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Research article

Effects of Tabata and HIIT Programs Regarding Body Composition and Endurance Performance among Female Handball Players

Ioana-Maria Curițianu [1], Ioan Turcu [2], Dan Iulian Alexe [3*], Cristina Ioana Alexe [3] and Dragoș Ioan Tohănean [2]

[1] Faculty of Physical Education and Mountain Sports, Department of Physical Education and Special Motility, Transilvania University of Brasov, 1 Universitatii Str., 500036, Brasov, Romania; ioana.curitianu@unitbv.ro;
[2] Faculty of Physical Education and Mountain Sports, Department of Motric Performance, Transilvania University of Brasov, 1 Universitatii Str., 500036, Brasov, Romania; ioan.turcu@unitbv.ro; dragos.tohanean@unitbv.ro;
[3] Faculty of Movement, Sport and Health Sciences, Department of Physical Education and Sports Performance, Vasile Alecsandri University of Bacau, 157 Marasesti Str., 600115, Bacau, Romania; cristinaioana.alexe@yahoo.com; alexedaniulian@ub.ro;
* Correspondence: alexedaniulian@ub.ro,

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Abstract: (1) Background: The purpose of the study was to analyze the effect of two different training modes towards the development of body composition, aerobic and anaerobic endurance of female handball players aged 18-23, in COVID-19 pandemic. (2) Methods: 18 female handball players from the second division were divided into two groups: Group 1 subjected to Tabata Program (n=9) and Group 2 trained using HIIT Program (n=9). (3) Results: Paired Sample T-Test was carried in the statistical analysis and the significance level was determined ($p < .005$). The group subjected to HIIT training achieved greater increases in endurance performance than the group carrying out Tabata training ($p < .005$). (4) Conclusions: Different results were obtained when studying changes regarding segmental analysis of upper, lower limbs and trunk. Both groups undergoing Tabata and HIIT training registered improvements.

Keywords: COVİD-19 pandemic; handball game; aerobic and anaerobic endurance; fitness programs

1. Introduction

Handball is a very strenuous body-contact sport characterized by highly developed motor skills such as speed, explosive power, endurance, and strength [1].

Anthropometric characteristics, such as body size, body mass, body mass index, and body fat percentage, play a highly important role when discussing sport success and results [2-4]. Body size has a strong positive effect on throwing performance and isometric strength [3, 4].

Moderate intensity aerobic exercise in outdoor environments with special attention to maintaining safe distance with others and surfaces may be a proper alternative. However, the hazards of high-intensity exercise in public gyms and crowded environments may outweigh the benefits and should be avoided [5].

A high aerobic capacity appears to be important to maintain a high level of performance over the 60 minutes of playing time. Aerobic capacity and maximal aerobic power can distinguish between women handball players of different levels: more aerobically resistant players are at a clear advantage during international handball competitions [6].

The effects of high-intensity interval training on the human body's aerobic energy-releasing system were thoroughly examined by Fox & Mathews [7, 8]. He showed that the improvement of the body's maximal oxygen uptake (VO_2max) after high-intensity interval training is linearly related to the oxygen demand (expressed as % VO_2max) of the high-intensity interval training, indicating that exercise intensity is a key factor for the improvement of the body's maximal aerobic power after high-intensity interval training [8, 9].

Intermittent training and interval training differ significantly, and it is important to keep in mind that Tabata training is an intermittent-exercise training method [10, 11].

In team sports like handball, players are characterized as strength-and-power athletes. Athletes are usually large and muscular. However, depending on the specific position, body composition varies slightly [12].

After a study upon the structural and functional characteristics of elite Croatian handball players, a strong negative correlation was found between body fat and maximal running speed. Experienced coaches can used this information in the process of designing a training program to maximize the fitness development of handball players, with one purpose only, to achieve success in handball [13].

Muscle strength is an important factor in handball performance [14]. Most researchers agree that higher maximal power and strength may be associated with an advantage in blocking, hitting, pushing [15], and ball throwing velocity [16-19]. Nevertheless, little is known about changes in power and strength with regard to training in women's handball players. Body size, fat-free mass, and percent of body fat seem to be important factors in physical performance, even within a rather homogenous group of highly skilled athletes.

The aim of the study was to provide information regarding the modifications that appear in athletes by using two different training programs. Because of that, we hypothesize that by analyzing two different training modes we can obtain the influence between the physical capacity and body composition of the subjects understudy.

4. Materials and Methods

2.1. Participants

This study involved 18 female athletes aged 18-23 who play performance handball. The participates were separated in two groups, Group 1 trained using Tabata Program and Group 2 using HIIT Program. The average height of the athletes included in Group 1 was determined as 175.1 ± 3.95 (cm), their average body weight as 71.4 ± 3.9 (kg), their average body mass index as 23.3 ± 0.82 (kg/m^2) the average body fat percentage as 26.9 ± 1.04 (%), muscle percentage had the value of 11.4 ± 1.84(%). Regarding the athletes from Group 2, the average height was calculated as 176.7±4.52, their average body weight as 72.8 ± 5.96 (kg), their average body mass index as 23.2 ± 1 (kg/m^2) the average body fat percentage as 27.2± 1.65 (%) and muscle percentage had the value of 12.8 ± 2.25(%).

2.2. Procedure

2.2.1. Training program

18 female handball players participated in a training program, four days per week, with training sessions of 25 respectively 45 minutes. Subjects were divided in two groups: Group 1 (9 athletes) used Tabata Scheduled training and Group 2 (9 athletes) the High Intensity Interval Training Program. Initial and final assessments were used to observe the evolution of body composition and physical performance respectively aerobic and anaerobic endurance of participants. The stage plan was scheduled on a period of two months. Tables 1 and 2 present the programs used by the subjects understudy.

Table 1. Tabata Training Program

Brief warm-up;
The exercises are performed 8 times, one set of each move, completing the full series 2 times.
Exercises are worked on maximum intensity for 20s and 10s rest between them.
At the end of the program 5 minutes of stretching exercises were required.
First & second weeks - Exercises
Mountain climbers
Squat jumps
Burpees
Ski moguls
Jumping rope
Third &fourth weeks – Exercises
Burpees
Squats
Mountain climbers
Push-ups
Crunches
Fifth & sixth weeks – Exercises
Squat thrust to frog jump
Side skaters
Russian twist
Plank with row
Broad jump to fast feet
Seventh and eight weeks – Exercises
Rotating lunge switches
Squat jumps
Broad jump to fast feet
Squat thrust to frog jump
Crunches

Table 2. High Intensity Interval Training Program

Brief warm-up for 3-5 minutes;
The program will be repeated 5 times.
After each cardio exercise rest for maximum 30s.
The exercises are worked for 45s.
First and second weeks – Exercises
Squat thrust curl
Lateral lunge with single-arm row
Overhead triceps chop
Deadlift wide row
Reverse lunge with overhead arm circle
Single-leg deadlift row to single-arm press
Lat pullover to sit-up
Third and fourth weeks – Exercises
Renegade row
Grasshopper
Push-up frog pop
Side plank press
Low squat curl
Fifth and sixth weeks – Exercises
Squat thrusts
Mountain climbers
Russian twists
Jumping jacks
High knees
Seventh and eight weeks – Exercises
Spider lunge pledge
Standing long jump
Switch kick
Tuck jump
Criss-cross pickup

2.2.2. Anaerobic endurance

It assumes a sprint running test consisting of three maximal sprints of 15 meters, with a 90s rest period between each sprint, on an indoor court. During the 90s recovery period, the subjects walked back to the starting line. Time was recorded using stopwatches. The run with the lowest time was selected for further analysis.

2.2.3. Aerobic endurance

The Cooper 12 minutes Run Test was performed on the stadium with the size of 400m/turn. The players divided into groups of four started from a standing position. At 11 minutes and at 11 minutes 30 seconds after the beginning of the test, the athletes received verbal information about the time. The total number of meters with the assigned accuracy was recorded on the sheet for all the tests.

2.3. Analyses

In the analysis of the data, the statistical significance of the variables was determined with the Paired Sample T-Test. The data was evaluated with the SPSS 15 statistics software. Data are presented as the mean ± SD. Paired Sample T-Test was used to test the interaction between interventions (Tabata Training and HIIT Training) and between assessments of every group (first and second assessments).

3. Results

Measurements for each participant were undertaken within two categories: anthropometrical and body structure characteristics and endurance performance.

Table 3 shows the results from Groups 1 and 2 at the first and second assessments regarding body composition. The Paired Sample T-Test analysis size was used on assessments between each Group. This category showed statistically significant differences with a high effect between the two measures. Significant qualitative differences between the results of the first and second assessment during a monitored two months regarding the subjects from Group 1 (Tabata Training) were found in body weight ($t = 4.96$, $p < .005$), body mass index ($t = 4.94$, $p < .005$), body fat percentage ($t = 11.6$, $p < .005$), muscle percentage ($t = 4.35$, $p < .005$), segmental analysis of right foot fat and muscle mass ($t = 4.81$, $p < .005$; $t = 8.35$, $p < .005$), left foot muscle mass ($t = 7.82$, $p < .005$), upper limbs fat and muscle mass (right hand fat mass $t = 14.1$, $p < .005$; right hand muscle mass $t = 10.09$, $p < .005$; left hand fat mass $t = 9.16$, $p < .005$; left hand muscle mass $t = 5.7$, $p < .005$), trunk muscle mass ($t = 10.4$, $p < .005$). No significant differences were determined at analysis of fat mass in left foot and trunk ($t = 2$, $p < .081$; $t = 3.13$, $p < .014$). Group 2 that followed the HIIT Training Program had significant differences at the following indicators: body fat percentage ($t = 8.34$, $p < .005$), muscle percentage ($t = 4.71$, $p < .005$), segmental analysis of right foot fat and muscle mass ($t = 3.77$, $p < .005$; $t = 6.79$, $p < .005$), left foot muscle mass ($t = 6.81$, $p < .005$), upper limbs fat and muscle mass (right hand fat mass $t = 8$, $p < .005$; right hand muscle mass $t = 7.34$, $p < .005$; left hand fat mass $t = 10.11$, $p < .005$; left hand muscle mass $t = 4.76$, $p < .005$), trunk fat and muscle mass ($t = 4.46$, $p < .005$; $t = 4.27$, $p < .005$). No significant differences were found in the parameters of left foot fat mass, body weight and body mass index of Group 2.

Table 3. Antropometric and body structure characteristics (mean±SD) of Group 1 and Group 2

Variables		Group 1 – Tabata Training Program (n=9)		Group 2 – High Intensity interval Training Program (n=9)	
		1st assessment	2nd assessment	1st assessment	2nd assessment
Body Weight (kg)		71.44±3.90	67.5±4.87*	72.8±5.96	71.2±6.02NS
Body Height (cm)		175.1±3.95	-	176.7±4.52	-
Body Mass Index		23.3±0.82	22.01±1.23*	23.2±1.007	22.7±1.42 NS
Body Fat (%)		26.9±1.04	18.4±2.18*	27.2±1.65	19.7±2.65*
Muscle (%)		11.4±1.84	12.5±2.06*	12.8±2.25	14.1±2.70*
Right foot segmental analysis (kg)	**Fat**	3.37±0.41	3.07±0.37*	3.64±0.45	3.4±0.47*
	Muscle mass	8.47±0.45	8.95±0.51*	8.81±0.68	9.28±0.74*
Left foot segmental analysis (kg)	**Fat**	3.2±0.57	3±0.30 NS	3.41±0.41	3.32±0.51 NS
	Muscle mass	8.28±0.42	9.11±0,.6*	8.6±0.63	9.51±0.78*
Right hand segmental analysis (kg)	**Fat**	0.87±0.10	0.54±0.13*	1.06±0.23	0.62±0.12*
	Muscle mass	2.77±0.28	3.02±0.29*	2.84±0.26	3.14±0.33*
Left hand segmental analysis (kg)	**Fat**	1.03±0.15	0.55±0.14*	1.18±0.20	0.65±0.18*
	Muscle mass	2.56±0.31	3.05±0.28*	2.68±0.325	3.2±0.38*
Trunk segmental analysis (kg)	**Fat**	6.01±1.48	5.42±1.31 NS	6.5±1.68	6.17±1.72*
	Muscle mass	27.9±4.73	29.7±4.69*	29.9±2.11	31.9±2.19*

Note: Data is presented as mean ±sd; *Statistically significant differences between 1st and 2nd assessments ($p < .005$); #Statistically significant differences between Groups 1 and 2 ($p < .005$)

The descriptive results of the aerobic and anaerobic endurance of the subjects understudy are presented in Table 4. The performance of the women handball players after a period of two months training increased in both anaerobic and aerobic endurance. For the determination of the anaerobic endurance we used 3x15 meters Sprint Run and the data show a significant difference between the results obtained in the first and second assessment from Group 1($t = 7.07$, $p < .005$) and Group 2 ($t = 5.48$, $p < .005$). Regarding the aerobic endurance the Cooper Test Run for 12 minutes was used to show the physical evolution of the women handball players. Results show a qualitative increase of the results before and after the two months of training using Tabata ($t = 12.4$, $p < .005$) and HIIT Program ($t = 11.05$, $p < .005$).

Table 4. Descriptive statistics of anaerobic and aerobic endurence of Groups 1 and 2

Variables	Group 1 – Tabata Training Program (n=9)		Group 2 – High Intensity interval Training Program (n=9)	
	1st assessment	2nd assessment	1st assessment	2nd assessment
Anaerobic endurance (s)	5.66±1.41	4±1.11*	5.77±1.09	4±0.5*
Aerobic endurance (meters)	2388.5±57.8	2545.1±60.1*	2385±47.6	2553.1±70.4*

Note: Data is presented as mean ±sd; *Statistically significant differences between 1st and 2nd assessments ($p < .005$); #Statistically significant differences between Groups 1 and 2 ($p < .005$)

4. Discussion

Modern handball has developed into a fast-paced, full body contact sport, with short high anaerobic bouts interspersed with aerobic actions [20].

As a result of this evolution, variables related to constitution and conditioning abilities have become determinants of handball performance. In the last five years, 20% of the research published on handball were upon the physical capacities and conditions topic [21].

According to literature, body mass is determinant for performance, in the throwing events [22]. This study presents significant differences in body mass between the moments of evaluation that can be confirmed by the big differences in BMI, muscle and body fat percentages.

The research was conducted upon endurance performance and focused on aerobic and anaerobic endurance. Data showed increased levels of both, after 2 months, both Groups (Tabata and HIIT) had significant differences. The difference between this research and others that concerned handball is the fact that these athletes were obligated to start training indoor due to the pandemic and took a forced competition break in which the body and mind of the subjects suffered different changes.

Handball involves a large number of cyclic movements and acyclic activities with only short breaks. Consequently, a highly developed anaerobic endurance capacity seems to be necessary for players [23]. Regarding anaerobic endurance after using two programs that focus upon anaerobic endurance, respectively Tabata and HIIT Programs, these study demonstrated that young women handball players can obtain good results, after the scheduled training program, they had significant differences between the assessments at 3x15m Sprint Run Test.

Several scientists showed that players cover 4000–6500m/game, which makes advantageous to have a well-developed aerobic and anaerobic endurance capacity [24]. Accordingly, both athletes and coaches seem to ignore that aerobic capacity may help not only to keep endurance capacity and to avoid fatigue, but also help to maintain concentration, technical skills, and coordination until the end of the game [25-28]. Due to the presented above this research was conducted upon the endurance performance, mainly aerobic and anaerobic capacity of the players.

The study realized by Tabata et al. [10] found that HIIT improved aerobic capacity to a similar degree as moderate-intensity continuous training, but also resulted in a 28% increase in anaerobic capacity. Those findings led to the development of a wide variety of HIIT programs. Although there are many different ways to perform HIIT, all of the programs are characterized by periods of very heavy effort combined with periods of either complete rest or low intensity recovery. Tabata training has evolved to include a variety of modes and exercises performed in the classic 20-10 pattern.

Movements in team-handball are characterized mostly by short accelerations (0-3 m) with stops (30-40 per game) and changes in direction (30-40 per game) and less by sprints (10-30 m) over the entire game field [24, 29, 30], constituting only 1-3% of the total playing time per match were attributed to sprints or fast running. Tests including changes in direction might be more suitable to measure team-handball performance, although learning effects could influence the results (especially in training studies) and these tests could not resemble the real demands in team-handball competition.

5. Conclusions

This study provides information on the behavior of athletes during the COVID-19 pandemic. It is a novelty because they have not faced a competitive break in which they were forced to train indoor. The training programs aimed to maintain a good capacity for effort but also to secure parameters related to body mass indices. In addition, two training programs were chosen that are directly related to the specific effort encountered in the handball game. No significant differences were obtained between the two programs, Tabata and HIIT, but the physical parameters were maintained at a high potential, so that at the resumption of the competition program the team obtained victories in the following matches.

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