

Effects of High-Intensity Interval Training (HIIT) on BMI, bodyweight, body fat percentage and body circumference measurements in an adult group exercise setting.

Introduction

High-Intensity Interval Training (HIIT) is a type of cardio training in which you alternate short, high intensity intervals with longer slower intervals, which allows the body to recover. This type of training has been used by athletes and the average exerciser to improve performance. HIIT not only helps performance, it improves general physical fitness, and the body's ability to burn fat⁽¹⁻⁴⁾. A typical HIIT workout usually lasts about 20-30 minutes and involves a 2:1 ratio, meaning the recovery intervals are twice as long as the work intervals. A 1996 study by Dr. Izumi Tabata et al⁽⁵⁾ demonstrated that reversing this normal protocol to 2 parts work and 1 part rest was a powerful means to increase both aerobic and anaerobic fitness.

The purpose of this study was to determine if HIIT would improve the fitness of adults in a group exercise class setting using a variety of body weight exercise combinations with a variety of interval timing protocols.

The power of HIIT

There are a number of components involved in creating a successful HIIT group exercise class.

Component 1: Variable exercise formula. Understanding how to manipulate this formula is absolutely critical for success when using HIIT in a group exercise setting. The three parts of this variable formula are: 1) the number of sets or intervals; 2) the exercise time; and 3) the rest time. A basic formula will look like the following: 3i@10x10. This simple formula means 3 intervals at (@) 10 seconds of exercise and 10 seconds of rest. Depending upon the effect desired, this basic formula can take on three basic formats:

1. The first is by manipulating the number of intervals.

2. The second is by adjusting the time components of exercise and rest. The timing components can vary widely depending upon the physiological effect desired. The goal is to design an exercise timing protocol which allows the students to work at the highest possible intensity.
3. The third is to adjust the number of exercises. Once you add more exercises to the formula, the next decision is whether or not there will be rest between the exercises. A “greater than” sign (>) means no rest between exercises. A “plus sign” (+) in the formula means you take the designated rest time interval.

Component 2: Variability of exercises. When you use HIIT it is important to use a wide variety of exercises. The current study used 81 different exercises to maintain an elevated exercise intensity and student interest in attending class. The chosen exercises should allow the student to safely work as hard as possible.

Component 3: Exercise training principles. There are six universally accepted scientific exercise training principles. The principles are: individual differences, overload, progression, adaptation, use/disuse, and specificity, or SAID (Specific Adaptation to Imposed Demands). Using these principles to construct classes is important for success.

Example:

The following is an example of class #3 used during this study. This will provide an understanding of the variability of the exercises and the variability of the timing formula. The class included 11 different exercises and 4 different timing protocols. Here is a key to the exercises used in the formulas and a brief description: Jumping jacks = JJ; Power jacks = P Jacks: [an exaggerated jumping jack with a half squat]; Flying squats = FS: [full squats with as much speed as possible, making sure form is perfect before increasing speed of

movement]; Power squats = P squats: [same as power jacks except no arm movements]; Floor squats = F squats: [feet wider than shoulders, hinge at waist and bend knees to touch floor then jump squat]; Squat thrusts = SQTH: [hands to floor, kick feet back into push up position, bring feet back up and then stand up]; Jump squats = JSQ: [half squat with powerful jump]; Chop lunges: [lunge jumping using both legs to jump, complete arm chopping with each jumping movement]; Jump-hop-hop-hop-jump: [jump squat then keeping knees slightly bent 3 small hops while rotating 180 degrees then complete another jump squat]; Pike ups: [start in push up position with sliding discs under the feet; while keeping the knees locked, raise buttocks toward the ceiling and then descend back into the push up position]; Alternate lunge jumps = ALT Lunge Jumps: [place both arms straight overhead and grasp hands and then complete lunge jumping making sure to explode off the ground using both legs].

Class #3

Warm up

3i@10x10: JJ > P Jacks > FS

3i@10x10: P Jacks > P Squats > F Squats

Work

4i@15x15: SQTH > FS

4i@15x15: FS > SQTH

4i@15x15: JSQ > Chop Lunges

4i@15x10: Jump-hop-hop-hop-jump

4i@15x10: Pike ups: discs

Burn

2i@10x10: P Jacks > JJ > SQTH > FS > JSQ > ALT Lunge Jumps

Total sets = 33 Class time = 26:45

Total work time = 900 sec Total rest time = 390 sec

Average work time = 27.27 sec Average rest time = 11.81 sec

Overall intensity rating for class = .433

As stated previously, this workout contains 11 different exercises with 4 different timing protocols. The overall rating of (.433) is calculated by dividing the average rest time into the average work time. As workouts vary in intensity, the rating for the class reflects a specific work-to-rest ratio.

Materials and Methods

This current study applied the HIIT protocol by reversing the traditional 2 parts rest and 1 part work formula to a variation of the 2 parts work and 1 part rest protocol.

Subjects. This study followed 21 adults (15 female and 6 males) throughout a ten-week exercise regime (Table 1). Most were physically active (running, soccer, walking) and all subjects had participated in group exercise classes offered at the City of Eugene’s FitCity Wellness Center.

Table 1: Descriptive data of subjects

	Mean	Max	Min	STD
Age (years)	45.7	59	27	8.3
Height (inches)	65.14	76	55	5.02
Weight (lbs)	171	220	130	29

All participants were given a detailed explanation of the purpose, potential benefits, and risks associated with participating in this study.

Protocol. All classes were completed in a group exercise class format. After a brief warm-up, the subjects exercised at or near maximal effort using body weight exercises for the length of the class.

Exercise protocol. A unique variable exercise formula was utilized which included a specific number of sets or intervals, a work time value, and a rest time value. ¹

Experiment. Subjects exercised three days per week for ten weeks. All exercise sessions were conducted using HIIT. The students were encouraged to exercise as hard as possible for the duration of each class. Subjects were allowed to self-regulate their own intensity level. Even though they were encouraged to work as hard as possible, they were also encouraged to take mini-rest breaks if needed.

Methods

The following video link: [The HIIT Study](#) is a short demonstration of the general flow and how all the exercises fit together in a HIIT class. This is a shortened version of a regular class.

With the current study, the average class time of the 30 classes was 27:17 seconds, with a minimum time of 21:49 seconds and a maximal time of 32:41 seconds. There was a maximum of 1089 sets completed with an average of 39 sets per workout. The average work time for this study was 25.35 seconds and the average rest time was 11.59 seconds. The overall average intensity rating for all 30 classes was .457.

¹ Jon Joseph at FMWTraining.com has developed this unique variable exercise format which utilizes the basic concept of two parts work and one part rest developed by Dr. Izumi Tabata.

This current study had a possible 630 participation visits of which 561 visits were completed, resulting in an 89% participation rate. Up tempo music was used in each class with a 130-145 beats per minute pace. The same instructor taught all 30 classes.

Pretest. Subjects participated in a sub-maximal treadmill cardiovascular assessment to determine general fitness readiness. The Gerkin Fitness Protocol, which is a standard test on most treadmills, was used.

Body Measurements. Standard BMI and body weight measurements were taken. Body fat percentage was determined using the Jackson-Pollack 3-site method⁽⁷⁾ using a Lange Skinfold Caliper. Fat mass and fat-free mass was also calculated. Body circumference measurements were taken at the upper arms, chest, waist, hips, thighs, and calves.

Heart Rate. Subjects wore a Polar FT4 (Polar USA) chest strap and a watch to monitor heart rates. Average heart rate, maximum heart rate, and total calories expended were calculated after each workout to determine workout intensity.

Method of Analysis. Values are shown as means and standard deviations. The data was compared using a paired *t*-test using Microsoft Excel. The significance level for all comparisons was set at $P < 0.05$. The analysis was based on data collected from body weight, body fat, BMI, and body circumference measurements on 21 subjects over a ten-week period.

Results

Heart Rate Data. Average heart rate was collected during each class. Average heart rate was divided into a calculated maximal rate to determine the intensity of the workout illustrated in Table 2.

Table 2: Percent Mean of Maximum Heart Rate and Standard Deviations

	Weeks 1-2	Weeks 3-4	Weeks 5-6	Weeks 7-8	Weeks 9-10
Percent of Max HR	79.90%	80.66%	80.88%	81.61%	82.65%
STD	7.71%	6.18%	5.69%	6.05%	5.71%

Bodyweight. The study revealed that group mean bodyweight was reduced significantly ($P < 0.003$) after 10 weeks of training as shown in Table 3.

Table 3: Mean Bodyweight and Standard Deviations

	Pre-test	Post-test
Mean Bodyweight	171 lbs	167 lbs
STD	29.73 lbs	29.87 lbs

BMI. The group mean BMI was reduced significantly ($P < 0.002$) after 10 weeks of training using the study protocol as shown in Table 4.

Table 4: Mean BMI values and Standard Deviations

	Pre-test	Post-test
Mean BMI	27.40	26.64
STD	3.78	3.80

Body Fat Percentage. The group body fat percentage was reduced significantly ($P < 0.000$) as shown in Table 5.

Table 5: Mean Body Fat Percentage and Standard Deviations

	Pre-test	Post-test
Mean body fat %	26.2%	23.6%
STD	6.00%	6.02%

Fat mass. The fat mass group mean was reduced significantly ($P < 0.000$) as shown in Table 6.

Table 6: Mean Fat Mass and Standard Deviations.

	Pre-test	Post-test
Mean fat mass	44.61 lbs	39.31 lbs
STD	12.61 lbs	11.97 lbs

Fat Free-Mass. The fat-free mass did not reach significance ($P < 0.066$) as shown in Table 7.

Table 7: Mean Fat-Free Mass and Standard Deviations

	Pre-test	Post-test
Fat-free mass	126.15 lbs	127.64 lbs
STD	25.21 lbs	26.18 lbs

Body Circumference Measurements. The body circumference measurements of left/right upper arms, chest, waist, hips, and left/right calves were reduced significantly ($P < 0.000$, $P < 0.000$, $P < 0.002$, $P < 0.002$, $P < 0.000$, $P < 0.006$, $P < 0.014$). The left/right thighs did not reach significance ($P < 0.321$ and $P < 0.181$) as shown in Table 8.

Table 8: Mean body circumference measurements.

	Left Arm	Right Arm	Chest	Waist	Hips	Left Thigh	Right Thigh	Left Calf	Right Calf

Mean Pre-test	11.43"	11.29"	40.67"	36.26"	40.83"	21.26"	21.20"	14.43"	14.38"
Mean Post-test	11.05"	10.95"	39.96"	35.51"	39.86"	21.18"	21.35"	14.23"	14.17"

Discussion

The main findings of this study was that ten weeks of high-intensity interval training had a positive effect on body weight loss, reducing BMI, reducing body fat percentage, reducing fat mass, increasing fat-free mass, and reducing body circumference measurements.

In conclusion, HIIT three days per week for ten weeks produced significant reductions in body weight, BMI, body fat percentage and body circumference measurements except for the thighs. The total body circumference inches lost by all subjects was 73.45 inches: 15.75 inches was lost off the waist and 20.5 inches lost off the hips. HIIT reduced fat mass significantly and increased fat-free mass. This study suggests that using HIIT with high variability in timing protocols and high variability of exercises in an adult group exercise class is an effective way to produce positive fitness outcomes. With the success of this HIIT study, this type of group exercise class with variety in the timing and exercise formulas could have great potential for group instructors, personal trainers, and fitness facilities to increase revenue streams while using HIIT since each class is only 30 minutes.

References

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