match squad. Due to the Covid19 pandemic rules, football players with positive test results were excluded from the study.

Determination of Isoinertial Exercise Load

A Force Meter Sensor (PowrLink Loadcell) was connected to the waist belt of the isoinertial group while performing squat exercises on the isoinertial training device. Then, the maximal eccentric force loads were calculated and the weight wheels at the maximal load were determined. As a result, the isoinertial group was given exercises with weight wheels corresponding to 80% of their maximal intensities (Martinez-Aranda & Fernandez-Gonzalo, 2017).

Sample size determination

We applied the “t-test” analysis of the data obtained from the sample size. The researchers made two measurements for the two groups. We chose the values by taking references from similar studies, our hypothesis was bidirectional power magnitude (1-β)= 0.8, α=0.05, which is called the 1st type error or error level, and effect size(d) = 0.8. Using the G*Power 3.1.9.4 software, we calculated the sample size as 24 (12 training and 12 isoinertial groups) (Tous-Fajardo et al., 2016).

Jumping Test

We measured the jump test of the football players with a jump meter (Takai, Japan). In the jump test, the players placed their hands on either side of the waist and took a position with the feet shoulder-width apart. The football players' eyes focused forward, quickly bent their knees 90°, and then made a maximally vertical jump. The results of the football players in the jump test Comfort et al. (2013) stated

we recorded the highest degree achieved by the football players in centimeters from 3 trials (Comfort et al., 2013).

Statistical Analysis

The data were analyzed using the SPSS (Statistical Package for Social Sciences) Windows 24.0 program. The data we obtained from the research did show a normal distribution. Paired simple t-test was used to compare the pre-test and post-test of the groups. Independent simple t-test analysis was used for comparisons between groups. The researchers assessed the findings at the $p<0.05$ significance level.

RESULTS

Table 1: Comparison of the first tests and last tests of the isoinertial group

	N	Min.	Max.	Average	SD	t	p
first vertical jump	12	46	61	52	4,068	-3,073	0,011*
last vertical jump	12	47	64	55,08	4,602		

Table 1 illustrates that the first jump values of the isoenertial group were a minimum of 46 centimeters, a maximum of 61 centimeters, and the final values were minimum of 47 centimeters, a maximum of 64 centimeters. The study results displayed a significant difference between the vertical jump first and last tests of the isoneretial group ($p<0.05$).

Table 2: Comparison of the first tests and last tests of the training group

	N	Min.	Max.	Average	SD	t	p
first vertical jump	12	46	64	54,17	5,202	0,385	0,708
last vertical jump	12	46	64	53,67	5,742		

Table 2. The first jump values of the training group (TG) were 46 centimeters to 64 centimeters. The final jump values of this group were 46 centimeters to 64 centimeters. The findings indicated that the first vertical jump and last jump findings did not make a significant difference ($p>0.05$).

Table 3: Comparison of the groups first-test and last-test

Grups		N	Min.	Max.	Averrage	SD	t	p
IG	first vertical jump	12	46	61	52	4,068	-1,137	0,268
TG	first vertical jump	12	46	64	54,17	5,202		
IG	last vertical jump	12	47	64	55,08	4,602	0,667	0,512
TG	last vertical jump	12	46	64	53,67	5,742		

Table 3. No significant difference between the jumping first measurement findings and the last measurement findings of the groups ($p>0.05$).

Table 4: Comparison of the advancement differences between the groups

	Groups	N	Min.	Max.	Average.	SD	t	p
vertical jump advancement difference	IG	12	-1,85	24,49	6,09	7,059	2,13	0,045*
	TG	12	-9,8	23,08	-0,72	8,541		

Table 4 shows that the jump development differences of the groups were min -1,85 % max 24,49 % of IG; TG's min was -9.8%, max 23.08%. The results indicated a significant difference between the developmental difference values of the groups ($p<0.05$). The negative values shown in Table 4 show that the jump performance is less than the final test result of the first test. Therefore, the calculated vertical jump development difference average was negative.

DISCUSSION

The study investigated the effect of eight-week isoinertial training on jumping in young football players.

Recently, high-intensity movements have increased in football games. These movements play a decisive role in affecting the game's results (Barnes et al., 2014). Football players need to successfully perform football techniques to manage to apply these movements effectively. One of the techniques used in football is the head kick. Heading comprise approximately 20% of the goals in football games (Simiyu, 2013). As the vertical jump distance of the football player increases, a positive increase is noticed in the heading performance of the football player (Marcolin & Petrone, 2007; Paoli et al., 2012).

Researches on football players indicate that isoinertial exercises can effectively increase the jump height of football players (Petré et al., 2018; Beato & Dello Iacono, 2020). Elastic potential energy use increases during the stretch-shortening cycle when football players perform isoinertial exercises. This situation can make a crucial contribution to the football players' jumping performance (Bridgeman et al., 2018).

The study by De Hoyo et al. (2015) asserted that isoinertial strength training in football players under the age of 17 showed an improvement of 7.6% in vertical jumps of football players. However, the findings of our study revealed a 7.06% improvement in the isoinertial training group. These findings support the findings of De Hoyo et al. (De Hoyo et al., 2015).

Training with isoinertial devices leads to a better performance improvement than conventional strength training after overloading at different joint angles and versatile movements (forward, backward and lateral) of the body. Previous studies revealed that young football players applying isoinertial exercise in their training made significant improvements strength in the lower extremities of their bodies (Suarez-Arrones et al., 2019; Nunez et al., 2019). Cabanillas et al. stated in their study (2020) that eight professional basketball players, aged between eighteen and twenty-five, improved a significant difference in their jump performance as a result of an eight-week isoinertial squat exercise (43.75 ± 1.65; $p<0.05$) (Cabanillas et al., 2020). Another study showed that semi-professional athletes did eight weeks of isoinertial training. The study results presented that the vertical jump performance of the athletes showed moderate improvement (Coratella et al., 2019). Another study stated that thirty-eight amateur football players continued two isoinertial training sessions per week for six weeks, the results indicated that the athletes' vertical jump performance improved significantly substantially (Sagelv et al., 2020). Another study's findings displayed that isoinertial training done twice a week for six weeks also had a moderate improvement in the jumping performance of young football players (Fiorilli et al., 2020).

Research on young football players indicate that eight to ten sessions of isoinertial exercises can slightly and moderately improve young footballers' jumping performance. In addition, literature reviews prove that isoinertial practices that continue 2-3 sessions per week help increase the jump levels of football players (Fiorilli et al., 2020; Cabanillas et al., 2020; Sagelv et al., 2020; De Hoyo et al., 2015a; Raya-González et al., 2021b). The findings of the studies confirm that isoinertial exercises increase the jumping performance of football players, athletes should practice with isoinertial devices (De Hoyo et al., 2015a; Maroto-Izquierdo et al., 2017; Gonzalo-Skok et al., 2017; Mangion, 2017; Petré et al.,2018; Beato & Dello Iacono, 2020).

Mangion's study in 2017 stated that the jump height of the football players who reached the elite level reached approximately 55 centimeter, which was a crucial criterion for the football players (Raya-González et al., 2021a). Our study's findings revealed that isoinertial exercises collectively with training would make significant contributions to the jump performance of the isoinertial group (55.08 ± 4.602 cm) to become the best athletes.

CONCLUSION

The study displayed that eight weeks of eccentric-isokinetic training was highly effective for improving the jumping of young football players. Based on these findings and literature, it is likely that more effective interventions can be developed to help football players and coaches optimize their strength training (Schärer et al., 2022). Therefore, our study may help prevent worthless strength training and provide jump performance improvement if isoinertial exercise is carefully observed and executed. It is

recommend that football coaches and coaching students about the importance of training isoinertial exercises, which affect the development of jump performance.

PRACTICAL APPLICATION

It can be said that isoinertial strength exercises combined with football training have a positive effect on the jumping performance of football players. However, instead of performing football-specific strength training in weight rooms, portable isoinertial training devices can be used in training fields. Through to this type of combined education training, more time can be devoted to technical training and strength training. In order to investigate the different effects of isoinertial strength training, it is recommended to conduct new studies at different periods of football period and with different training loads.

ACKNOWLEDGEMENT

I would like to thank Istanbul Gedik University sports sciences and Marmara University sport science application and research center for their contributions**.**

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