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Research article

Effect of HIIT on Motor Performance in Female Handball Players

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Abstract: The aim of this study was to investigate the effects of interval training at four different intensities in addition to handball training for 8 weeks on aerobic-anaerobic, speed and agility parameters in female handball players. Twenty female handball players (experimental group: 10; control group: 10) voluntarily participated in the studyThe experimental group trained in high-intensity interval training (HIIT) 3 days a week for 8 weeks in addition to handball training, while the control group was allowed to continue their standard training program. The anaerobic capacity, speed, and agility of the experimental and control groups were measured twice before and after an 8-week training program. The HIIT training program for the experimental group was adapted to the movements most commonly used in handball. The values of the data obtained from the handball players were analyzed. ANOVA for mixed measures was applied to determine the difference between the pre-test and post-test values of the experimental and control groups. There was a statistically significant difference ($p < 0.05$) between the pre and post-test values of the 20-m sprint test of the experimental and control groups of HIIT training for handball players, while there was no statistically significant difference between the pre and post-test values of the anaerobic capacity and agility test of HIIT training. In conclusion, it is recommended to include HIIT training in the training periodization of handball players during the season, and it is believed that it will have a positive effect on players' speed performance.

Keywords: high intensity interval training; speed; agility; handball.

Introduction

Handball is a rapidly developing and very popular sport at national and international levels. Like other team games, it is a friendly battle between two teams who dominate each other within the rules of the game [1]. The game of handball requires physical exertion of short duration and high intensity and depends on the development of high anaerobic power [2]. Tactical knowledge and technical skills, anthropometric characteristics, high levels of strength and muscular power are considered important factors for handball [3]. Although playing handball in itself can increase many of these factors, top players need to undergo handball-specific conditioning that includes aerobic exercise, exercises to develop speed, agility, strength and power in combination with a high-intensity interval training method [4,5].

HIIT, which is very popular today, is a promising aerobic fitness development workout that combines shorter and more intense workouts with short rest periods, in conjunction with various training methods to improve body image and performance [6,7]. High-intensity interval training (HIIT) is considered an effective form of training to improve both the metabolism and cardiovascular function of athletes. HIIT is practised in most

sports, including team and endurance sports, to improve variables of endurance capacity. It creates higher-intensity stimuli that are particularly suited to the needs of male athletes [8]. Its effectiveness has been proven in many studies [9, 10, 11, 12, 13, 14, 15, 16, 17]. Not only athletes but also coaches and fitness enthusiasts favour this training method [7].

HIIT increases the aerobic and anaerobic performance of athletes more than other training programmes and requires less time per training session [18]. Regardless of the type of HIIT programmes, VO 2 max, RSA [19], change of direction speed, speed [20], lower extremity explosive strength and body composition [17].

HIIT is more effective and safer than a moderate-intensity exercise programme and is considered to be a more enjoyable activity with a high number of participants and a more economical and efficient use of time. The development of physical fitness and aerobic capacity has attracted attention as an optimal exercise programme due to the prevention and development of lifestyle-related diseases [6, 7, 21, 22, 23].

When examining the research conducted in the sports field in recent years, it was found that it was generally aimed at increasing performance and success. Based on the fact that handball is the fastest and most endurance-intensive team sport, our study aimed to investigate the effects of interval training at different intensities on aerobic-anaerobic, speed and agility parameters in handball players.

2. Materials and Methods

2.1. Study participants

In this study, the experimental group: 16.80 ± 1.87 years, control group: 16.80 ± 1.87 years, control group: 16.80 ± 1.87 years, control group: 16.80 ± 1.87 years, control group: 16.70 ± 1.82 years, 20 female handball players participated as volunteers (Table 1). The volunteers were divided into two groups: the experimental group (n=10) and the control group (n=10). The experimental group completed 4 different HIIT training sessions. In the study, 4 HIIT training models with different levels of difficulty were performed for 8 weeks on 3 days per week for a total of 24 training sessions.

Table 1. Demographic characteristics of athletes

	n	Year (yıl)	Sport age (yıl)	Height (cm)	Body weight (kg)	BMI(kg/m²)
Control Group	10	16,70 ± 1,82	4.90 ± 1.91	168,33 ± 5.11	59,40 ± 9.97	21,10 ± 2.60
Experimental Group	10	16,80 ± 1,87	5.10 ± 1.91	166,50 ± 7.21	64,23±13.69	23,04 ± 4.19

2.2. Study organization

In data collection, the players were informed about the tests before they were carried out. During the performance of the tests, the players were verbally reminded with motivating sentences that they should raise their performance to a higher level to achieve the best results. For each test, the same measurement was performed with 2 repetitions and the highest measurement was recorded. In the female experimental group, 4 different training programmes were applied at the beginning of the training, 3 days per week for 8 weeks for a total of 24 training sessions (Table 1). No extra training programme was used in the control group. The studies were conducted in the Aksaray Sports Hall. The athletes in the experimental group who participated in the study were asked to perform at their best during HIIT training and verbal motivational incentives were used when necessary.

2.3. Data Collection

All measurements of the athletes were carried out in the Aksaray sports hall. The height of the players was measured barefoot and in an upright position using a measuring device with an accuracy of 0.1 cm. Body weight was measured with bare feet, shorts and T-shirt on a scale with a sensitivity of 0.1 kg. BMI was calculated based on the height and body weight of the subjects.

The athletes' T-drill agility test was measured using a Microgate brand photocell, model Witty. Athletes were asked to step out when they were ready while waiting at the starting point. After starting the test, athletes were asked to run 10 m forward, then 5 m to the right, 10 m to the left, 10 m to the left, 5 m to the right again with a laterally offset step and reach the centre, run 10 m backwards and return to the starting point. 2 measurements were taken and the best value was recorded.

Table 2. Training program contents

1. Aerobic Interval Continuous Training Programme	2. Extensive Interval Training Programme
60 s jump rope + 30 s isometric core + 30 s dynamic core x 12 station= 24 min	30 s jogging 30 s jumping jacks 30 s long jump 30 s 1-2-3 step 30 s but kicks 30 s high knees 30 s mummy kicks 3 set
HR measurement and 30 s break	HR measurement and 30 s break
7 min stretching	7 min stretching
30 min break	30 s break
20 s leg work + 10 s jump x 8 station (Tabata Protocol))	30 s hit the floor 30 s power squat 30 s mountain climbing 30 s ski down 30 s break 3 set
HR measurement and 30 s break	HR measurement and 30 s break
20 s leg work + 10 s jump x 8 istasyon (Tabata Protocol)	30 s scissors run 30 s skipping 30 s Handball shot 4 push up + 8 sprinting (4 repetitions) 30 s swing legs 30 s back and forth legs 30 s defense touches 30 s cross jacks 30 s break 3set
HR measurement and 30 s break	HR measurement and 30 s break
3 min stretching + Cool Down	3 min stretching + Cool Down

3. Intensive Interval Training Programme	4. High-Intensity Interval Training Programme
30 s jogging 30 s power jack 30 s long jump 30 s 1-2-3 step 30 s but kicks 30 s high knees 30 s vertical jumps — 3 set	30 s jogging 30 s jumping jack 30 s heisman 30 s 1-2-3 step 30 s but kicks 30 s high knees 30 s mummy kicks — 3 set
HR measurement and 30 s break	HR measurement and 30 s break
7 min stretching	7 min stretching
30 s break	30 s break
30 s power jump 30 s squat kick 30 s hit the floor 30 s V push up 30 s triceps dips 30 s one leg triceps dips — 3 set	60 s suicide drill 60 s swith kicks 60 s skipping 60 s stance jacks 60 s sprint-lungs 60 s side stepping 60 s power jacks
HR measurement and 30 s break	HR measurement and 30 s break
30 s hurdle jump 30 s square jump 30 s moving push up 30 s floor sprint 8 hop squat 8 push up — 3 set	8 push-up + 8 skipping + burpee 60 s frog jump 60 s power knees 60 s mountain climbing 60 s ski down 60 s scissors run 60 s burpee 60 s push up jacks
HR measurement and 30 s break	HR measurement and 30 s break
3 min stretching + Cool Down	3 min stretching + Cool Down

The 20 m sprint test was carried out with a Microgate brand photocell, model Witty. The athletes ran 20 metres at maximum speed and high power in a fixed 20-metre range. The test was repeated twice and the best value was recorded.

The 30-15 Intermittent Fitness Test is used to assess elements such as aerobic and anaerobic capacity, anaerobic speed level, recovery ability and the ability to change direction in athletes [24]. In the test, the athletes' heart rate (HR) was measured and recorded using a Kalenji 110 Polar watch. The athletes run from point A to points B and C, accompanied by a beep. They then change direction and run back to point A. During the 15-second pause, the athletes wait in a 3-metre area until the 15-second phase has elapsed. After 15 seconds, the athletes begin to run in their running direction from the 3-metre area where they are waiting. The test ends when the player stops running or fails to reach the 3-metre zones three times in succession at the same time as the beep.

2.3. Statistical analysis

The SPSS 17.0 package programme was used for the statistical analyses. The difference between the pretests of the experimental group and the control group, the difference between the posttests of the experimental group and the control group and the question of whether the groups were normally distributed were determined using parametric or nonparametric statistical analysis methods. The means and standard deviations of the data collected from the handball players were analysed. ANOVA for mixed measures was used to determine the difference between the pre-test and post-test values of the experimental and control groups. The significance value used was $p < 0.05$.

3. Results

In the study, the results of ANOVA for mixed measures for the effect of HIIT exercises applied to volunteers on BMI values are shown in Table 4.

Table 4. Effects of HIIT on variables

Variable	Group	N	Pre-test		Pro-test		F	p
			Mean	SD	Mean	SD		
BMI	Experimental	10	23,04	4,1934	22,782	3,91002	2,778	0,113
	Control	10	21,1	2,6098	21,181	2,66252		
T Drill Agility Test	Experimental	10	11,64	1,04015	11,131	1,34843	1,021	0,326
	Control	10	11,119	0,54171	10,82	0,93227		
20 m sprint test	Experimental	10	3,565	0,37161	3,469	0,35921	3,836	,046*
	Control	10	3,385	0,17475	3,356	0,18709		
HR	Experimental	10	186,6	7,4117	190,5	4,6007	0,192	0,667
	Control	10	188,1	10,7647	190,4	7,0742		
30-15 Intermittent Fitness Test	Experimental	10	15,51	3,48	16,11	3,66	0,36	0,556
	Control	10	16,39	3,4	16,69	3,79		

P<0.05

When Table 3 was analysed, a statistically significant difference was found between the 20 m sprint test pre- and post-test HIIT in the experimental and control groups ($F (1-18) =3.836$, $p < 0.05$). However, there was no statistically significant difference between the BMI, T-drill test, HR and 30-15 IFT test levels pre-test and pro-test, and there was no effect on the 30-15 IFT test levels ($F (1-18) =2.778$, $p> 0.05$; ($F (1-18) =1.021$, $p> 0.05$; $F (1-18) =.192$, $p> 0.05$ and $F(1-18)=.360$, $p> 0.05$, respectively). Accordingly, HIIT had a similar effect on BMI, t-drill test, HR and 30-15 IFT test scores, while it had a positive effect on 20 m sprint test values.

4. Discussion

The study was conducted to investigate the effects of interval training at different intensities on aerobic-anaerobic, speed and agility parameters in handball players. The results of the study show that high-intensity interval training increases the speed performance of female handball players and that there is a significant difference in mean speed values between the experimental and control groups. In addition, high-intensity interval training has a positive effect on the speed ability of female handball players. Iacono et al [12] reported that there was a significant difference in the mean values of the 10-metre running test of the high-intensity interval training group in elite female handball players. In a study conducted with football players, the effect of 8 weeks of high-intensity interval training on explosive power and aerobic capacity was investigated. A significant difference was found between the mean values of high-intensity interval training and the 30-metre sprint test [25]. Similarly, Akılveren [26] investigated the effects of 8 weeks of high-intensity interval training on speed, agility and aerobic capacity in football players and reported a positive increase between high-intensity interval training and the mean values of the 30-metre sprint test. Han et al [27] found a significant difference in straight sprint and standing long jump values in the experimental group compared to the control group after 12 weeks of high-intensity interval training and . Gaamouri et al [28] significantly improved sprint performance, change of direction test times, jumping performance, repeated sprint T-test values and 20 m shuttle run performance in young male handball players in an 8-week combination of HIIT and plyometric training. In another study in the literature, Fernandez et al [11] investigated the effects of high-intensity interval training and repeated sprint training on performance variables and found that there was no statistically significant difference between the mean values of high-intensity interval training and 20-metre sprint test.

In our study, no statistically significant difference was found between the values of the T-Drill agility test pre-test and post-test high-intensity interval training. However, the effect was clearly noticeable in the athletes. In one study, the agility of athletes was tested using the T-test. The result of the pre-test of the research group before fatigue was 10.74 ± 0.67 s and the result of the post-test after fatigue was 10.65 ± 0.73 s [29]. This study was similar to our study. In another study, the effect of high-intensity interval training on athletic performance of mid-season football players was investigated and it was found that there was no statistically significant difference between the mean values of high-intensity interval training and the agility test. Hammami et al [30] compared strength training and agility values in football players and found significant improvements in agility values. Hammami et al [31] found that 8 weeks of HIIT and plyometric training significantly improved sprint and agility performance as well as 20 m shuttle run performance in young male handball players. Our study investigated how agility develops as a result of the 8-week high-intensity interval training and which training programme is better at improving these parameters. The result of the analysis was that there was no statistically significant difference between the groups, although the mean values of agility improved after the test in the experimental group and the control group.

Another result of our study is that the average maximum heart rate (HRmax) in the experimental group, which was 186 ± 7.41 beats/min before the 8-week training programme, was 190.5 ± 4.60 beats/min after the training programme. In the control group, HRmax, which was 182.1 ± 5.04 beats/min before the 8-week training programme, was recorded as 190.4 ± 7.07 beats/min after training. There was no statistically significant difference between the data obtained pre-test and pro-test of the 8-week training. In a study similar to our study, the effect of 8 weeks of high-intensity training in elite athletes was investigated and the HRmax achieved was improved [32].

In the final result of our study, no statistically significant difference was found between the measurement of the 30-15 intermittent fitness test and the measurement of anaerobic

capacity pre-test and pro-test following high-intensity intermittent training. However, the effect was noticeable in athletes with a visible situation. In the 30-15 intermittent test we performed for the anaerobic capacity parameter, the average values of the experimental group (pre-test 15.51 ± 3.48 s; post-test 16.11 ± 3.66 s) and the average values of the control group (pre-test 16.39 ± 3.40 s; post-test 16.69 ± 3.79 s) were found. One of the studies in the literature testing different methods of high-intensity interval training reported that high-intensity interval training improved aerobic performance after strength training in football players [25]. Siahkouhian et. al [33] investigated the effect of high-intensity interval training on aerobic and anaerobic performance and found that there were significant increases in peak performance and average performance values. In another study, 2 HIIT protocols with different interval durations were shown to improve aerobic fitness and the ability to repeat high-intensity efforts with changes of direction in adult handball players during the preseason [34]. The study investigated the effects of 8 weeks of high-intensity interval training (HIIT) on male handball players under the age of 19. While the study found no statistically significant difference in speed, agility and aerobic-anaerobic capacity, it did show improvements in average values and speed performance. These results are consistent with some of the existing literature but differ from others. This demonstrates the complexity of the topic and the need for further research to fully understand the effects of HIIT on young female athletes. Further research is required to investigate this topic in more detail.

In conclusion, this study suggests that the inclusion of HIIT training in the training plan for female handball players during the season can have a positive effect on speed performance. The lack of significant differences in the non-numerical parameters could be due to factors such as the use of field tests and the high level of training of the athletes. However, the implementation of a training programme that focuses on the technical and tactical aspects of handball should be evaluated as it may lead to positive and significant differences between pre and post-test results. It is important to consider factors such as the athletes' training level, age, number of groups, and physical and mental strength as they can influence the results. It is also recommended to study HIIT both in-season and out-of-season to gain a full understanding of the effects on athletes.

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