Original Article

Health and fitness benefits using a heart rate intensity-based group fitness exercise regimen

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ABSTRACT

Inactivity leads to morbidity and mortality, while novel and engaging approaches to fitness improve health outcomes. The current study examined an 8-week commercial group exercise regimen for high intensity interval training (HIIT) in order to examine comprehensive metrics of health and fitness. Aerobic fitness, body composition, resting metabolic rate, blood cholesterol and glucose, in addition to resting blood pressure were quantified in a laboratory setting independent of the training facilities. Exercise training utilized multimodal HIIT-based exercises and work intensity was gauged by real-time heart rate feedback. All participants completed the required two sessions per week. Pre-Post analyses indicate aerobic fitness (Pre $\dot{V}O_{2max}$ = 36.8 ml•kg^{-1}•min-^{1}; Post $\dot{V}O_{2max}$ = 40.8 ml•kg^{-1}•min-^{1}), % fat (Pre = 28.1%; Post = 27.0%), resting metabolic rate (Pre = 1557 kcals; Post = 1664 kcals), resting blood pressure (Pre = 128.8/78.1 mmHg; Post = 116.7/75.4 mmHg), and circulating triacylglycerol (Pre = 100.0 mg/dl; Post = 78.7 mg/dl) were significantly altered. This study quantified improvements in aerobic fitness, body composition, resting metabolic rate, resting blood pressure, and triacylglycerol after an 8-week HIIT regimen. The implications of heart rate (HR) monitoring within franchised group exercise with wearable technology serves as an unexplored scientific approach to understand novel exercise prescriptions on health-fitness outcomes. Future research should investigate sociological aspects of program adherence, while biological applications should examine the adaptive stimuli of HIIT training on health and fitness improvements.

Keywords: Aerobic fitness; Cardiovascular health; HIIT; VO_{2max}; Interval training; Group exercise.

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INTRODUCTION

Over the last 50+ years industrialized countries have experienced lifestyle-influenced morbidity and mortality. Regular physical exercise participation is among the most potent lifestyle counter measures to combat the detrimental effects of inactivity (Haskell et al., 2007; Lee et al., 2010). While the various causes of wide-spread inactivity and barriers to regular exercise participation are numerous, two mitigating factors to exercise adherence include the time required to exercise and an inverse relationship between high exercise intensity and exercise adherence (*ACSM's guidelines for exercise testing and prescription*, 2016; Racil et al., 2013). Nonetheless, high intensity interval training (HIIT) is among the popular exercise trends. HIIT is an encompassing term for a variety of time efficient interval-type exercises (Oliveira et al., 2018). While HIIT exercise is well characterized in terms of fitness adaptations (Gaesser & Brooks, 1984), the health benefits conferred by HIIT continue to be revealed in newly published research literature. In addition to aerobic power, 3-12 months of HIIT exercise elicits many beneficial alterations to body composition, blood lipids, and various cardiovascular health variables (Izadi et al., 2018; Khammassi et al., 2018; Racil et al., 2013; Racil et al., 2016; Roy et al., 2018; Sijie et al., 2012). Long-term physiologic outcomes to HIIT are the culmination of biochemical alterations that emerge days to weeks (Fisher et al., 2011; Talanian et al., 2007) following the introduction of HIIT exercise. However, other investigations clearly demonstrate that exercise program persistence underpins comprehensive health and fitness benefits (Roy et al., 2018; Sperlich et al., 2018). For instance, basal metabolic rates and excess post exercise oxygen consumption (EPOC) are acutely increased by HIIT (Gaesser & Brooks, 1984; Talanian et al., 2007), but body composition require an indefinite participation extending beyond 4-weeks (Sperlich et al., 2018).

In regard to HIIT applications, commercial fitness approaches have been used for decades to improve cardiorespiratory fitness and muscular strength (Claudino et al., 2018; Kerksick et al., 2009). Another recent health and fitness trend includes group exercise approaches within franchised fitness centres that prescribe a common workout regimen nationally/internationally (Claudino et al., 2018). Wide-spread availability of franchised group fitness facilities may be of particular scientific interest in that exercise regimen are developed within a central corporate office and disseminated nationally/internationally. While not yet quantified scientifically, the franchised approach to group fitness is a novel venue to understand the impact of exercise prescriptions on individual groups (and subgroups). Examination of franchised group exercise in combination with modern application of wearable technology presents an unprecedented venue by which health and fitness benefits can be quantified. According to this rationale, we partnered with a national/international fitness franchise which features HIIT-based cardio-strength exercise while using real-time HR-feedback.

MATERIALS AND METHODS

Participants

Twenty-eight participants were recruited for the current study, granted written informed consent for participation in a health and fitness testing program, and signed a release document with [removed for blinding]. Prior to initiation of baseline testing, each participant completed an AHA/ACSM cardiovascular risk assessment to confirm that inclusion criteria were met (*ACSM's guidelines for exercise testing and prescription*, 2016). Of the original 28 participants, 5 participants were excluded due to post-test scheduling logistics. In this regard, the 5 excluded participants were unable to get post tested before they completed two additional weeks of exercise training. For this reason, and to preserve the 8-week exercise intervention, a total of 23 participants completed the entire study and were included in the final data. Data were collected at the funding organization facility. All data analysis, manuscript preparation, and interpretation occurred at the University of Montana.

Measures

Participants arrived for Pre and Post morning testing sessions, following a 12-hour overnight fast. The procedure for Pre and Post testing was identical and conducted within a common two-hour time window. Data collection proceeded from RMR, to resting blood pressure, body composition assessment, a finger prick for blood cholesterol and glucose assessment, and concluded with a VO_{2max} treadmill test.

RMR

Fasted participants reported to the laboratory for RMR testing having abstained from exercise for 48-hours. RMR protocol adhered to established best practices and were administered identically for Pre and Post testing scenarios (Compher et al., 2006). Prior to testing, participants rested in the supine position for at least 20-minutes, followed by a 15-minute RMR test. RMR was quantified via indirect calorimetry using Vyntus CPX metabolic cart (Vyaire Medical, Mettawa, IL).

Blood pressure

Resting blood pressure was performed via manual auscultation. Blood pressures were quantified in the left arm, at the end of the RMR test, with participants in the supine position. Measures were recorded twice, with a third trial being performed when values differed by more than 5 mmHg. Final blood pressure values reflect an average of the collected measures.

Body composition

Body composition was quantified using an InBody 570 bioelectrical impedance device (InBody, Buena Park, CA). In contrast to prior bioelectrical devices, the InBody system exhibits improved estimates by incorporating 2-connections (hand and foot), in addition to five current frequencies between 1kHz and 1MHz. This approach reduces confounding effects related to acute hydration changes. Resultant body composition measures are further strengthened by five calculations derived from impedance values of different body segments: arms and legs only, left and right arm-leg combinations, and a total body measure. Validation studies of the InBody device are based on DEXA references (Volgyi et al., 2008).

Fasting cholesterol and glucose

Fasting whole blood capillary samples (30µl) were collected and processed in a portable automated Cholestech LDX blood analysis system (Abbot Diagnostics, Santa Clara, CA). Specifically, the Alere Cholestech LDX Lipid Profile*Glu Cassette was used. The automated assay cassette directly quantified: total cholesterol, HDL cholesterol, triacylglycerol, and glucose, while LDL cholesterol was derived.

Max testing

Maximal aerobic testing was performed on a Vyntus CPX metabolic cart (Vyaire Medical, Mettawa, IL) and a Star Trac 8TRX treadmill (Core Health & Fitness, Lake Forest, CA). Individualized treadmill protocols were employed in a user-defined approach based on recent walking or running behaviours. All participants began the test with a two-minute warm-up stage walking at 3.5 mph. Subsequent two-minute stages were based on whether the participant was a runner or walker. Runners undertook subsequent stages at five mph, while walkers proceeded with increments above 3 mph. For each two-minute stage increment, speed was increased by one mph for all participants. Stage-by-stage feedback was used to gauge whether one mph speed or three percent grade increments would occur, with the latter being increased once a participant perceived that peak treadmill speed was obtained. This approach in healthy adults was based on understanding that progressive workload increases of one mph or three percent grade increments approximate a one MET workload increase. Maximal intensity was based on achieving at least two criteria: heart rate, rate of perceived exertion (RPE), respiratory exchange ratio (RER), oxygen consumption plateau with an increased workload (*ACSM's guidelines for exercise testing and prescription*, 2016). Anaerobic threshold (AT) was determined using the V-slope method of plotting carbon dioxide output ($\dot{V}CO_2$) against oxygen uptake ($\dot{V}O_2$) (Gaskill et al., 2001; Schneider et al., 1993). HR was determined using a Polar Bluetooth heart rate monitor. Treadmill speed and grade were used to calculate MET loads at maximal intensity exercise and AT (*ACSM's guidelines for exercise testing and prescription*, 2016).

Experimental overview

Recruitment was based on e-mail invitations to participate in a fitness study. Inclusion was based on being apparently healthy as determined by Physical Activity Readiness Questionnaire - Plus (PAR-Q+) criteria. The study population included apparently healthy, middle age males and females exposed to a comprehensive battery of tests to gauge program impact on aerobic fitness, body composition and resting metabolic rate, blood lipid and glucose profiles, and resting blood pressure. Given prior unknowns about the time-course for acquisition of wide-spread health and fitness benefits to HIIT, participants were tested prior to program initiation and after 8-weeks of completion. The latter time frame being within the 4-week to 12-week window when most of the adaptive benefits appear likely to emerge (Khammassi et al., 2018; Oliveira et al., 2018; Racil et al., 2013; Sperlich et al., 2018). The previously unpublished study design included a recruitment phase, an identical and comprehensive pre- (Pre) and post-test (Post) battery of measures to quantify resting metabolic rate (RMR), blood pressure (BP), a fasting blood cholesterol profiles and glucose, body composition assessment, and a VO_{2max} test. Because potential participants were recruited from volunteer registrants of a commercial fitness facility, a quasi-experimental design was employed whereby Pre and Post testing variables were collected. Between the Pre and Post testing time periods participants completed an 8-week exercise intervention whereby intensity was gauged through continuously monitored heart rate prescriptions. The study design is presented in Figure 1.

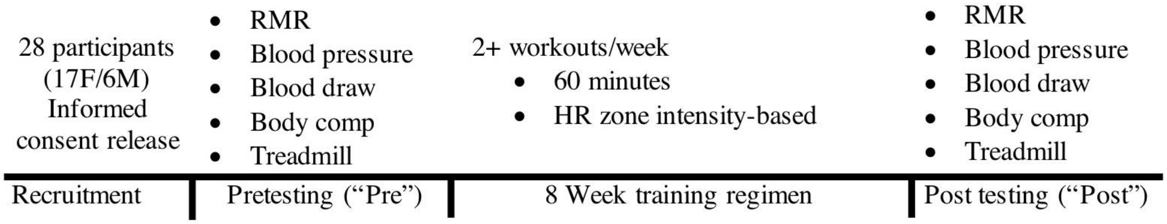


Figure 1. Study design figure. Participants were recruited to undertake an 8-week exercise regimen that emphasised a HR-based intensity prescription. A common Pre/Post testing battery included RMR, resting BP, a fasting blood draw for a basic cholesterol profile and glucose, body composition assessment, and a maximal aerobic capacity test.

Exercise intervention

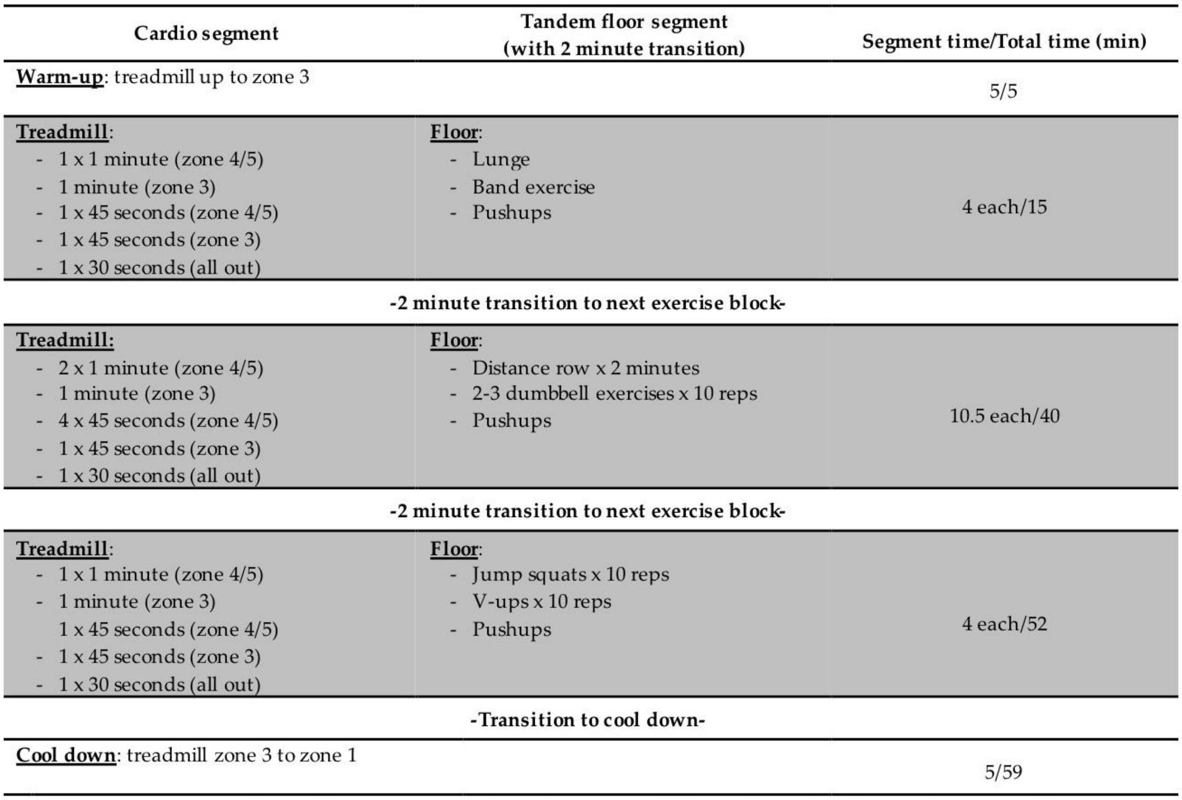
Participants engaged in an 8-week exercise intervention within a franchised commercial exercise facility. Exercise was cardio-based but included full body exercises with components of muscular strength and muscular power. Daily exercise programs were administered during hour-long group sessions of heart rate-focused interval training. Participants were educated on their HR zones and viewed their real-time heart rate responses during the exercise sessions using Orange Theory Fitness HR monitors with findings displayed on overhead screens as a means of immediate intensity feedback and motivation. Moreover, zone HR was conveyed to participants through a color-coded display whereby designated colours on a participants' screen indicated their current intensity zone. Exercise was prescribed on a self-selective basis within five HR intensity zones delineated within the upper and lower limits of ACSM prescriptive criteria for healthy adults (*ACSM's guidelines for exercise testing and prescription*, 2016):

- Zone 1 – 64% HRmax – 90% AT
- Zone 2 – 90% of AT
- Zone 3 = HR at AT
- Zone 4 = HR at 1.06% of AT
- Zone 5 = HR at 95% of HRmax

In an effort to achieve elicit adaptive responses to moderate-to-high intensity exercise in response to sustained exercise, novice participants were instructed to perform most of their cardio within zone 3, while intermittent higher intensity "push" exercise would be maintained for 30 seconds to four minutes. Participants were reminded that exercise in zone 4/5 elicits increased EPOC (Gaesser & Brooks, 1984). Time spent in zone 4/5 was tracked in order to incentivise participants for high intensity engagement. Accordingly, participants were directed to set workloads according to whether their treadmill tempo pace involves walking, jogging or running. In this scenario, walkers engaged in a zone 4/5 "push" interval by increasing treadmill grade, while joggers and runners primarily increased speed.

Workout

Table 1. A representative workout from the 8-week exercise intervention.



Cardio segment	Tandem floor segment (with 2 minute transition)	Segment time/Total time (min)
Warm-up: treadmill up to zone 3		5/5
Treadmill: - 1 x 1 minute (zone 4/5) - 1 minute (zone 3) - 1 x 45 seconds (zone 4/5) - 1 x 45 seconds (zone 3) - 1 x 30 seconds (all out)	**Floor**: - Lunge - Band exercise - Pushups	4 each/15
	-2 minute transition to next exercise block-	
Treadmill: - 2 x 1 minute (zone 4/5) - 1 minute (zone 3) - 4 x 45 seconds (zone 4/5) - 1 x 45 seconds (zone 3) - 1 x 30 seconds (all out)	**Floor**: - Distance row x 2 minutes - 2-3 dumbbell exercises x 10 reps - Pushups	10.5 each/40
	-2 minute transition to next exercise block-	
Treadmill: - 1 x 1 minute (zone 4/5) - 1 minute (zone 3) 1 x 45 seconds (zone 4/5) - 1 x 45 seconds (zone 3) - 1 x 30 seconds (all out)	**Floor**: - Jump squats x 10 reps - V-ups x 10 reps - Pushups	4 each/52
	-Transition to cool down-	
Cool down: treadmill zone 3 to zone 1		5/59

Notes: [1]Workout segments and parallel segments are performed as sequential blocks of exercise with a 2 minute transition time included. [2]Zone 3 = HR at AT; Zone 4 - HR at 1.06% of Anaerobic Threshold; Zone 5 - HR at 95% of maximal heart rate.

Participants were required to complete at least two 60-minute sessions/week for the duration of the 8-week study. Daily sessions were variations of a 50-minute workout including a five-minute warmup/cool down. Within the 50-minute multimodal exercise program, approximately ½ of the time was dedicated cardio (~26 minutes), with the remainder (~24 minutes) incorporating floor work, such as calisthenics, burpees and strength-based exercises with kettle bells, resistance bands, dumbbells, and suspension training devices. A representative workout is summarized in Table 1.

Analysis

Pre and Post testing data were analysed using paired sample t-tests via SPSS version 24 software (IBM, Armonk, NY). Selected Pearson product moment correlations were performed for body composition, resting metabolic rate, blood pressure, blood lipids and glucose, and maximal/submaximal intensity exercise performance outcomes. Secondary analyses were performed in order to determine where significant mathematical relationships existed between variables. Values are presented as means ± standard error (SEM). Statistical significance was set at p ≤ .05, a priori.

RESULTS

Participant characteristics and performance data

Study participant physical characteristics and performance data are presented in Table 2. Exercise HR represents an average response for the duration of the exercise sessions. All recruited participants completed the 8-week exercise regimen, but due to testing logistics only 23 participants (17 females, 8 males) completed both Pre and Post testing. Sex differences were not examined due to the number of participants.

Table 2. Study participant physical characteristics and performance data.

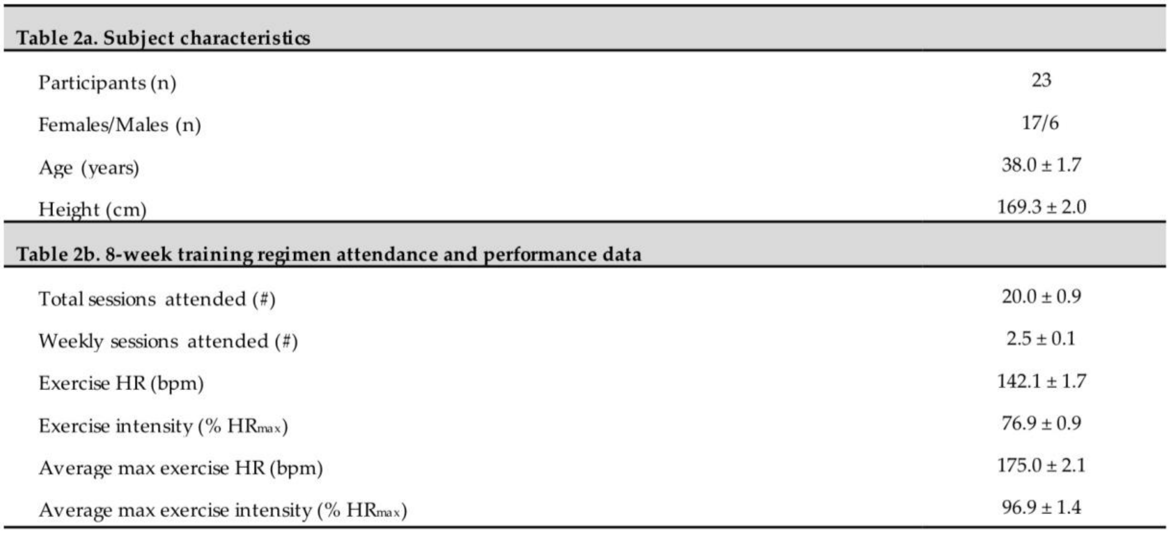


Table 2a. Subject characteristics	
Participants (n)	23
Females/Males (n)	17/6
Age (years)	38.0 ± 1.7
Height (cm)	169.3 ± 2.0
Table 2b. 8-week training regimen attendance and performance data	
Total sessions attended (#)	20.0 ± 0.9
Weekly sessions attended (#)	2.5 ± 0.1
Exercise HR (bpm)	142.1 ± 1.7
Exercise intensity (% HR_{max})	76.9 ± 0.9
Average max exercise HR (bpm)	175.0 ± 2.1
Average max exercise intensity (% HR_{max})	96.9 ± 1.4

Note. [1]Values are expressed as Means ± SEM.

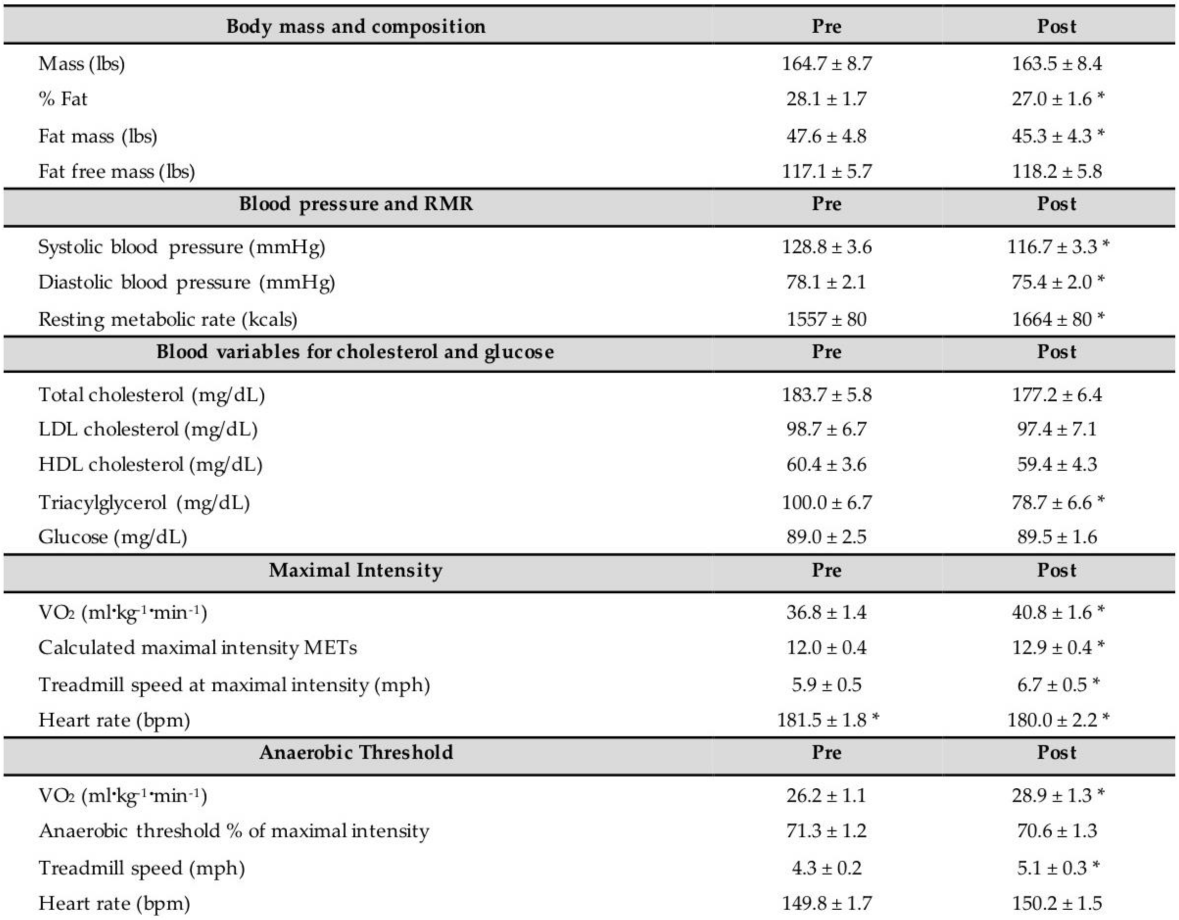
Training regimen attendance and performance data

Performance outcomes and attendance for the 8-week training regimen are presented in Table 3. All recruited participants adhered to the prescribed 8-week training regimen, completing an average of 20 exercise sessions/person. As prescribed, all participants completed at least 2 sessions/week, averaging 2.5 sessions/person/week for the duration of the study.

Body composition, body mass, blood pressure and RMR values

Pre and Post body composition, body mass, blood pressure and RMR data are presented in Table 3. Total body mass (p = .271) and fat free mass (p = .110) were unchanged after the training regimen. In contrast, %fat (p = .007) and fat mass (p = .027) were lower Post training as compared to Pre. Pre-to-Post training, RMR increased by an average of 107 kcal/participant (p < .000). Both systolic (p = .005) and diastolic (p = .014) resting blood pressure were lower Post training.

Table 3. Pre and post training regimen body composition, body mass, blood pressure, RMR, cholesterol, glucose, and maximal aerobic power performance values.



Body mass and composition	Pre	Post
Mass (lbs)	164.7 ± 8.7	163.5 ± 8.4
% Fat	28.1 ± 1.7	27.0 ± 1.6 *
Fat mass (lbs)	47.6 ± 4.8	45.3 ± 4.3 *
Fat free mass (lbs)	117.1 ± 5.7	118.2 ± 5.8
Blood pressure and RMR	**Pre**	**Post**
Systolic blood pressure (mmHg)	128.8 ± 3.6	116.7 ± 3.3 *
Diastolic blood pressure (mmHg)	78.1 ± 2.1	75.4 ± 2.0 *
Resting metabolic rate (kcals)	1557 ± 80	1664 ± 80 *
Blood variables for cholesterol and glucose	**Pre**	**Post**
Total cholesterol (mg/dL)	183.7 ± 5.8	177.2 ± 6.4
LDL cholesterol (mg/dL)	98.7 ± 6.7	97.4 ± 7.1
HDL cholesterol (mg/dL)	60.4 ± 3.6	59.4 ± 4.3
Triacylglycerol (mg/dL)	100.0 ± 6.7	78.7 ± 6.6 *
Glucose (mg/dL)	89.0 ± 2.5	89.5 ± 1.6
Maximal Intensity	**Pre**	**Post**
VO_2 ($ml·kg^{-1}·min^{-1}$)	36.8 ± 1.4	40.8 ± 1.6 *
Calculated maximal intensity METs	12.0 ± 0.4	12.9 ± 0.4 *
Treadmill speed at maximal intensity (mph)	5.9 ± 0.5	6.7 ± 0.5 *
Heart rate (bpm)	181.5 ± 1.8 *	180.0 ± 2.2 *
Anaerobic Threshold	**Pre**	**Post**
VO_2 ($ml·kg^{-1}·min^{-1}$)	26.2 ± 1.1	28.9 ± 1.3 *
Anaerobic threshold % of maximal intensity	71.3 ± 1.2	70.6 ± 1.3
Treadmill speed (mph)	4.3 ± 0.2	5.1 ± 0.3 *
Heart rate (bpm)	149.8 ± 1.7	150.2 ± 1.5

Maximal aerobic power and anaerobic threshold

Maximal aerobic fitness data from Pre and Post training examinations are presented in Table 3. $\dot{V}O_2$max increased 4.0 ($ml•kg^{-1}•min^{-1}$), averaging 40.8 ($ml•kg^{-1}•min^{-1}$) Post training (p < .000). Accordingly, calculated maximal intensity MET levels increased from 12 to 12.9 (p < .000). As expected, HRmax was not different between Pre and Post (p = .399). Finally, maximal treadmill speed increased 14% over Pre values (p = .001), averaging 6.7 mph in the Post training $\dot{V}O_2$max test.

Determination of anaerobic threshold using the V-slope method revealed that $\dot{V}O_2$ at AT increased 2.67 ($ml•kg^{-1}•min^{-1}$) (Pre = 26.2 ± 1.1 $ml•kg^{-1}•min^{-1}$, Post = 28.9 ± 1.3 ($ml•kg^{-1}•min^{-1}$); p < .002), although as a percent of $\dot{V}O_2$max these values were not different between Pre and Post training (p = .613). Importantly, HR at AT was not altered by the 8-week training regimen (149.8 ± 1.7 bpm Pre vs. 150.2 ± 1.5 bpm Post, $p = .563$). Treadmill speed at AT increased 19% between Pre and Post testing ($p < .000$).

Fasting blood variables

Pre and Post training examination of fasting blood glucose and a basic cholesterol profile are presented in Table 3. Following the 8-week training regimen, circulating triacylglycerol levels were 21% lower in Post training blood samples ($p = .008$). In contrast, total cholesterol ($p = .098$), LDL cholesterol ($p = .630$), and HDL cholesterol ($p = .627$) were not different between Pre and Post training. Similarly, blood glucose was not different between Pre and Post time points ($p = .782$).

DISCUSSION

The current study demonstrates that an 8-week commercial group fitness program, emphasizing HR monitoring to gauge intermittent high intensity multimodal exercises, elicits improvements in aerobic fitness in healthy, untrained individuals. In addition to fitness gains, components of a comprehensive cardiovascular, metabolic, and blood lipid examination were improved following the 8-week training regimen. While some aspects of HIIT and HR-derived exercise prescriptions are well described (Talanian et al., 2007), the magnitude of health and fitness gains achieved following the current two-month intervention extend upon prior knowledge. We observed that aerobic power, body composition, resting blood pressure, resting metabolic rate and circulating triacylglycerol levels were improved by an average of 20 exercise sessions. Perhaps most notably among these benefits, $\dot{V}O2$max increased more than one (MET). This latter finding is important given the well-established relationship between one (MET) improvements in aerobic fitness and the corresponding drop in all-cause mortality (Warburton et al., 2006). Participants in the current study likely continued to accrue health and fitness benefits as exercise participation extended beyond the 2-month intervention. To this end, prior 12-week investigations of HIIT exercise programs support time-dependent health and fitness gains by extended duration program participation (Racil et al., 2013; Racil et al., 2016; Sijie et al., 2012). If correct, the current findings would be impactful in that improved aerobic fitness is a potent independent predictor of reduced cardiovascular (Lee et al., 2010), and all cause, morbidity and mortality (Warburton et al., 2006).

Time on task and health fitness improvements

The current data set from an 8-week high intensity exercise intervention reveals changes in aerobic power, body composition, and health-related variables. Beneficial health and fitness outcomes were achieved by 20 exercise sessions performed over eight weeks. While cautiously recognizing that various HIIT protocols elicit variable outcomes, several important trends exist between the current study and prior research.

Among the health variables altered by this intervention, blood plasma triacylglycerol concentrations decreased by 21% and proportional to longer duration HIIT interventions (Khammassi et al., 2018; Racil et al., 2013). Given the positive relationship between body fat stores and circulating triacylglycerol, it was noted that drops in body fat were not statistically correlated to triacylglycerol changes ($r = .054$, $p = .808$). Other lipid profile variables were unaltered by the exercise training regimen, although limited evidence suggests that sustained training (> than 12 weeks) impacts other cholesterol sub-fractions (Khammassi et al., 2018; Racil et al., 2013). Resting blood pressure was also improved by exercise training, exhibiting a clinically and statistically significant drop of 8.1 mmHg systolic and 2.7 mmHg diastolic. This short-term finding reinforces similar blood pressure improvements following a 6-week HIIT intervention (Izadi et al., 2018) and supports prior observations that vascular responses to HIIT are among the first observed physiologic changes (Eskelinen et al., 2016; Sawyer et al., 2016). Finally, while blood glucose was unaltered post training regimen.

However, our participants were apparently healthy non-diabetics and insulin responsiveness and glucose control were not investigated. In support, a recent investigation reported that HIIT exercise altered insulin control, but not glucose responsiveness to oral glucose tolerance testing in a similar participant cohort (Lithgow & Leggate, 2018). Additional research is needed to better understand how these cardiovascular health variables are influenced as a function of HIIT exercise. Future work with similar group fitness HIIT approaches should also examine those with homogenous expression of cardiovascular risk – pre-diabetic, pre-hypertensive, dyslipidemic, etc. To this point, the current study was initiated in participants with normal cardiovascular risk variables. Thus, observed improvements in aerobic fitness, circulating triacylglycerol, and resting blood pressure are all the more notable.

Training intensity considerations

Health and fitness benefits in the current study appear to have been magnified by engagement in episodic high intensity cardiovascular exercise. Ample evidence indicates that variations of HIIT exert an adaptive advantage as compared to moderate intensity exercise (Racil et al., 2013; Racil et al., 2016; Sijie et al., 2012). In extension, the current sample trained at an average HR of 142 bpm; within 8 beats of AT or 77% of HRmax. Notably, however, this average HR includes approximately 10 recovery periods per exercise session, indicating that training intensity was at or above AT. In support, HRmax during exercise (with recovery periods interspersed) was 175 bpm, within 5-6 bpm of the recorded HRmax. Based on these observations of exercise training intensity and aerobic power improvements, secondary correlation analyses indicated the magnitude of change in $\dot{V}O_{2max}$ was proportional to the average exercise training HR ($r = .624$, $p = .001$).

Among the benefits of HIIT training is the extended impact of EPOC on basal metabolic rates (Gaesser & Brooks, 1984; Khammassi et al., 2018; Roy et al., 2018). Current participants experienced an average of a 107 kcal increase in resting metabolic rate as determined by indirect calorimetry. This outcome associated with a 1.1% decrease in %fat mass (-2.3lbs fat mass) over the 8-week intervention. One previous study revealed that a 4-week HIIT intervention did not alter body composition (Sperlich et al., 2018), while another extended duration investigation in obese adults suggests that HIIT training provides additive body composition changes (Roy et al., 2018). Additive body composition changes are important in that, the training period concluded, both male and female %fat values were categorized as “poor” (*ACSM’s guidelines for exercise testing and prescription*, 2016). Thus, body composition improvements in the current study, and prior observations following a 1-year intervention (Roy et al., 2018), offer a hopeful solution to the obesity pandemic. Adherence to the exercise program is essential to successful alteration of body composition (Haskell et al., 2007).

Exercise adherence and psychological considerations

Among the most important current findings is the voluntary participation rate. Subjects were instructed to attend 2+ sessions/week, with up to four permitted absences prior to study exclusion. Of note, compliance to the current regimen was 100%, with all participants completing the required two sessions per week. This finding supports prior observations of high voluntary compliance rates to a year-long HIIT exercise program (Roy et al., 2018). Combined with prior outcomes, the current HIIT program, provides new insight to classical notions that exercise adherence is inversely related to exercise intensity (Haskell et al., 2007). Current emphasis on self-selected workout pace appears to have been critical, as prior work with a variety of HIIT exercise/recovery approaches suggest that individual and sex-specific preferences are important (Laurent et al., 2014).

The impact of this exercise approach is magnified by the fact that the exercise training facility is a franchised US-based fitness company with a significant international presence and growth trajectory (Bellafante, 2016). Thus, the specific exercise programming is simultaneously applied nationally/internationally. Interest in this HR-directed approach parallels phenomena from other internationally successful commercial fitness centres with group-based, and sometimes HIIT-centred, exercise classes (Claudino et al., 2018; Kerksick et al., 2009). Different from these other commercial approaches, real-time HR-intensity feedback was a likely motivation. Additional considerations of exercise adherence to group HIIT programming include the fact that multimodal commercial fitness approaches have recently surged in popularity. This phenomenon may reflect the convenience of an exercise prescription (Claudino et al., 2018; Kerksick et al., 2009), although modern group exercise approaches also benefit from a sense of created community (Claudino et al., 2018). In this regard, we performed secondary analyses using the Oxford Happiness Questionnaire, a validated metric with established relationships between physical activity and healthy lifestyle behaviours (Torchyan et al., 2016). Preliminary data indicated that only spiritual wellbeing was altered (+13%, $p = .012$) after training. This tentative finding, independent of religion, supports understanding that a spontaneous sense of community and connectedness can occur through group fitness (Racil et al., 2013; Racil et al., 2016; Sijie et al., 2012). As such, facets of social engagement, motivation, and efficacy should be central to future social science research, behaviour change, and health outcomes following similar exercise interventions.

The importance of motivation for exercise adherence cannot be understated. We previously investigated motivational exercise engagement at a local fitness facility where client memberships were based on individualized prescriptions rather than group exercise. The key finding of this prior study was that exercise motivation was largely age-, but not sex-, dependent. Moreover, stress relief and stress management were the key motivational factors leading to exercise participation in those middle aged individuals (Quindry et al., 2011).

Study limitations

As with this prior investigation, the current study is limited by the quasi-experimental design and that all participants self-selected to engage in the training intervention as paying clients. Whether similar findings exist in disengaged individuals is beyond the scope of this research. Moreover, whether the age-dependent findings of our prior study also apply to the current middle-aged cohort is unknown. Additional research efforts should examine the extent to which social dynamics and various intrinsic motivators influence participation in healthful HIIT exercise. Interestingly, a recent meta-analysis purported that HIIT training in middle aged obese adults may improve affect and exercise enjoyment (Oliveira et al., 2018), although the psychological underpinnings are unresolved. Another limitation of the current study is borne out of the comprehensive nature used to examine a host of health and fitness variables, where no single study facet was examined in depth. Future examinations would benefit from in-depth investigation of the components of health and fitness examined currently. Moreover, follow-up study should include larger samples sizes and emphasize sex differences, in addition to clinical and healthy populations.

CONCLUSIONS

The current study examined acute health and fitness benefits of group exercise training within a franchised commercial fitness setting. Prescriptive exercise based on HR determined intensity in combination with mass implementation across franchised fitness centres is a relatively new phenomenon, and in the age of wearable technology, provides novel understanding exercise approaches to combat lifestyle-related morbidity and mortality. Based on current findings, in combination with prior HIIT research, it appears that many adaptive benefits begin to accrue predictably in 6 weeks (Izadi et al., 2018; Sperlich et al., 2018), exhibit body-wide changes at about 8-weeks as currently studied, and continue to accrue from 12 weeks (Khammassi et al., 2018; Locke et al., 2018; Oliveira et al., 2018; Racil et al., 2013) to beyond 12 months (Roy et al., 2018).

While it is premature to apply these findings beyond the current population, the body-wide health and fitness benefits achieved by this 8-week exercise intervention are remarkable and include improvements in maximal aerobic power, sub-maximal workloads, plasma triacylglycerol, body composition changes, elevated resting metabolic rate, and lowered resting blood pressure. The cumulative exercise time to achieve these outcomes was short, as spread over 20 exercise sessions/participant, and represents an excellent return on the time investment. These outcomes are related to the fact that exercise intensities were high, and yet program completion was 100%. This exercise adherence response highlights the need for additional research to better understand exercise engagement in sedentary populations. Future work should clarify how health and fitness benefits are elicited by the HIIT stimulus. For instance, our research group previously demonstrated that HIIT training produces acute alterations in post exercise inflammation and immune cell antioxidant defences (Fisher et al., 2011; Kliszczewicz et al., 2015). More recent investigations extend on this work and suggest that HIIT exercise benefits inflammation in combination with cytokine/myokine (Cabral-Santos et al., 2016) and microRNA (Schmitz et al., 2018) responses that may underpin previously undiscovered adaptive stimuli.

AUTHOR CONTRIBUTIONS

Conceptualization, J.Q. and J.F.; methodology, J.F.; formal analysis, J.Q.; investigation, J.F.; resources, J.F.; data curation, J.Q. and J.F.; writing—original draft preparation, J.Q.; writing—review and editing, J.Q., C.W.R., and J.F.; validation, J.K.; visualization, J.Q., J.F., and C.W.R.; software, not applicable; supervision, J.F.; project administration, J.F.; funding acquisition, J.Q.. All authors have read and approved the final version of the manuscript and agree with the order of presentation of the authors.

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CONFLICTS OF INTEREST

J.Q. and C.W.R. declare no conflict of interest. J.F. acknowledges the potential for a perceived COI as he is employed by the funding agency. To avoid conflict, data analysis and original manuscript preparation were performed by J.Q. Prior to analyses and manuscript preparation, the funding agency waived rights toward final publication decisions.

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