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Not All HIFT Classes Are Created Equal: Evaluating Energy Expenditure and Relative Intensity of a High-Intensity Functional Training Regimen

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ABSTRACT

International Journal of Exercise Science 13(4): 1206-1216, 2020. The demand for efficient and effective exercises has grown in concert with increased attention to fitness as a determinant of overall health. While past studies have examined the benefits traditional conditioning exercises, there have been few investigations of high intensity functional training (HIFT). The aim of this study was to measure the energy expenditure and relative intensity from participation in a signature, 35-minute group-based HIFT regimen. During the HIFT session, 13 volunteers (aged 23-59 years, 6 females) donned a portable breath-by-breath gas analyzer and a heart rate monitor. Mean caloric expenditure (528 ± 62 kcal), maximum heart rate (172 ± 8 bpm), and metabolic equivalents (12.2 ± 1.4 kcal/kg/h) were characterized as a vigorous-intensity activity according to the Compendium of Physical Activities guidelines. Moreover, implementing this high energy expenditure session twice weekly may comport with *Physical Activity Guidelines for Americans* weekly physical activity recommendations. HIFT training may provide time-efficient exercise for those seeking exercise-related health benefits.

KEY WORDS: Exercise, high intensity functional training, physical activity, training, metabolic equivalent, caloric expenditure

INTRODUCTION

Almost 85 years have elapsed since fitness pioneer, Jack LaLanne, opened what is considered the first gym in the United States. The landscape of gyms has drastically changed from the early "grunt and clank" style of basement-like weightlifting gyms to "big box" health clubs and to smaller fitness boutique franchises. Within the past five years, some of these fitness boutiques have been embraced by many consumers and experts alike by specializing in niche exercise programming that may maximize health-fitness outcomes via group training. This movement credits the logic that training with others builds feelings of affiliation and challenge, leading to greater program adherence and work effort (6, 10, 15). One such program is High-Intensity Functional Training (HIFT). HIFT incorporates many of the same principles as High-Intensity Interval Training (HIIT), including the relatively high work-to-rest intervals (11). However, HIFT training goes further and weaves multimodal resistance training with cardiovascular exercises. Functional training is exercise in multiple planes (i.e. sagittal, frontal, and transverse) that is tailored to each participant to improve performance of activities of daily living (31). HIFT consists of a variable series of these functional whole-body exercises with little rest, while HIIT consists of unimodal, single-plane movements with distinct periods of low-intensity activity or rest (12).

HIFT further distinguishes itself through its incorporation of dynamic rest intervals in a balanced blend of exercises, producing a high intensity workout that elicits both cardiovascular and musculoskeletal adaptions (12). This premise has been demonstrated across different genders and fitness levels as both inactive and recreationally active individuals experienced enhanced performance after undergoing HIFT training (7, 13, 21). During independently conducted 4-week (21), 8-week (7), and 16-week (13) trials, improvements in overall body composition, aerobic capacity, and muscular strength were observed. Brisebois et al. also reported an increase in lean body mass as well as reductions in diastolic pressure and resting heart rate (7).

While the benefits of general HIFT have been investigated in various studies, existing research does not consider the diversity that exists within HIFT (9, 17, 38). CrossFit emerged early on as a popular form of HIFT among fitness enthusiasts, in which gymnastics, weightlifting, and cardiovascular exercises are performed at a high intensity with little to no rest between sets (24). Since then, several other branches of HIFT training have emerged. All subclasses are united in their ability to synchronously stress various body systems. However, their categorization under HIFT does not impose limits on the work-to-rest intervals or the exercises performed.

Willis et al. recently analyzed the energy expenditure and relative intensity of another HIFT class and concluded that this general format is compliant with healthy exercise recommendations (38). Though a paucity of research exists on HIFT, this work establishes a baseline for future comparison while validating energy expenditure and intensity as key metrics for evaluating HIFT's potential to efficiently fulfill national exercise guidelines. The *Physical Activity Guidelines for Americans* describes how adults should participate in 150 to 300 minutes of moderate-intensity activities, or 75 to 150 minutes of vigorous-intensity activities, per week in order to achieve substantial health benefits (32). While HIFT has been demonstrated to procure beneficial fitness outcomes, further investigation is needed to determine the efficacy of the many available HIFT programs. Previously conducted trials commonly used self-paced resistance and cardiovascular training (26, 38). However, this does not account for protocol variations, such as incorporating intermittent active recovery and rounds of aerobic training (e.g. Assault Airbike) between sets of functional training. As with many forms of exercise, not all HIFT classes are created equal and it is important to examine and characterize the various regimens that are becoming widely available.

The purpose of this study is to objectively measure energy expenditure and intensity of a signature, proprietary form of group-based High-Intensity Functional Training (HIFT). Furthermore, this HIFT class has distinct features that may distinguish it from other HIFT formats and enable it to meet the weekly exercise standards established by the *Physical Activity Guidelines for Americans* in a time-efficient manner. Our hypothesis is that this specialized group based HIFT class will meet national recommendations for exercise based on energy expenditure and intensity due to its unique regimen design.

METHODS

Participants

The cohort for this study included 13 adult volunteers (aged 23-59 years, 6 females) with membership at Basecamp Fitness® (Basecamp Fitness LLC, Woodbury, MN), located in West Hollywood, CA. Recruitment consisted of verbal advertising at this location. Study exclusion criteria included the presence of musculoskeletal, cardiovascular, pulmonary, metabolic, or other disorders that would preclude high-intensity exercise training. All participants provided written informed consent at the beginning of the study. This research was approved by the UCLA Institutional Review Board and carried out fully in accordance with the ethical standards of the Helsinki Declaration. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (29).

Protocol

This was a prospective, exploratory study using apparently healthy, aerobically trained individuals with varying experience completing HIFT classes. Prior HIFT experience was obtained via company computer records of classes completed in the past 12-months while height and weight were measured at the facility with a Physician's Beam scale (Detecto, Webb City, MO). Participants were asked to maintain their normal diet and refrain from strenuous or unaccustomed exercise 24 hours prior to testing.

Each participant completed one session of the signature proprietary group based HIFT class. The study took place at the Basecamp Fitness location in West Hollywood, CA. The 35-minute class was led by a group instructor and consisted of thirty 1-minute rounds of work separated with 10-second intervals of rest and transition. Rounds of work alternated between 15 minutes on an Assault Airbike® (Assault Fitness, Carlsbad, CA) (averaging 55-65 rpm interspersed with 10-sec sprints halfway through) and 15 multiplanar functional upper and lower body resistive exercises on a matted floor. The resistive exercises equipment included TRX Suspension Training® (Fitness Anywhere LLC, San Francisco, CA), kettlebells, barbells, dumbbells, and one's body weight (Figure 1). Initial weights were individually chosen by participants while the group instructor encouraged subsequent weights on each exercise to be increased. Although there were many frontal and sagittal plane-oriented exercises, rotational motions including twisting/turning (i.e. transverse plane) were integrated into a number of exercises in the last 15-20 seconds of each minute (e.g. KB Reverse Lunge with Rotation). This unified combination recruited larger quantities of total musculature in a synchronized fashion and ensured greater stabilized force transfer through the multiple joints of the class participants.

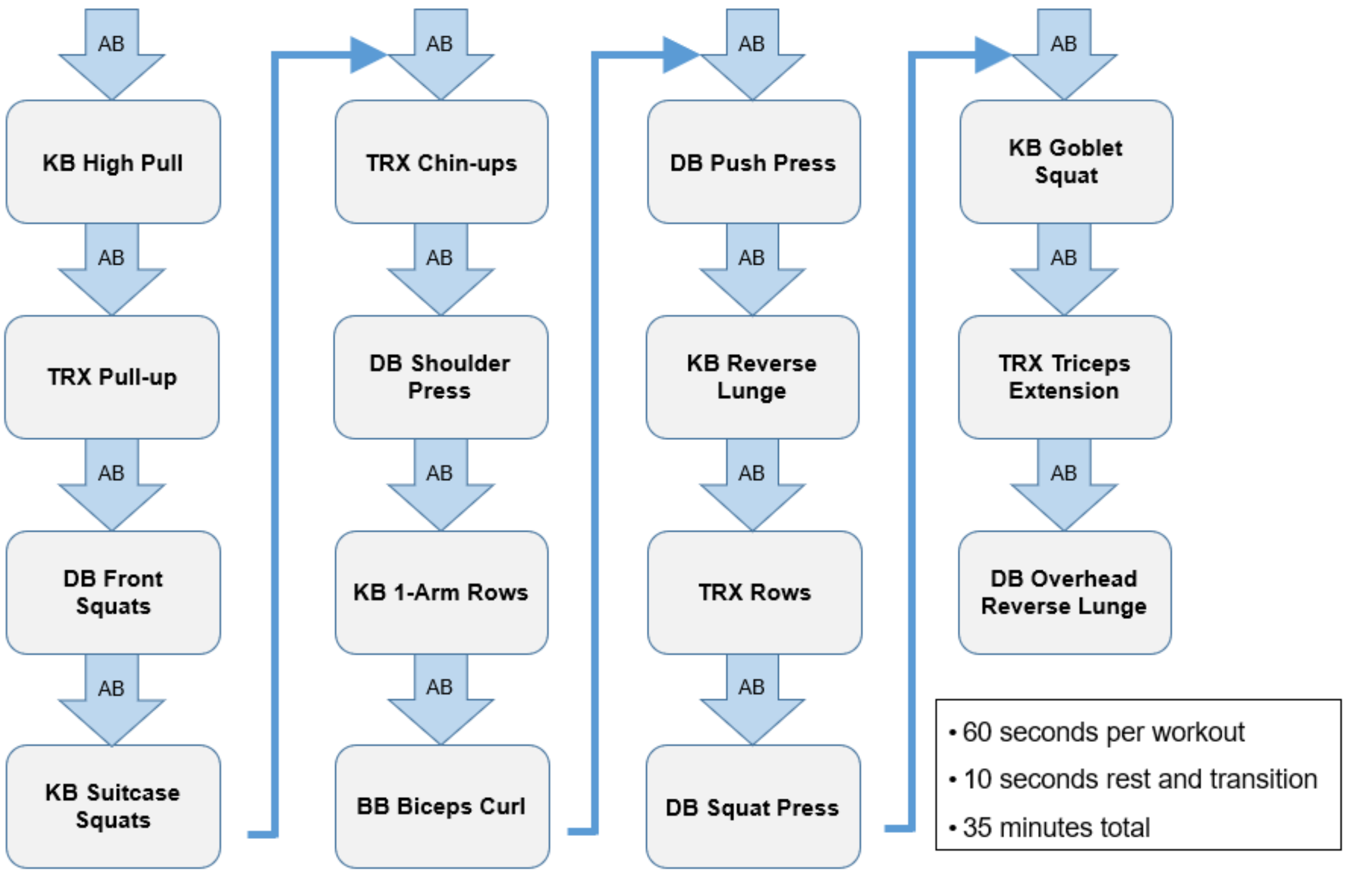

Figure 1. Example of a signature group based HIFT class (5). AB = Assault Bike; KB = Kettle Bell; TRX = Total Resistance Exercise Suspension Trainer; DB = Dumbbell; BB = Barbell.

The main outcomes for this study were exercise intensity and energy expenditure. Validated in prior HIFT research (38), the Polar® (Polar Electro Inc., Bethpage, NY) RS400 Heart Rate chest strap monitor helped quantify exercise intensity and determined whether this training regimen met national exercise guidelines. During the HIFT session, heart rate was recorded in 15-second periods and time-aligned with the PNOĒ onboard firmware. Energy expenditure was simultaneously measured by a PNOĒ® (ENDO Medical, Palo Alto, CA) lightweight (approximately 800g) portable indirect calorimeter. The PNOĒ system has been previously validated (34). This open-circuit device measured breath-by-breath gas exchange including minute ventilation and concentration of expired oxygen and carbon dioxide. The PNOĒ was attached by a shoulder harness face-forward to the participant's upper torso. The participants wore a standard Hans Rudolph (Hans Rudolph, Shawnee, KS) face mask attached to the devices MEMS-based hot film anemometer flow sensor (for ventilation measures). Prior to testing, explanation of device functionality and proper fitting of the equipment to each participant was determined. To allow time for participants to acclimate to the facemask and to determine if the indirect calorimeter was functioning properly, energy expenditures were measured for approximately 3 minutes prior to beginning the HIFT session. These data were not included in the analysis. Per manufacturer instructions, the gas analyzers were calibrated prior to each assessment. Participants wore the devices and data collections lasted for the duration of the HIFT session (i.e. 35 minutes), however it did not include warmup and cooldown segments since these were not standardized for this class (i.e. participants conducted warmup and cooldown exercises individually without the group and instructor). Data were transmitted real-time via telemetry and stored in the PNŌE iCloud platform for further analysis. Average calorimeter data were calculated for the entire session by analyzing 15-second epochs. The abbreviated Weir formula (energy expenditure = 1.44 × (3.9 × [VO_2 consumed] + 1.1 × [VCO_2 produced])) was used to determine average energy expenditure (36). Standard resting energy expenditure values (3.5 ml/kg/min) were used to determine metabolic equivalents (MET).

Statistical Analysis
Descriptive statistics are presented as mean ± standard deviation (SD). Statistical significance was determined based on $\alpha = 0.05$, and all tests were two-tailed. Continuous variables were first assessed for normality via Shapiro-Wilk tests. Between-group comparisons were made by Welch's t-tests as all data did not significantly deviate from normality. A Holm-Bonferroni correction to control the familywise error rate was applied. Effect sizes were measured by Hedges' g. Analysis was performed in Excel (Microsoft Corporation, Redmond, Washington) and R version 3.5.1 (R Foundation for Statistical Computing, Vienna, Austria). Based on a pre-hoc power analysis using previous literature of similar design (38), we calculated a required group sample size of 14 based off energy expenditure in total kcal to detect significant differences assuming $\alpha = 0.05$ and $\beta = 0.8$.

RESULTS

Out of 15 initial participants, only 13 successfully completed the program. This discrepancy was due to one participant dropping out at the beginning of the class and an equipment malfunction in another participant. Demographic and selected physiological data are depicted in Table 1. The cohort mean BMI was 24.8± 2.9 kg/m^2. Prior HIFT history ranged from 20 to over 500 classes. During the HIFT session, males measured an average of 582 ± 14 total kcal, while females measured 465 ± 16 total kcal. The cohort average MET was 12.2 ± 1.4 kcal/kg/hr.

No significant differences in baseline demographics were found between the male and female participants. Similarly, METs, average HR, max HR, and %max HR did not significantly differ between sexes. In contrast, significant differences in EE were evident between men and women after correcting for multiple comparisons. Men demonstrated greater utilization of kcal/min ($P = 0.010$, $g = 6.50$) and total kcal ($P = 0.010$, $g = 7.86$) compared to women despite no differences in height, weight, or BMI.

Table 1. Demographic and Physiologic responses to a specialized 35-minute HIFT session (n=13).

Parameter		Total (n=13)	Male (n=7)	Female (n=6)
Demographics	Age	32.7 ± 10	31.0 ± 5.6	35.0 ± 13
	Height (cm)	174 ± 10	179 ± 9.9	168 ± 5.2
	Weight (kg)	74.8 ± 9.2	79.2 ± 9.1	69.7 ± 6.7
	BMI	24.8 ± 2.9	24.7 ± 2.1	24.9 ± 3.8
Energy Expenditure	kcal/min	14.9 ± 1.8	16.4 ± 0.33 *	13.1 ± 0.61
	Total kcal	528 ± 62	582 ± 14 *	465 ± 16
METS	kcal/kg/hr	12.2 ± 1.4	12.7 ± 1.6	11.5 ± 0.91
Heart Rate	Average bpm	165 ± 4.8	164 ± 5.9	167 ± 3.1
	Max bpm	172 ± 8.0	173 ± 4.0	172 ± 12
	% HR max	92.1 ± 1.3	91.0 ± 1.2	92.9 ± 0.95

Values are mean ± SD. *Significantly different from females ($p = 0.01$).

DISCUSSION

Exercises eliciting high caloric expenditure, such as HIFT, have been shown to effectively induce weight loss and mitigate certain cardiometabolic risk factors (1, 38). The mean energy expenditure in this study was 528 ± 62.3 kcal per session with a mean expenditure rate of 15.1 ± 1.8 kcal/min (Table 1). This is comparable to a 45-minute vigorous cycling session (519 ± 60.9 kcal) and exceeds the calories burned during a typical 2:1 (work-to-rest ratio) high-intensity interval training session (261 ± 43.6 kcal) (19, 22). The energy expenditure found in this study also exceeded vales from another HIFT study that used a portable metabolic analyzer (144.99 ± 37.13 kcal) (26). Based on these energy expenditure results, two HIFT sessions per week would satisfy the 75-150 minutes of vigorous exercise recommendations from the *Physical Activity Guidelines for Americans* (32). This confirms our hypothesis that a specialized HIFT regimen can fulfill national exercise guidelines.

As another key index to quantify exercise intensity, METs were used to characterize the metabolic demand relative to each participant's mass. The mean cohort MET found in this study was 12.2 ± 1.4, with no substantial difference between males and females (Table 1). The derived MET values indicate that our participants each measured over 12 times as much oxygen than they would have at rest (20, 25). The MET value for this study scores highly as a "vigorous-intensity exercise" relative to other common activities listed in the Compendium of Physical Activities (2). Compared to other forms of exercise in Figure 2, the HIFT training class is comparable to activities such as running or mountain biking. This specific program not only surpasses traditional conditioning exercises, such as calisthenics or circuit training, but also exceeds a similar HIFT program. Willis et al. investigated HIFT classes and found that male and female participants elicited mean metabolic equivalents of 9.2 and 8.1, respectively (38). While HIFT classes generally have high relative METs, this variation may indicate metabolic advantages to specialized regimens. Additional research of specialized HIFT programs will provide further insight to this comparison. From these results, it is presumable that prior experience is not correlated with the intensity of the workout (as defined by MET). In other words, the HIFT regimen in this study provided workouts of comparable intensity independent of prior training experience.

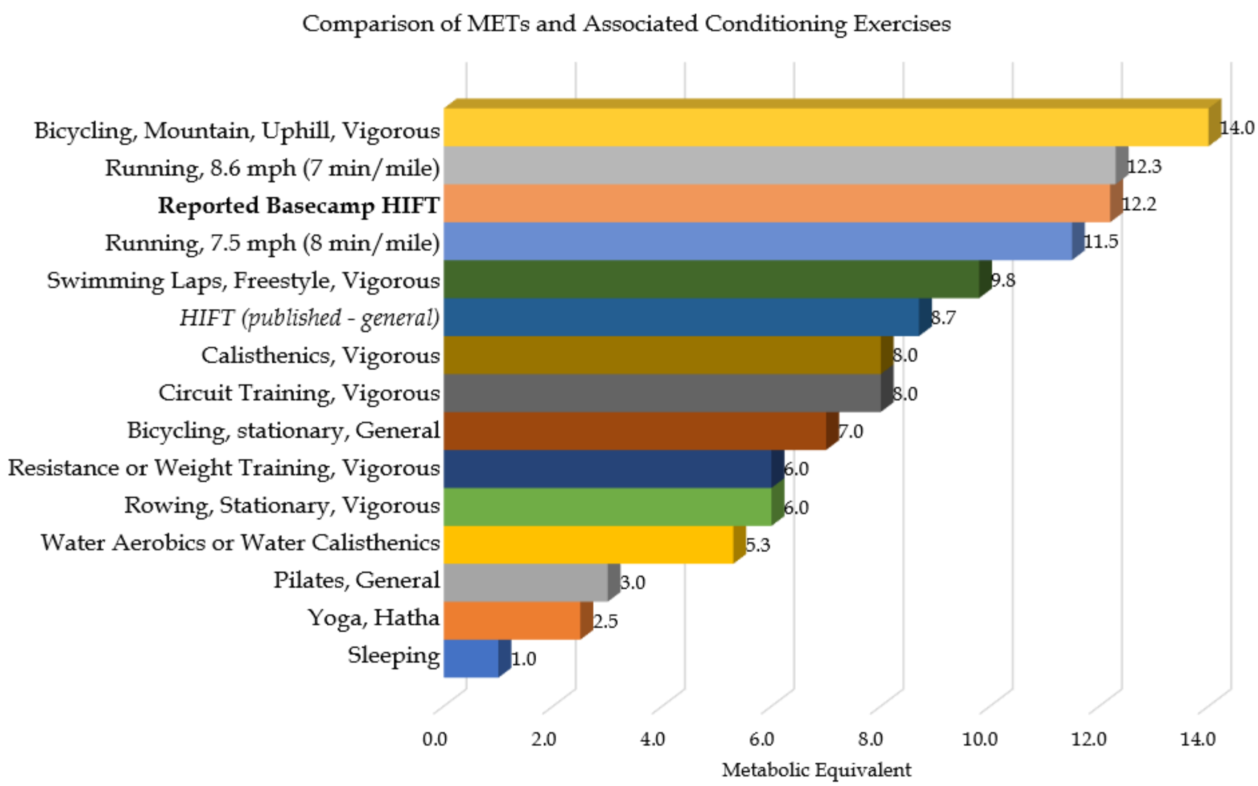

Figure 2. Comparison of this study's HIFT MET (bolded) with other conditioning exercises. The HIFT MET found by Willis et al. is denoted in italics (38). All other MET values are drawn from the Compendium of Physical Activities (2).

When comparing genders, males demonstrated a greater energy expenditure than females. Males have been shown to possess greater heart size (i.e. larger stroke volume) and hemoglobin level, which can facilitate the transfer of oxygen and increase metabolic rates (23, 28, 37). Additionally, individuals with greater weight and higher levels of fat-free mass tend to have higher metabolic rates than those with less weight and lower levels of free-fat mass (18).

This study focused on a HIFT class with specialized features that may explain the MET and energy expenditure results. First, the classes used group-oriented workouts to motivate participants. Group exercises have been shown to promote enjoyment, affective valence, and exertion, specifically when perceptions of "groupness" were high (15). Performing the same exercises alongside others can help motivate individuals to persist longer than they would have otherwise. This phenomenon is known as the Köhler effect (14). Therefore, the HIFT training regimen from this study may foster a friendly environment for exercise, while cultivating a sense of community amongst the members. This is turn promotes participant enjoyment during HIFT sessions and makes a long-term commitment to training more likely thereby facilitating better overall fitness and health (10). Considering the design of our study, the Köhler effect may have contributed to the relatively high and similar MET values across the study cohort.

Secondly, the low-intensity transitions between high-intensity exercises during this HIFT session may provide metabolic advantages. Thirty 1-minute rounds of work were separated by 10-second intervals of low intensity transitions or rest. Integration of intermittent active recovery can lead to higher lactate thresholds compared to those who engage in passive recovery (27). Additionally, sustained high intensity exercises promote less efficient fat oxidation, which occurs maximally at exercise intensities between 47% to 75% (33). The increase in fat oxidation occurs within 15 minutes of interval exercise with peak being met within 25 minutes (3). With the studied HIFT session limited to 35 minutes of repeated oscillations of high and moderate intensity exercise, adequate time and exercise intensity may have been reached to effectively induce optimal rates of metabolism.

Finally, the HIFT class utilized in this study uniquely incorporates intermittent 1-minute rounds on an Assault Airbike, which includes an upper body ergometer component to its lower body ergometer (4). Compared to leg pedaling bikes alone, the Assault bike's upper body ergometer provides additional muscle mass and subsequent stress to the cardiovascular system than leg pedaling alone, as evidenced by the increased heart rate rates (163-170 bpm) found in this study. Elliptical machines, which also include an upper body component, have been shown to elicit a higher heart rate than running on a treadmill (8). The average % HR_{max} of 91% in men and 93% in women exceeded the cutoff for high intensity exercise (60-84%) as described by the Physical Activity Guidelines for Americans (30, 35). These factors may explain the elevated metabolic cost and MET value of the HIFT from this study. Together, these results indicate that the studied HIFT workout provides adequate intensity for improving health and fitness outcomes.

The cohort for this study shared similar attributes (age, height, weight, and BMI) and was considered empirically healthy (16). While the homogeneity in the demographics indicated uniformity in body composition and health, the cohort did exhibit variability in HIFT experience. With a broad range in the number of classes completed prior to testing (20-600 classes), the participants differed in exposure to the specific training regimen examined in this study. Thus, the results of this investigation may be interpreted based on a uniform cohort with different HIFT experience levels.

This study was conducted in the health-fitness club environment with member volunteers. The extent to which the findings reported here might be seen in other locations or health-fitness club chains is uncertain. Moreover, additional participants would further substantiate these study findings and add statistical power. As such, limitations must be considered when interpreting the data. Additional cardiovascular measurements, such as a VO_{2max} test, could also supply an objective measure of each participant's fitness level which can serve as a covariate in the data analysis. Body composition analysis, including body fat percentage, muscle mass, and fat mass, may provide more quantitative data in lieu of BMI. These suggestions would bolster future findings and better elucidate the physiology behind specialized HIFT programs.

Given the importance of exercise as a component of overall health, specialized group based HIFT, such as described herein, may provide a practical solution. This study demonstrates that certain exercises, time-intervals, and sequences can induce maximal caloric expenditure and exercise intensity. The HIFT regimen investigated in this study potentially fulfills the national exercise guidelines for weekly vigorous-intensity activities, as outlined by the *Physical Activity Guidelines for Americans*. Furthermore, the time-efficient nature of such programs may promote greater participation from the public. Nevertheless, many other specialized HIFT regimens have yet to be investigated for their efficacy. Additional research is required to assess the efficacy of this and other specialized HIFT programs. The results of this study encourage future creativity when designing and implementing effective, advantageous HIFT regimens.

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