ORIGINAL ARTICLE

TRENDS in
Sport Sciences
2020; 27(**3**): 157-165
ISSN 2299-9590
DOI: 10.23829/TSS.2020.27.3-6

The influence of high-intensity functional training versus resistance training on the main physical fitness indicators in women aged 25-35 years

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Abstract

Introduction. **Improving the physical fitness and performance of young women depends on the differentiated selection of methods and the amount of the load, the optimal selection of training methods. The aim of the study was to evaluate the influence of 24-week high-intensity functional training (HIFT) program compared to the resistance training (RT) program on health-related physical fitness indicators of women aged 25-35.** Material and Methods. **Thirty-six women (age 30.23 ± 3.5 years) were divided into two groups: experimental (EG; n = 18) – HIFT program, and control group, practicing RT (CG; n = 18). Both programs included exercises with massage rollers, exercises to overcome the weight of their own body, with fitness accessories, three times a week for 24 weeks. Classes in the EG were distinguished by performing 2-3 sets of exercises 15-20 times each (at 85-95% HRmax), separated by 10-30 s to 1 min periods. CG participants trained with an intensity of 60-70% HRmax. Differences in the effectiveness of HIFT and RT were determined by changes from the baseline to the final level in health-related indicators and physical fitness, evaluated by the ALFA-fitness program.** Results. **All scores in the EG and CG, except for the "one-leg stand" (p = 0.056) in CG, improved (p < 0.01 pre- vs post-training increases for each group). Post-training, waist circumference (69.28 ± 5.00 vs 74.19 ± 6.30 cm, p = 0.014), BMI (22.09 ± 1.54 vs 23.27 ± 1.51 kg/m^2, p = 0.027), "figure-of-eight run" (7.96 ± 0.61 vs 9.03 ± 1.24 s, p = 0.002), "jump-and-reach" (32.33 ± 4.79 vs 26.00 ± 5.25 cm, p = 0.001), "2-km walk test" (15.38 ± 0.93 vs 16.86 ± 1.16 m, s, p = 0.0001) were better in EG than in CG, respectively.** Conclusions. **RT and HIFT are effective in terms of health and fitness. Compared to RT, HIFT training is more effective in reducing waist circumference, BMI, increasing agility and lower muscle strength, and improving cardiorespiratory fitness.**

KEYWORDS: multifunctional exercises, circular training, working capacity, balance, muscle strength.

Received: 23 January 2020
Accepted: 10 August 2020

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Introduction

An urgent problem of our time is the low motor activity of people, which provokes the occurrence of disorders in the musculoskeletal, cardiovascular, digestive, and respiratory systems, the appearance of excess body weight [2, 13]. A sufficient amount of physical activity for health − recommended for adults − implies a weekly dose of exercise of 150 to 300 min of medium intensity or 75 to 150 min of high intensity [13]. Starting training, women hope to quickly adjust body composition, improve functional abilities and physical fitness, and expand social contacts [10, 12, 13]. The lack of time, insufficient variety, complexity, and monotony of the proposed programs, or fear of injuries can reduce the commitment to systematic training or become the reasons for the termination of training in the first months [12, 15, 16]. Thus, developing an effective fitness program, suitable for physically inactive women, becomes more and more important.

In 2020 fitness trends in Europe the leading is high intensity interval training (HIIT), with body weight training (BWT), functional fitness training (FFT), occupying second, third and fourth places, respectively [5]. Resistance training (RT) is traditionally popular; it helps to maintain or to increase the level of physical and functional capabilities, increase endurance, speed and agility, and is an essential element of recommendations for physical activity [13, 20, 22, 24]. Long-term and systematic RTs contribute to an increase in skeletal muscle strength and mass, walking speed, and improved dynamic balance among women of different ages [1, 17]. However, along with this, comparatively quick adaptation to the nature of the same type of repetitive exercises in the traditional pattern is noted, which can slow down progress in achieving goals, cause boredom, and reduce motivation to continue training [15, 16]. Determining a way to increase functional and physical fitness that would not have the disadvantages of traditional training protocols and at the same time provide the desired health benefits in less time is relevant.

Recent studies confirm that high intensity functional training (HIFT), combining aerobic and power loads, has a positive effect on health, increases interest in physical activity, due to the high emotionality and attractiveness of both the exercises themselves and new types of equipment, it has a similar or superior comparison with RT efficiency [3, 7, 8, 15]. Several variations of HIFT programs, based on bodyweight training, functional fitness training, high-intensity circular training, high-intensity power training, CrossFit®, Tabata, SuperSlow and others, are universal and integrative, characterized by compliance with the principles of HIIT and FFT, include exercises for various joints and muscle groups using bodyweight and various fitness accessories [8, 11, 16, 20, 25]. In a recent in-depth review, Feito et al. [12] show the compelling benefits of using HIFT programs for different groups of people, describe the main differences in HIFT and HIIT methodologies that provide important differences in physiological responses and adaptations.

Having the advantages of traditional RT and HIIT, HIFT programs make it possible to individualize the load as much as possible and focus on improving general physical fitness, including cardiorespiratory fitness, endurance, strength, flexibility, speed, coordination, agility, balance and is perceived by participants as time-efficient and exciting training [16, 19, 20, 21, 25, 28]. HIFT helps to improve performance in everyday functions, provides body composition correction, and has a potential osteogenic effect, in less time than RT [8, 12]. HIFT mode is widely used in the training process of athletes, contributing to the improvement of neuromuscular status, anaerobic power, heart rate restoration, and improves the structure and function of peripheral vessels [28, 29]. Recent, relatively short-term (8-16 weeks) studies show the effectiveness of various HIFT program options, such as multimodal high-intensity interval training, high-intensity power training, CrossFit, CrossFit Teens™ to improve health and fitness levels of different groups of people, increase the popularity of these programs [7, 11, 25]. For example, after 8 weeks of HIFT training, previously physically inactive adults showed improvements in VO_2max, body composition, muscle strength and endurance of the upper and lower body, and flexibility [6]. In longer research (6 months), an assessment of changes in key physical fitness indicators of young women practicing HIFT also showed significant and positive changes in flexibility, muscle strength, and muscle endurance [10]. However, only a few studies attempted to compare RT and HIFT [24, 26, 28]. The advantage of short-term (4-8 weeks) HIFT programs over traditional RTs have been identified in terms of strength, muscle endurance, flexibility, and aerobic abilities for male and female college students [19, 24]. Sobrero et al. [26], comparing the effectiveness of 6-week HIFT and traditional circular training, found that the HIFT program provided better results in terms of body composition and similar improvements in muscle strength and performance of recreationally active women. However, we note that most of these studies were conducted in the early stages of adaptation to training loads and focused on assessing individual indicators of physical fitness, for example, strength or cardiorespiratory fitness [6, 25]. There is very little evidence of optimal ways to implement HIFT to improve the indicators related to health and physical fitness in the long term, so we compared the effectiveness of HIFT and traditional RT programs. We hypothesized that (a) after the introduction of HIFT, there will be an improvement in body composition, cardiorespiratory fitness, muscle strength of the upper and lower parts of the body, muscle endurance of the upper body, balance, agility, and (b) that this training will demonstrate higher efficiency in comparison to the RT group. Thus, the aim of the study was to evaluate the impact of the 24-week HIFT program compared to the RT program on physical fitness indicators related to health among women aged 25-35.

Material and Methods

Participants. The randomized controlled trial was performed in 36 young, non-obese (BMI <30 kg/m^2), healthy women (without chronic diseases), willing to do fitness (Table 1). The participants were on average 29.72 ± ± 3.23 years old, their height was 169.06 ± 3.54 cm, and their mean body weight was 70.5 ± 5.9 kg. Participants were randomly assigned either to the experimental (EG; n = 18) or control (CG; n = 18) group. There were no significant differences between the studied groups. All participating women were informed about the procedures and the main purpose of this study and gave their written informed consent.

Table 1. Baseline characteristics of young women participating in the research assigned to in experimental (EG; n = 18) and control (CG; n = 18) groups

Group	Age (years)		Body weight (kg)		Body height (cm)	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
EG	29.97	3.53	70.38	6.31	169.67	4.39
CG	29.46	2.97	70.63	5.64	168.44	2.41

Note: $\bar{x}$– arithmetic mean, SD – standard deviation

Organization of research. During the 24-week research, workouts were conducted three times per week (Monday, Wednesday, and Friday) in both groups (72 workouts). Each training session, in both groups, consisted of the preparatory, main and final part, and lasted 50 min. Our experimental program was developed by one of the authors of the study who conducted the training sessions. In both training programs, exercises of various intensity with bodyweight or different weights were used to develop endurance, strength, balance, and flexibility. The research program included three stages: 1) preparatory stage (1-4 weeks), the task of which was to prepare the participating women for the loads during the main stage, master the basic elements and comprehensive development of physical qualities, and develop a steady interest in physical exercises; 2) main stage (5-12 weeks) aimed at an in-depth study and improvement of the technique of performed physical exercises and achieving a higher level of physical fitness; 3) supporting stage (12-24 weeks) aimed to maintain and further improve physical fitness and health-related indicators.

Each participant used a Polar® heart rate monitor to measure heart rate during exercise and recovery. The calculation of the intensity was carried out according to the Karvonen formula (Target Heart Rate = [(max HR – resting HR) × % Intensity] + resting HR) [18]. The intensity of the exercises, according to the individually calculated training heart rate, was adjusted at the end of each stage of training, which made it possible to control the intensity levels within the desired ranges, ensuring that women of both groups performed exercises with a given intensity.

In the main part of the training (up to 30 min), the EG performed exercises aimed at developing the strength of the muscles of the arms and chest, back, legs, and abdominals. The exercises were performed 8-12 times (85-95% HRmax), with 10-60 s (50% HRmax) rest between each exercise. In the first 4 weeks, we used exercises with body weight and intensity of 75-85% HRmax. It was allowed to replace exercises by lighter ones (pull-ups on a low crossbar, knee-bending arms, etc.). At 1, 4, 7, 10 training sessions, exercises were carried to strengthen triceps, back muscles, deltas, and abs. Exercises for strengthening the arm, chest, and abdominal muscles were performed during 2, 5, 8, 11 sessions. In the 3rd, 6th, and 9th training sessions, exercises were performed to strengthen the muscles of the legs, chest, back and abdominals, using a circular training method. The exercise complex of the circular training consisted of seven exercises (the number of reps 15 times, the rest time 10 s), which were performed one after another. For example, 1st station: pull-ups on a low crossbar; 2nd station: reverse hyperextension on the bench; 3rd station: kettlebell swing, one weight, 6 kg; 4th station: handstand push-up; 5th station: dumbbell lateral raise; 6th station: box jump; 7th station: reverse crunch. When seven exercises were completed, a period of rest (1-2 min) began. After this, two following circles were performed. At the 12th lesson, a set of stretching exercises was carried out (runner's lunge with quad stretch, pigeon stretch, backstretch bridge, backstretch, quad stretch walk, reverse hip skip, carioca quickstep, and foam roll), each exercise took 45-60 s, and the rest time was 10-15 s. Over the next 5-24 weeks, EG women performed complexes containing multimodal, plyometric exercises, and exercises with external resistance (dumbbells, shock absorbers, body bars). With an increase in the level of physical fitness, the intensity of the exercise and the complexity of the exercises was increased by integrating various elements into one exercise, using fitballs, medicine balls, and TRX loops.

CG women trained according to the RT program (60--70% HRmax, individually determined according to Karvonen's formula), which was based on a linear progression of loads: women performed 6-8 exercises (basic, classical power and isolated), with absolute precision and maximum amplitude, trying not to deviate from a given trajectory of movement, working out muscle groups: arm and chest muscles (barbell biceps curl, hammer curl, decline triceps extensions, standing calf (heel) raise, inclined dumbbell bench press, flat dumbbell fly, wrist extension), backs (bent-over row, one-arm dumbbell row, seated pulley row, upright row), legs (leg press, lunges, standing leg curls, leg extensions), press (bent-knee sit-up, abdominal crunch, physioball back extension). In the final phase of the movement, muscle contraction was held for 2-3 s. When returning to the starting position in an eccentric mode, the movement was performed smoothly, without jerking. The exercises were carried out in the order recommended by ACSM, namely, for optimal warming up and increasing the efficiency of subsequent exercises, large muscle groups were worked out first, then smaller muscle groups [13]. CG women performed 2-4 sets of 8-12 repetitions, with 60-90 s rest between multiple sets. Progression was carried out in two ways: method I – by repetitions, when the weight of the weights and the number of repetitions remained the same, and method II – progression by repetitions, when the weights and approaches remained the same, and the number of repetitions increased [13]. Weekly exercise options, as they adapt, every one to two months, changed. Option I: training of the large or small muscle antagonists. On Monday, exercises were performed for the large muscles of the agonists: the chest and back, as well as for the rectus abdominis. On Wednesday, exercises for small muscle groups: deltoid, biceps, and triceps muscles of the shoulder (antagonists), as well as lower legs and rectus abdominis. Large muscle groups were worked out on Friday: exercises for the quadriceps and biceps of the thighs (antagonists), gluteus and adductors, as well as the rectus abdominis muscle. Option II: training of the flexors or extensors. Monday: flexor muscles (biceps of the shoulder, biceps of the thighs, rectus abdominis, etc.). Wednesday: extensor muscles (quadriceps femoris, triceps brachii, extensors, etc.). Friday: training was carried out according to the program of Monday. Option III: training the muscles of the upper or lower torso. Monday: muscles of the thorax, back, biceps and triceps muscles of the shoulder, deltoid muscles and rectus abdominis muscle. On Wednesday, the muscles of the legs, buttocks, legs, and rectus abdominis muscle. On Friday, the workout was carried according to Monday's program.

The final part, among women of both groups, lasted 8-10 min (40-50% of HRmax) and contained exercises for the development of flexibility and relaxation of muscles such as: hanging on the crossbar, longitudinal and transverse splits, and their auxiliary exercises, a bridge, exercises on a massage roller.

Testing procedures. To measure and evaluate the health-related components of fitness, at the beginning and the end of the study, all participants of the experiment were tested using the ALPHA-FIT (Assessment of Physical Activity and Physical Fitness) test pack for adults aged 18-69. Testing was carried out in strict accordance with the recommendations described in detail in the manual. Before testing, warm-up or stretching exercises were not performed for participants [27]. Following indicators were registered: body composition (waist circumference, BMI); motor fitness (one-leg stand, figure-of-eight run); musculoskeletal fitness (shoulder-neck mobility, hand grip, jump-and-reach, modified push-up, dynamic sit-up); cardiorespiratory fitness ("2-km walk test") [27]. Bodyweight (kg) and height (m) were measured to calculate BMI (kg/m^2), bodyweight was measured to the nearest 0.01 kg using electronic scales Seca 703 (Seca North America, Chino, CA, USA), and height was measured to the nearest 0.5 cm using a stadiometer Seca 264 (Seca North America, Chino, CA, USA).

Statistical analysis

All statistical analyzes were carried out with SPSS version 22.00 software (IBM SPSS, Armonk, NY, USA). All data are presented as mean ± standard deviation of the mean (SD). The data were checked for normal distribution using the Kolmogorov–Smirnov test, the achieved significance level was more than 0.05. One-way analysis of variance (ANOVA) was used to compare the average values between the results in independent groups, namely, preliminary testing in the EG and CG, and the results of post-testing in the EG and CG. To compare the average values in dependent samples, i.e. between the results in the EG (pre- and post-training) and comparison of the average values between the results in the CG (pre- and post-training), we used one-way analysis of variance for repeated measurements (Repeated Measures ANOVA). Measures of the effect size (ES) for differences were calculated by dividing the mean difference by the standard deviation (SD) of the pre-training measurement. The magnitude of the ES was classified according to the following criteria: $0.2 < d < 0.5$ was considered "small", $0.5 < d < 0.8$ represented "medium", and $d > 0.8$ constituted "large" [9]. Differences were considered to be reliable at a significance level of $p < 0.05$.

Results

Prior to the experiment, no significant differences were found between the groups ($p \geq 0.05$) in body composition, cardiorespiratory fitness, muscle strength and endurance of the upper and lower body parts, the level of agility, and development of the stability functions. This signifies the homogeneity of the groups before the research.

The first hypothesis was fully confirmed, all assessments in the EG showed an improvement from pre-testing to post-testing ($p < 0.0001$). Most significantly, in this group, improved short-term endurance capacity of the upper extremity extensor muscles and the ability to

Table 2. Health-related fitness test scores before (pre-test) and after 24 weeks of training (post-test) in experimental (EG; n = 18) and control (CG; n = 18) groups

Measurable indicators	Groups	Pre-test $\bar{x}$ (±SD)	Post-test $\bar{x}$ (±SD)	P	ES	Δ%
Waist circumference (cm)	EG	74.46(6.6)	69.28(5.00)*†	0.0001	0.88	–6.95
	CG	78.23(7.12)	74.19(6.30)*	0.0001	0.60	–5.11
	p	0.110	0.014			
BMI (kg/m²)	EG	24.82(2.12)	22.09(1.54)*†	0.0001	1.47	–10.99
	CG	24.78(2.13)	23.27(1.51)*	0.0001	0.81	–6.09
	p	0.947	0.027			
One-leg stand (s)	EG	50.33(21.92)	57.61(22.60)*	0.0001	0.33	14.46
	CG	45.94(24.90)	46.91(25.11)	0.0560	0.04	2.11
	p	0.578	0.188			
Figure-of-eight run (s)	EG	8.83(1.02)	7.96(0.61)*†	0.0001	1.04	–9.85
	CG	9.27(1.33)	9.03(1.24)*	0.0050	0.18	–2.59
	p	0.263	0.002			
Shoulder-neck mobility (points)	EG	7.67(1.61)	8.56(1.34)*	0.0010	0.60	11.60
	CG	6.94(2.41)	8.55(1.38)*	0.0001	0.82	23.19
	p	0.298	0.715			
Hand grip (kg)	EG	39.12(4.57)	42.92(5.23)*	0.0001	0.77	9.71
	CG	38.70(5.72)	40.36(5.76)*	0.0001	0.29	4.28
	p	0.808	0.173			
Jump-and-reach (cm)	EG	27.17(5.47)	32.33(4.79)*†	0.0001	1.00	18.99
	CG	25.22(5.43)	26.00(5.25)*	0.0001	0.15	3.09
	p	0.292	0.001			
Modified push-up (total number)	EG	8.39(2.00)	12.00(2.40)*	0.0001	1.63	43.02
	CG	11.33(2.22)	8.89(2.42)*	0.0001	1.05	21.54
	p	0.940	0.393			
Dynamic sit-up (total number)	EG	12.67(3.50)	16.78(3.70)*	0.0001	1.14	32.43
	CG	13.38(3.64)	16.67(3.71)*	0.0001	0.89	24.58
	p	0.548	0.894			
2-km walk test (m, s)	EG	16.90(1.13)	15.38(0.93)*†	0.0001	1.47	–8.99
	CG	17.08(1.10)	16.86(1.16)	0.0001	0.18	–1.23
	p	0.630	0.0001			

Note: CG – control group, EG – experimental group, ES = Cohen's d effect size, $\bar{x}$ (±SD) = mean ± standard deviation, * $p \leq 0.05$ (between study terms), † $p < 0.05$ (between study groups) stabilize the body. So in the test "modified push-up" the number of repetitions increased by 3.61 ± 0.40 ($F = 270.48$, df = 1.17, $p = 0.0001$), and in the test "dynamic sit-up" the number of repetitions increased by 4.11 ± 0.20 ($F = 173.68$, df = 1.17, $p = 0.0001$). Agility and muscular power of lower extremities, according to the results in "figure-of-eight run", also improved ($F = 30.86$, df = 1.17, $p = 0.0001$). Waist circumference and BMI ($p < 0.0001$) decreased significantly. All test results in CG, except for "one-leg stand" ($F = 4.22$, df = 1.17, $p = 0.056$), also showed an improvement from pre-testing to post-testing ($p < 0.05$). The most functional mobility of the shoulder and neck region was significantly improved according to the results of the "shoulder-neck mobility" test ($F = 23.172$, df = 1.17, $p = 0.0001$). Table 2 shows a comparison of physical fitness indicators (ALPHA-FIT test) obtained before and after the experiment.

Regarding the second hypothesis, a comparison of the results of the final testing in EG and CG revealed that the HIFT training showed higher efficiency compared to RT in five indicators. Thus, statistically significant differences were found in the indicators of waist circumference ($F = 6.71$, df = 1.35, $p = 0.014$), BMI ($F = 5.38$, df = = 1.35, $p = 0.027$), the level of agility ("figure-of-eight run", $F = 10.75$, df = 1.35, $p = 0.002$), the strength of the lower body muscles ("jump-and-reach", $F = 14.31$, df = = 1.35, $p = 0.001$), and the cardiorespiratory efficiency ("2-km walk test", $F = 17.665$, df = 1.35, $p < 0.001$). Both training programs caused similar changes in mobility of the shoulders and neck, handgrip strength, the number of push-ups, and the values of the dynamic squat test.

Discussion

The main finding of this study was that both, HIFT and RT contribute to positive changes in the studied parameters (body composition, motor, and musculoskeletal fitness, cardiorespiratory fitness), which indicates the effectiveness of both programs in general. However, when comparing the two training programs, HIFT caused a greater effect on waist circumference, BMI, agility development, the lower body muscles' strength, and cardiorespiratory fitness. The ability to maintain body balance in difficult postural conditions increased only in the HIFT group.

Body composition. A change in body composition is widely used as an indicator of the effectiveness of the selected training regime. The study found that both training programs are effective in reducing waist circumference (WC) and lowering BMI among healthy, young women. However, HIFT was significantly more effective in reducing these parameters, which corresponds with comparable reductions in subcutaneous adipose tissue reported after 8 weeks of HIFT [11, 12, 26]. Significant efficacy of CrossFit Teens™ training (60 min twice a week) was found in adolescents; among others WC decreased by 3.1 cm ($p < 0.001$), BMI decreased by 1.38 kg/m^2 ($p < 0.001$) [11]. Smith et al. [25] reported that 10-week high-intensity power training programs using "day training" (WOD) contributed to a decrease in BMI by 0.7 ± 0.1 kg/m^2 ($p = 0.01$). However, our data are not consistent with the data of Heinrich et al. [15], Tomljanović et al. [28], who did not find significant changes in WC and BMI in men and women (22-30 years old) after identical, but shorter (5-8 weeks) training programs. These discrepancies can be in great part explained by the shorter duration of interventions, the intensity, and type of exercise, the studied categories of participants (men and women), their number (9-15 people), or the presence or absence of obesity.

Motor fitness. In this study, the ability to maintain body balance in difficult postural conditions, according to the results of the "one-leg stand" test, significantly changed only in EG. Despite that Cosgrove et al. [10] did not find balance improvements after HIFT for young women, there are reports of improved balance after RT among older women [17]. The significant changes in the results of the "figure-of-eight run" test (specifying the level of agility development) indicate a greater influence of HIFT on the efficiency of neuromuscular coordination. Our data are consistent with the results of Barranco-Ruiz and Villa-González [4], which reported that 16 weeks of Zumba Fitness® training, supplemented with bodyweight strengthening exercises, significantly improved the results of "figure-of-eight run". Also, Rogers et al. [22] reported a 9.8% agility improvement after RT.

Musculoskeletal fitness. We assessed the posture and functional mobility of the shoulder and neck region, since among adults sometimes pain and restrictions in the sagittal mobility of the lower cervical and upper thoracic spine may be observed [14, 23]. Both types of training increased the range of motion of the lower cervical and upper thoracic spine. Moreover, in CG women, the improvement in this indicator was more significant. Probably, performing a variety of exercises in which the short rotator muscles were involved, and exercises with a wide range of motion in the shoulder joints, cervical and lumbar spine significantly improved this ability. Although at the time of publication, we have found no other studies examining the effect of HIFT on posture and functional mobility of the shoulder and neck region based on the results of the "shoulder-neck mobility", our results are comparable with the data of Barranco-Ruiz and Villa-González [4], which revealed an increase in the mobility of the neck and shoulders by 2.123 ± 0.47 points ($p = 0.0001$; Cohen's d = 0.60). Our results indirectly correlate also with a 10-20% increase in isometric neck strength and an improvement in the neck range of motion among adults with chronic neck pain after RT [14]. We believe that a scrupulous study of the effect of HIFT on the functional mobility of the shoulder and neck region is required.

In the present study, an improvement in hand muscle strength, which is necessary for many daily functions, was noted in both the EG and CG, yet the greater difference was caused by HIFT. The greater effect in improving hands muscle strength among women from EG can be explained by the 25% higher intensity of that strength training. However, that considerable difference between groups in the intensity of the training was not large enough to cause a significant difference in muscle strength' increases between groups. The increments in hands muscle strength are similar in the present study to those found in young women practicing the modified Zumba Fitness program ($p < 0.05$) [4] and in older women after the strength training (16.31%; $p < 0.01$) [21].

The muscle strength of the lower body improved only after HIFT training. The most probably the performance of plyometric exercises that effectively influenced the "jump-and-reach" test result in EG. Buckley et al. [7] reported an increase in muscle strength (squat, deadlift, and overhead press strength) after high-intensity multimodal exercise ($p < 0.01$). Sobrero et al. [26] noted an improvement in the "vertical jump" test after 10 weeks of HIFT ($p = 0.029$). However, Ahtiainen et al. [1] also reported that after 6 months of RT training, women under the age of 45 years, had a maximal bilateral concentric strength of the hip and knee extensors, and plantar flexors increased by 26.7 ± 13.9%.

Both indicators of muscular endurance of the body (the number of repetitions performed during the "modified push-up" and "dynamic sit-up" tests) show a significant improvement among women in the EG and CG groups. Probably, the combination of gymnastic and weightlifting exercises in the HIFT program contributed to a greater increase in the efficiency of movements. Our results are similar to improved muscle endurance ($p < 0.0001$) and upper body strength ($p = 0.007$) after HIFT and traditional circular training [26], and 18.6% increase in bench press and 22.7% increase in leg press after HIFT showed by Brisebois et al. [6]. Improvements in both of these assessments are expected since each group performed the exercises using both their body weight and fitness accessories [3, 12, 13]. Sartor [24] found that after 8 weeks of both HIFT and traditional strength training, participants significantly improved muscle endurance, without significant differences between groups. In this case, it can be argued that both of these methods are important and effective in increasing the muscular endurance of the trunk.

Cardiorespiratory fitness. A significant decrease of 8.99% in the time of the "2-km walk test" was noted among women from the EG group, compared to 1.23% in women from CG. Possibly, aerobic exercise included in the high-intensity functional training led to a greater adaptation of the oxygen delivery system and improved its use by active muscles. Furthermore, the active rest between exercises also helped to improve muscle metabolism. In our opinion, aerobic exercises aimed at developing general endurance were not sufficiently included in the exercise complexes used in the control group. Our findings can only be compared to other studies indirectly, and with caution, since most of the changes in cardiorespiratory fitness were judged by changes in VO_2max level measured using laboratory tests, while in our study we used a field test. We assume that the improvement in cardiorespiratory fitness is comparable to previous studies, which reported significant improvements in VO_2max from 7% to 11.8% after 4-10 weeks of training [6, 7, 25]. For example, after a 6-week multimodal HIIT, a 7% increase in VO_2max was found [7], and participation in a 4-week Tabata training resulted in a 7-8% increase in VO_2max ($p < 0.05$) in young women [20]. After 10 weeks of Crossfit-based high-intensity power training, the relative VO_2max improved by 11.8% [25]. Brisebois et al. [6] reported that among previously inactive men and women, after 8 weeks of HIFT, the absolute VO_2max increased by 6.3% ($p = 0.003$; Cohen's d = 0.23), and relative VO_2max by 5.5% ($p = 0.003$; Cohen's d = = 0.21). Cosgrove et al. [10] found that the time to cover a distance of 1.5 miles was significantly shorter in the less experienced group (0-6 months) compared to the more experienced group (7+ months). In contrast, Sobrero et al. [26] showed that 6 weeks of HIFT training did not significantly affect the cardiorespiratory fitness of women. Also, Kim et al. [19] received no evidence of a positive effect of 4 weeks of either RT or SuperSlow resistance training on aerobic abilities of young women.

A limitation of this study is that one of the researchers was involved in the design and implementation of the HIFT program. Besides, this study was limited by sample size. Since there are many different HIFT and RT training programs, the comparison of results obtained by us does not guarantee that the HIFT applied in this study is superior to other training programs.

Conclusions

As far as we know, this was the first study that compared the effectiveness of 24 weeks of HIFT and RT concerning the health and physical fitness of young women. Our results could be significant for public health as they show that both programs contribute to positive changes in the studied indicators. However, we identified differences in effectiveness that depend on the type of program. The obtained results allow us to consider HIFT as a more effective and alternative choice to RT to improve body posture, working capacity, health indicators, and promote a long-term commitment to physical activity. These results may also be of interest to researchers and fitness trainers and can be used to develop training programs for women who begin to do fitness to improve their well-being and overall health.

Conflicts of Interest

The authors declare no conflict of interest.

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