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**Research Article / Araştırma Makalesi**

# *The Effect of Six-week Bodyweight High-intensity Interval Training on the Performance of Young Female Athletes*

*Altı Haftalık Vücut Ağırlığı ile Uygulanan Yüksek Şiddetli İnterval Antrenmanın Genç Kadın Sporcularda Performans Üzerine Etkisi*

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**Abstract:** This study aimed to assess the impact of high-intensity interval training with bodyweight on the physical performance of young female athletes. Thirteen young female athletes participated in the study. Participants performed HIIT with bodyweight three times a week for six weeks, following five months of standardized training. The study examined participants' aerobic and anaerobic performance, including their countermovement jump (CMJ), 30-meter sprint, change of direction (COD), flexibility, weight, and body mass index (BMI). The study was designed as a single-blind, posttest-only, single-group repeated measurement study. All analyses were conducted with a 95% confidence interval, and a significance level was accepted as α = 0.05. The effect size (ES) was calculated according to Cohen's effect size. The study revealed statistically significant differences in all outputs except for BMI ($p < 0.05$). Bodyweight HIIT had a large to small effect on the following parameters: VO2max (d = 1.48), Illinois COD test (d = 0.93), 30-meter sprint (d = 0.78), CMJ (d = 0.75), flexibility (d = 0.63), BMI (d = 0.62), peak power (d = 0.61), weight loss (d = 0.58), mean power (d = 0.55). The study results indicated that HIIT with bodyweight could improve the performance of young female athletes.

**Keywords:** Athletic Performance, Exercise Program, High-Intensity Intermittent Exercises, Young Female.

**Öz:** Çalışma, vücut ağırlığı ile uygulanan yüksek şiddetli interval antrenmanın (HIIT) genç kadın sporcuların fiziksel performansı üzerindeki etkisini değerlendirmeyi amaçladı. Çalışmaya on üç genç kadın sporcu katıldı. Katılımcılar, beş aylık standardize antrenmanı takiben, altı hafta boyunca haftada üç kez vücut ağırlığıyla HIIT gerçekleştirdi. Çalışma, katılımcıların aktif sıçrama (CMJ), 30 m koşu, yön değiştirme (COD), esneklik, ağırlık ve vücut kütle indeksi (VKİ) dahil aerobik ve anerobik performanslarını inceledi. Çalışma tek kör, sadece son test, tek grup tekrarlı ölçümler olarak tasarlandı. Tüm analizler %95 güven aralığı ile yürütüldü ve anlamlılık seviyesi α = 0,05 olarak kabul edildi. Etki büyüklüğü (EB) Cohen'in etki büyüklüğüne göre hesaplandı. Çalışma, VKİ hariç tüm çıktılarda istatistiksel olarak anlamlı farklılıklar ortaya çıkardı ($p < 0,05$). Vücut ağırlığı ile uygulanan HIIT aşağıdaki parametreler üzerinde büyükten küçüğe etki gösterdi: $VO2_{max}$ (EB= 1,48), Illinois COD testi (d= 0,93), 30 m koşu (d= 0,78), CMJ (d= 0,75), esneklik (d= 0,63), VKİ (d= 0,62), zirve güç (d= 0,61), kilo kaybı (d= 0,58), ortalama güç (d= 0,55). Vücut ağırlığı ile uygulanan HIIT, genç kadın sporcularda performansı arttırabilir.

**Anahtar Kelimeler:** Atletik Performans, Egzersiz Programı, Yüksek Şiddetli İnterval Antrenman, Genç Kadın.

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**Introduction**

Endurance can be defined as the ability to resist fatigue or maintain a sport-specific task. Athletes' endurance level may affect the sport-related actions performed during the competition (Helgerud et al., 2001). For example, researchers observed significant improvements in football players (n = 19) following aerobic endurance training. These improvements included a 100% increase in linear sprint performance, a 6.7% improvement in running economy, a 24% enhancement in actions involving a ball, and a 20% increase in the covered distance (Helgerud et al., 2001). Similarly, it was reported that basketball players (n = 24) improved their chest pass skills (ES = 0.25) and shuttle sprint time with the ball (ES = 0.56) after endurance training (Aschendorf et al., 2019). In addition, these results were evaluated in relation to other team sports. The researchers stated that endurance performance could have an impact on sports-specific complex skills (Bishop and Girard, 2013). On the other hand, endurance performance can also contribute to developing motor skills. In one study, it was found that anaerobic endurance had a positive correlation with strength (r = 0.05), countermovement jump (r = 0.49), and squat jump (r = 0.55) performance (Alemdaroğlu, 2012). Similarly, researchers reported a strong correlation (r = 0.74 - 0.96, $p$ < 0.001) between anaerobic endurance and swimming sport-specific sprint ability (Hawley and Williams, 1991). The findings of these studies showed that endurance performance is an essential athletic performance component that needs to be developed.

High-intensity interval training (HIIT) is one of the training methods preferred by coaches to increase endurance performance. HIIT is based on the principle of combining fast-paced activities performed by high oxygen consumption with low-intensity rests (Gibala et al., 2012). In addition, HIIT is divided into running-centered and resistance-centered (Kilpatrick et al., 2014). While running-centered HIIT is defined as aerobic HIIT, resistance-centered HIIT is expressed as bodyweight HIIT (Kilpatrick et al., 2014). Many studies have investigated the effect of HIIT on motor skills (Alonso-Fernández et al., 2017; Martínez-Rodríguez et al., 2021), team sports (Aschendorf et al., 2019; Rowan et al., 2012), and different age groups (Engel et al., 2018; Stern et al., 2023). Previous studies stated that HIIT positively affects various performance components, age groups, and athletes (Aschendorf et al., 2019; Engel et al., 2018; Martínez-Rodríguez et al., 2021; Rowan et al., 2012; Stern et al., 2023). Although previous studies claimed that HIIT is an important method to increase athletic performance, there were controversial results regarding the effect of HIIT on gender (Engel et al., 2018). Many studies reported that HIIT positively affects the male population (Hannan et al., 2018). However, the researchers stated that the effect of HIIT on the male population was evaluated 5.5 times more than the female population (Hannan et al., 2018). Another systematic review and meta-analysis declared insufficient studies to interpret HIIT regarding gender (Engel et al., 2018). In addition, the researchers noted that the female athlete population is a highly unexplored group in exercise science and recommended that future studies be conducted on the female population (Engel et al., 2018). Other researchers reported similar recommendations (Astorino et al., 2012). Researchers emphasized that the effect of HIIT applied for more than three weeks on the performance of female athletes should be investigated (Astorino et al., 2012). HIIT is a basic method for athletic performance, and its effect on female athletes is still controversial. Therefore, evaluating the impact of HIIT on female athletes' performance should need for the subject area, coaches, and practitioners.

This study may offer an original approach to the literature in terms of evaluating female athletes, a group that has yet to be discovered in exercise science. The main aim of the study was to evaluate the effect of bodyweight HIIT versus standardized training on the physical performance of young female athletes and to compare training methods. We hypothesized that HIIT would increase physical performance and improve the



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anthropometric characteristics of young female athletes.

### *Material and Method*

### *Study Design*

While the study was designed according to a similar study protocol (Twist et al., 2022), the current study was based on the design of single-blind, posttest-only, single-group repeated measurement. Before the study, the participants received the same training five days a week for five months, and none of them participated in different training. Details of this training are given in Appendix 1. Pretest measurements were not taken as the inclusion criteria homogenized the participants. Posttest measurements were taken three days after participants followed a standard training protocol three days a week for six weeks. Participants were informed regarding the performance tests to reduce the learning effect, and each participant performed the performance tests at least once. Countermovement jump, Illinois agility test, and 30-meter sprint performance were measured on the first day, while anthropometric, flexibility, and yo-yo intermittent endurance test I performance were measured on the second. Participants were evaluated at the same times on both test days. To avoid fatigue, the rest periods after each test were left to the participant's preference, and the tests were continued when all participants declared that they were ready for the next test. Before tests, a standard warm-up was done for 15 minutes, and no stimulant use (e.g., caffeine, smoke, supplement) was allowed during the trial. After the measurements, the participants were given three days of rest. Then, the same participants performed HIIT thrice a week for six weeks, and posttest measurements were measured again. While one researcher included the study process, the other included the analysis process. The researcher who performed the performance tests was blinded to the study analyses, while the researcher who conducted the analysis was blinded to the intervention process. The flow diagram of the study process is given in Figure 1. The Reporting of Evaluations with Nonrandomized Designs (TREND) checklist was used to improve the reporting quality in the study. Detailed information on the checklist is given in Appendix-2. Open access to the working process documents was provided through the Open Science Framework (OSF).

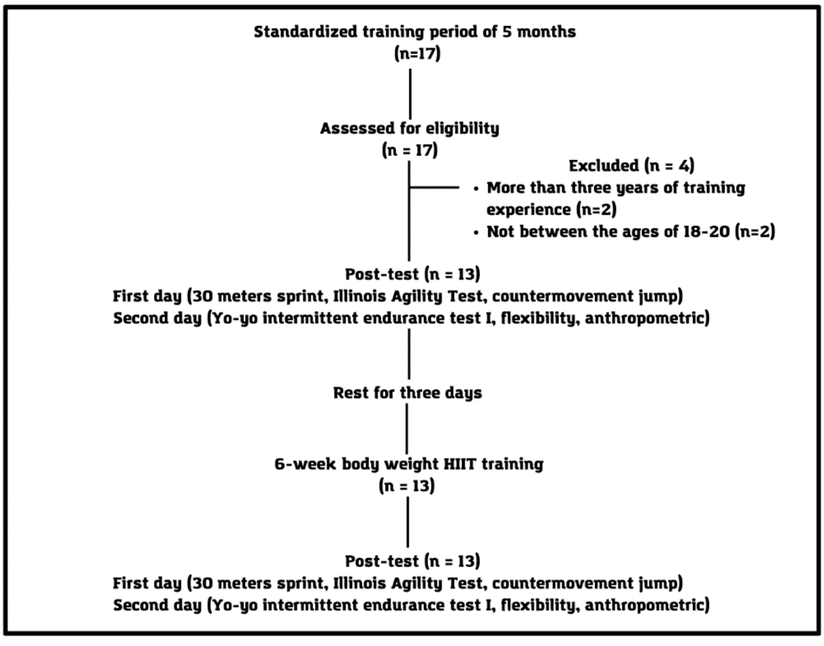


**Figure 1.** Flow diagram of the study process.



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### Participants

The purposive sampling method was preferred to determine the study's sample type. Seventeen participants were evaluated for eligibility. Four participants were excluded because they did not meet the inclusion criteria (Figure 1). Thirteen young female athletes who met the following criteria were included in the study; (i) young female athletes with a maximum of three years of training experience, (ii) between the ages of 18-20, (iii) without any injury in the last six months, (ii) healthy young female athletes.

G*Power (Duesseldorf University, Germany) package program was used to determine the sample size. Most researchers agree that HIIT positively affects different motor abilities. In addition, a very large effect on many motor abilities, such as anaerobic power, aerobic power, and strength, was reported in reference studies (Bauer et al., 2022; Martínez-Rodríguez et al., 2021). Therefore, a two-way hypothesis was established to identify the study's sample size, and power analysis was performed at the large effect level ($\alpha$ = 0.05, $\beta$ = 0.80, and effect size = 0.85). The power analysis results indicated that a minimum of 13 participants should be included in the study. As a result, 13 young female athletes who met the inclusion criteria, received the same training for five months and were preparing for the sports science exam of universities were included in the study. Detailed information on the anthropometric characteristics of the participants is given in Table 1.

**Table 1.** Anthropometric and physical characteristics of the participants (Mean ± SD).

| Age (y) | Height (cm) | Body Mass (kg) | BMI |
|---|---|---|---|
| 18.8± 0.8 | 167±4.84 | 61.5±8.73 | 22±2.23 |

***Note.*** Y: Years; cm: Centimeter; kg: Kilogram; BMI: Body mass index.

Before starting the study, the advantages and disadvantages of the training protocol were communicated to the participants verbally and in writing. However, participants were not given details about the experimental and control conditions. Moreover, the participants were assured that they could leave the research without being penalized for any reason. All protocols necessary for the study were designed following the Declaration of Helsinki, which allows the ethical use of human subjects. This research was approved by local ethical committee (Approval No: 2022/9).

### Procedure

*Vertical Jump Performance:* The vertical jump test was performed with a standardized protocol on the participants through the countermovement jump test (CMJ) (Martínez-Rodríguez et al., 2021). The CMJ performance of the participants was measured with a Takei jump meter. Participants were asked to use their arms, jump as high as possible, and fall onto the jump meter pad. The obtained data were also used to calculate the anaerobic peak and mean power. The formula PP= 60.7 × (jump height [cm]) + 45.3 × (body mass [kg]) − 2055 was used for peak power. The formula (21.2 x jump height (cm)) + (23.0 x body mass (kg)) – 1393 was preferred for mean power.

*Linear Sprint Performance:* In this study, the sprint performance of the participants was evaluated with the 30-meter sprint test. Two pairs of timing gate devices (the Newtest Powertimer 300, Finland, accuracy 1000Hz) were used to assess the 30-meter sprint performance. Timing gates were positioned 1 meter above the ground. When the participants felt ready on the hardwood floor, they started the test. Each participant's starting positions were standardized, and the athletes began the test 0.5 meters behind the timing gate.

*Change of Direction Performance:* The Illinois agility test was used to determine young female athletes' change of direction (COD) performance (Quezada-Muñoz et al., 2021). The test field was designed with four funnels arranged vertically at 3.3 meters distance and four corner funnels



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arranged around these funnels at five meters horizontally and 10 meters perpendicular. Athletes started testing 0.5 meters behind the timing gates when they felt ready. Participants were informed of the change of direction in the Illinois agility test. During the trial, participants changed direction and sprinted at 10-meter intervals. Test times were measured via timing gates (the Newtest Powertimer 300, Finland, accuracy 1000Hz). Timing gates were placed at a height of 1 meter from the ground.

*Anthropometry measurements:* This study used height and body weight measurements to evaluate anthropometric characteristics. While body weight was measured with a smart scale (Aprilla ABS 10809), a tape measure was used for height measurement. From these data, the body mass index values of the participants were determined according to the Body weight [kg] / Body Height [cm] ^ 2 formula. Anthropometric measurements were made in the morning hours. Participants were instructed to adopt an upright posture for height measurement, while kilograms were measured with T-shirts and shorts.

*Flexibility Performance:* The sit and reach test was preferred to evaluate the hamstring flexibility of the participants. Participants stretched their soles flat on the test bench on a bench with a length of 35 cm, a width of 45 cm, and a height of 32 cm. Participants leaned forward as far as possible without bending their knees and arms. The value at the last point reached is recorded. If the given instructions were not followed, the test was repeated.

*Aerobic Endurance Performance:* While many field tests measured $VO_{2max}$, Yo-yo Intermittent Endurance Test I, preferred in similar populations, was used in this study (Rowan et al., 2012). The participants tried to stay within the determined area until they heard the beep within the 20-meter area. The test of the participant who made three mistakes was terminated. Participants cut eating at least 3 hours before the test so that endurance performance was not affected. $VO_{2max}$ value was calculated according to the following formula on the running distance of the participants; $VO_{2max}$ (ml/min/kg) = distance run (m) × 0.0084 + 36.4.

**Table 2.** Six week HIIT programming with bodyweight resistance exercise.

| Exercises | Training Intensity | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 |
|---|---|---|---|---|---|---|---|
| | | Reps x Work (sec) x Rest (sec) | | | | | |
| Jumping Lunges | As fast as possible | 8x20x10 | 8x20x10 | 8x20x10 | 10x20x10 | 10x20x10 | 10x20x10 |
| Burpee with Star | | 8x20x10 | 8x20x10 | 8x20x10 | 10x20x10 | 10x20x10 | 10x20x10 |
| Mountain Climbers | | 8x20x10 | 8x20x10 | 8x20x10 | 10x20x10 | 10x20x10 | 10x20x10 |
| Jumping Squat | | 8x20x10 | 8x20x10 | 8x20x10 | 10x20x10 | 10x20x10 | 10x20x10 |
| Knee Tucks | | 8x20x10 | 8x20x10 | 8x20x10 | 10x20x10 | 10x20x10 | 10x20x10 |
| Explosive Surfer | | 8x20x10 | 8x20x10 | 8x20x10 | 10x20x10 | 10x20x10 | 10x20x10 |
| Knee Push-Up | | 8x20x10 | 8x20x10 | 8x20x10 | 10x20x10 | 10x20x10 | 10x20x10 |
| Push-Up | | 8x20x10 | 8x20x10 | 8x20x10 | 10x20x10 | 10x20x10 | 10x20x10 |

***Note.*** sec: Second.

### *Training Program*

The training protocol consisted of bodyweight HIIT for six weeks. The program design was adapted according to the protocol of a similar study (Mcrae et al., 2012). Participants performed the training protocol three days a week for six weeks. A 48-hour rest period was given between training sessions. The training includes eight exercises: push-ups, jumping lunges, burpee with star, jumping squats, knee tucks, explosive surfer, mountain climbers, and knee push-ups. Bodyweight HIIT was performed according to the Tabata protocol, based on the principle of 20 seconds of working and 10 seconds of rest. The



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time total of the bodyweight HIIT was determined as 8 minutes for the first three weeks, and as of the fourth week, the movement was performed for 10 minutes. Each training started with a standardized warm-up of 15 minutes and ended with a 5-minute cool-down activity. The training took about 25 minutes. Detailed information on the training protocol is given in Table 2.

***Data Analyses***

Statistical analyzes of the study were carried out with Jamovi 1.8.0, R (R Core Team), and G*Power (Duesseldorf University, Germany) package program. Normality distributions were checked with the Shapiro-Wilk test and skewness-kurtosis values. The normality distribution results showed that all data assumed normality except the 30-meter sprint and peak power (Appendix 3). In-group analyses of 30-meter sprint and peak power data were analyzed with the Wilcoxon test. Paired sample T-test was used in the analysis of other dependent variables. The statistical significance level was accepted as $p < 0.05$ in the analyses performed. The rate of change was calculated according to the following formula: ([Bodyweight HIIT value – Standardized five months training values] / Standardized five months training values) x 100. Effect sizes were evaluated according to Cohen's d formula and interpreted according to the specified reference values; (< 0.2) = trivial, (0.2 – 0.6) = small, (0.6 – 1.2) = moderate, (1.2 – 2.0) = large, (2.0 – 4.0) = very large and (> 4.0) = extremely large (Hopkins et al., 2009). The sensitivity analysis was performed to calculate the estimated effect size. The results indicated that the dependent variables' estimated effect level was moderate ($\alpha = 0.05$, $\beta = 0.80$, Total sample size = 13, estimated effect size = 0.86).

**Results**

A total of 13 moderately active young female athletes participated in this research. All of the participants were included in the pre-test and post-tests. No injury or injury related to the research protocol was encountered during the six-week HIIT protocol. Detailed information about the research results is given in Table 3 and Figure 2.

**Table 3.** Mean ± SD of biomotor parameters in the intervention group before and after the 6 week of HIIT

| **Valuable** | **Pre Test (n = 13)** | **Post Test (n = 13)** | **Comparison Within Group (*p*-value)** | **Percent Change (%)** | **ES (Cohen' d)** | **ES (Interpretation)** |
|---|---|---|---|---|---|---|
| Body weight (kg) | 61.5±8.73 | 59±7.01 | 0.002** | 4.06 ↓ | 0.58 | Small |
| $VO_{2max}$ (ml/kg/min) | 30.8±4.12 | 37.2±4.50 | 0.001** | 20.77 ↑ | 1.48 | Large |
| 30 Meters Sprint (sec) | 5.54±0.47 | 5.11±0.44 | 0.001** | 7.90 ↑ | 0.78 | Modarate |
| *Illinois* Test (sec) | 21.4±1.24 | 18.9±1.05 | 0.001** | 11.68 ↑ | 0.93 | Modarate |
| Flexibility (cm) | 39.5±5.06 | 41.6±5.35 | 0.001** | 5.04 ↓ | 0.63 | Modarate |
| CMJ (cm) | 37.6±4.03 | 41.9±4.93 | 0.001** | 10.26 ↑ | 0.75 | Modarate |
| Peak Power (watt) | 3010±392 | 3163±350 | 0.002** | 5.08 ↑ | 0.61 | Modarate |
| Mean Power (watt) | 817±191 | 853±158 | 0.004** | 4.40 ↑ | 0.55 | Small |
| BMI | 22±2.23 | 21.1±1.80 | 0.088 | 4.09 ↓ | 0.62 | Modarate |

***Note.*** **: $p < 0.01$; ES: Effect size; sec: Second; BMI: Body mass index; kg: kilogram; max: Maximum.

*Effect of bodyweight HIIT on weight loss and body mass index*

The HIIT applied with strength exercises at the end of 6 weeks created a statistically significant difference in the weight loss of young female athletes ($p = 0.002$). It was determined that this training protocol had a minor effect on the weight loss of young women, while a 4% change in weight loss of the participants was achieved (d = 0.58). However, the HIIT had a greater effect on the



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participant's body mass index, which was not statistically significant (*p* = 0.08, d = 0.62).

*Effect of bodyweight HIIT on vertical jump performance*

The vertical jump performance of the participants increased by 10% in the post-test. This performance increase was considered statistically significant (*p* < 0.001). The study's results showed that the HIIT with resistance exercises moderately affected CMJ performance (d = 0.75).

*Effect of bodyweight HIIT on change of direction speed performance*

COD performance results indicated a statistically significant difference (*p* < 0.001). The HIIT increased the COD performance of young female athletes by 11% and was found to have a moderate effect (d = 0.93). Similar results were observed in the sprint performance of young female athletes. While there was an approximately 8% increase in 30-meter sprint performance, a statistically significant difference was determined with a moderate effect (*p* < 0.001, d = 0.78).

*Effect of bodyweight HIIT on aerobic endurance performance*

The HIIT with resistance exercises had the greatest effect on the $VO_{2max}$ values of young female athletes (d = 1.48). While six weeks of HIIT provided a 20% improvement in endurance performance, the analysis results showed a statistically significant difference (*p* < 0.001).

*Effect of bodyweight HIIT on anaerobic endurance and flexibility performance*

On the other hand, a statistically significant difference was found for anaerobic power values (*p* = 0.002, *p* = 0.004). The HIIT allowed a moderate effect on the peak power of young female athletes (d = 0.61), while it had a minor impact on the average power values (d = 0.55). The 6-week HIIT moderately affected flexibility, which was considered statistically significant (*p* < 0.001, d = 0.63).



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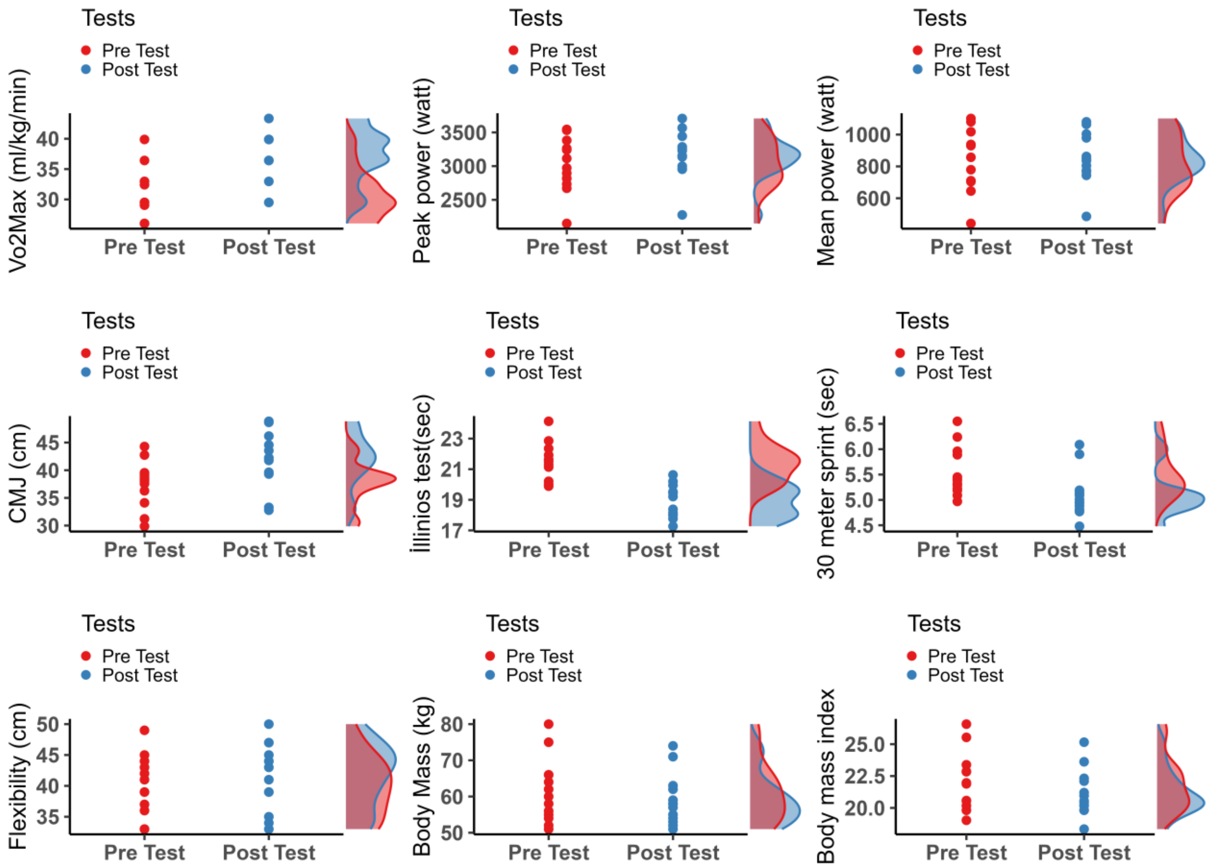


**Figure 2.** The effect of six week bodyweight HIIT on young female athletes.

## Discussion

This study examined the effect of bodyweight HIIT for six weeks on athletic performance in young female athletes. The results showed that bodyweight HIIT positively affected athletic performance at various levels. While body weight and mean power were below the expected effect size, other athletic performance components' effect sizes had at least 80% power.

Bodyweight HIIT improved the $VO_{2max}$ levels of young female athletes (d = 1.48). The improvement in $VO_{2max}$ observed in this study agreed with previous studies that performed a similar HIIT protocol in active women and team athlete females (Alonso-Fernández et al., 2017; Mcrae et al., 2012). Alonso-Fernández et al. (2017) reported that after eight weeks of HIIT combined with functional exercises, the $VO_{2max}$ levels of young female handball players improved by 6.19% and that the combined HIIT provided a moderate (d = 0.78) effect on $VO_{2max}$. Similarly, in a study involving 22 active women, aerobics and strength training were combined, and the study results indicated an 8% increase in the $VO_{2max}$ level of active women ($p < 0.05$) (Mcrae et al., 2012). The rise in $VO_{2max}$ levels with the bodyweight HIIT is explained by some mechanism (Astorino et al., 2012; Gibala et al., 2012). It is stated that bodyweight HIIT can provide an increase in peroxisome proliferator-activated receptor alpha (PGC)-1α activity. This receptor protein can trigger the adenosine triphosphate (ATP) production mechanism and allow mitochondrial biogenesis (Gibala et al., 2012). In addition, bodyweight HIIT can enhance $VO_{2max}$ levels by improving cardiac function or $O_2$ pulse (Astorino et al., 2012). These mechanisms may contribute to enhancing the $VO_{2max}$ level in young female



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athletes. The study's results also showed that peak power (d = 0.61) and mean power (d = 0.55) could be improved with Bodyweight HIIT (d = 0.55). Improving anaerobic performance with bodyweight HIIT is based on increasing the ability to move at high blood lactate concentrations, improving lactate buffering capacity, and stimulating supraspinal nervous system adaptations (Kinnunen et al., 2019; Laursen and Jenkins, 2002; Sporis et al., 2008).

On the other hand, bodyweight HIIT can contribute to body composition by providing 24-hour energy consumption and increasing calorie burn in individuals (Andreato et al., 2019; Falcone et al., 2015; Skelly et al., 2014). Researchers observed that HIIT versus continuous moderate-intensity training had similar oxygen consumption ($p > 0.05$) (Skelly et al., 2014). A similar study investigated the effects of HIIT, aerobic, and resistance training on calorie consumption (Falcone et al., 2015). Study results showed that resistance and HIIT increased calorie consumption compared to the others ($p < 0.05$) (Falcone et al., 2015). These results may explain the improvements in participants' weight loss and BMI levels.

Bodyweight HIIT had a moderately positive effect on the 30-meter sprint (d = 0.78), countermovement jump (d = 0.75), and COD (d = 0.93) performances of young female athletes at the end of 6 weeks. Discussions on these study findings have continued in the literature. Although some researchers claim that HIIT can affect sprint, vertical jump, and COD performance, others state that HIIT does not affect these abilities (Aschendorf et al., 2019; Engel et al., 2018). Some physiological mechanisms can explain these controversial results. Endurance training, such as HIIT training, stimulates mitochondrial biogenesis through intracellular metabolic reactions initiated by the activating protein kinase (AMPK) enzyme within the cell (Akın et al., 2018). In addition, this training also inhibits the mammalian target of the rapamycin protein complex (mTOR) enzyme, which effectively enhances the neuromuscular system and improves strength, speed, and agility performance (Nader, 2006). According to this information, it is concluded that there is an inverse relationship between the development of movement patterns that require high intensity and adaptations to endurance training. However, developing parallel endurance and strength parameters is possible with appropriate training design. Both endurance and strength-based abilities can be created simultaneously by combining strength and endurance exercises that incorporate appropriate loads (Baar, 2014; Petre et al., 2018; Wong et al., 2010). This situation is explained by concurrent training adaptations (Gravelle & Blessing, 2000; Hawley, 2009; Nader, 2006). In this study, the selection of body-weight HIIT training over running-based HIIT training may account for the performance improvements observed in test protocols that require explosiveness. In similar protocols, improvements were observed in participants' vertical jump, speed, and agility performances. It was also stated that endurance adaptations did not inhibit neuromuscular adaptations (Petre et al., 2018; Wong et al., 2010). Studies reported that these motor skills could be improved when appropriate loads are combined with endurance and resistance exercises (Baar, 2014; Petré et al., 2018), and this mechanism has been explained by concurrent training adaptations (Hawley and Williams, 1991). This study’s preference for Bodyweight HIIT may explain the increase in COD, sprint, and jump performance. In previous studies, improvement in the vertical jump, speed, and COD performances of participants was observed, and it was stated that endurance adaptations did not inhibit neuromuscular adaptations (Petré et al., 2018; Wong et al., 2010).

This study had some limitations. The study includes young female athletes between the ages of 18-20. Additionally, young female athletes did not have elite training experience. Therefore, there is a need for the study to be studied with female athletes in different age groups.

As a result, bodyweight HIIT can improve young female athletes' endurance performance and body composition. However, it should not be forgotten



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that as long as calorie deficit is created, both HIIT and continuous moderate-intensity training have similar effects on long-term fat loss and both are an important tool for body composition. In this case, HIIT can be considered a time-efficient alternative for managing weight loss. In addition, bodyweight HIIT can improve young female athletes' strength-based motor skills, such as COD, linear sprinting, and jumping. Field professionals, practitioners, and coaches may choose bodyweight HIIT over the long-term to improve their female athletes' athletic performance. Bodyweight HIIT, which is a safe and effective training method, should be progressively optimized according to the training period. While acknowledging the necessity for additional studies employing diverse approaches, including our own methodology, we contend that the proposal outlined in this study offers a straightforward approach to structuring and organizing bodyweight HIIT sessions. This study discussed possible mechanisms of how HIIT improves aerobic and anaerobic performance. However, the relationship between existing mechanisms and body weight HIIT needs to be supported by empirical evidence. Therefore, the effect of bodyweight HIIT training on biomarkers can be investigated. In this way, HIIT training can be comprehensively evaluated regarding possible mechanisms.

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