

THE EFFECT OF INTERVAL INTENSITY ON TIME TO EXHAUSTION DURING  
HIGH INTENSITY INTERVAL TRAINING (HIIT) RUNNING IN RECREATIONAL  
MALE RUNNERS

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## ABSTRACT

### THE EFFECTS OF INTERVAL INTENSITY ON TIME TO EXHAUSTION DURING HIGH INTENSITY INTERVAL TRAINING (HIIT) RUNNING IN RECREATIONAL MALE RUNNERS

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High Intensity Interval Training (HIIT) has become extremely popular in recent years, however, current HIIT prescriptions lack guidelines regarding interval intensities and associated margins. The purpose of this study is to investigate Run Time to Exhaustion ( $T_e$ ) and provide insight regarding HIIT intensities for future aerobic exercise programming. Ten healthy adult male recreational runners (Age= $22.9 \pm 2.5$  yr., Ht= $1.72 \pm 0.1$ m, BM= $74.1 \pm 7.4$  kg) measured maximal oxygen consumption ( $\dot{V}O_{2max}$ ) ( $52.4 \pm 6.1$ ml/kg/min) with a graded exercise test (GXT). Running speed was determined using ACSM running equation for exercise metabolism. Protocols 1-3 were HIIT running sessions, and Protocol 4 was a continuous running trial, all of the same average intensity ( $80\% \dot{V}O_{2max}$ ). All HIIT trials implemented aerobic style bout durations of 2 minutes each, with a 1:1 work to active rest/recovery ratio. A repeated measures ANOVA determined that mean  $T_e$  differed statistically between the 4 protocols. Protocol 1 elicited a significant reduction in mean  $T_e$  when compared to all other conditions. Based on the findings of this study, recreational runners can monitor variables and/or prescribe intensities to maximize economy and efficacy of aerobic HIIT program implementation.

## TABLE OF CONTENTS

ABSTRACT .....	ii
LIST OF TABLES.....	v
LIST OF FIGURES .....	vi
INTRODUCTION .....	1
METHODS.....	7
Experimental Approach to the Problem .....	7
Experimental Running Sessions .....	7
Subjects.....	8
Equipment.....	9
Statistical Analyses.....	9
RESULTS.....	10
Run Time to Exhaustion.....	10
Oxygen Consumption (VO <sub>2</sub> ), Heart Rate (HR) & Rate of Perceived Exertion (RPE)....	11
Respiratory Exchange Ratio (RER) & Stride Frequency (SF).....	12
DISCUSSION.....	15
Practical Applications.....	19
REFERENCES .....	20
APPENDIX .....	23
APPENDIX A. Experimental Design.....	23
APPENDIX B. Medical History Documentation .....	24
APPENDIX C. Informed Consent Documentation .....	31
APPENDIX D. Physical Activity Readiness Questionnaire (PAR-Q) Documentation...	37

APPENDIX E. Institutional Review Board (IRB) Documentation..... 38

## LIST OF TABLES

<b>TABLE 1.</b> REVIEW OF LITERATURE .....	4
<b>TABLE 2.</b> PARTICIPANTS AND DESCRIPTIVE BASELINE DATA (N = 10).....	8
<b>TABLE 3.</b> THE RELATIONSHIP BETWEEN RUNNING PROTOCOLS AND TIME TO EXHAUSTION (N = 10).....	10
<b>TABLE 4.</b> MEAN $\dot{V}O_2$ , HR AND RPE BY INTERVAL STAGE DURING HIIT CONDITIONS (N=5).....	12
<b>TABLE 5.</b> MEAN RER, SF AND SL BY INTERVAL STAGE DURING HIIT CONDITIONS (N=5).....	13

## LIST OF FIGURES

<b>FIGURE 1.</b> RUNNING PROTOCOLS VS. RUN TIME TO EXHAUSTION (TE).....	10
<b>FIGURE 2.</b> RUNNING PROTOCOLS VS. RESPIRATORY EXCHANGE RATIO (RER) .....	14
<b>FIGURE 3.</b> RUNNING PROTOCOLS VS. STRIDE FREQUENCY (SF).....	14
<b>FIGURE 4.</b> EXPERIMENTAL DESIGN .....	23

## INTRODUCTION

The benefits of exercise on health and fitness components are well documented in a spectrum of exercise modes, intensities, and protocols yet exercise adherence remains a continual issue. One of the main reasons individuals report they are unable to exercise, is due to a perceived lack of time (9). To combat this perceived lack of time, optimization of training programs and efforts are of great interest to individuals. As a result, High Intensity Interval Training (HIIT) has become extremely popular in recent years in attempts to maximize training benefits with limited available time. Further, according to the American College of Sports Medicine (ACSM), HIIT is the reported as the top fitness trend of 2018 (15). Previous research has shown various HIIT training modalities to improve health and performance while decreasing training times or volume (Table 1). In addition, research has shown HIIT training to be superior regarding many health and performance variables when compared with moderate intensity continuous training (MICT) (Table 1). HIIT training has also been shown to be more subjectively more enjoyable when compared with moderate intensity continuous exercise, despite reporting higher Rates of Perceived Exertion (RPE) (3).

The National Strength and Conditioning Association (NSCA) and ACSM defined High Intensity Interval Training (HIIT) as repeated bouts of high intensity, followed by rest or recovery (2,15). The American College of Sports Medicine (ACSM) characterizes HIIT exercise session duration as completed in under 30 minutes (15, ACSM Health & Fitness Journal, 2018). Additionally, ACSM recommends a given exercise session energy expenditure to range from 150 to 400 kilocalories (15). Although safe implementation of high intensity exercise requires preliminary caution, prerequisite training, and high exercise

tolerance, HIIT training provides an effective and efficient method for developing aerobic and anaerobic fitness simultaneously (2). High aerobic fitness or Cardiorespiratory fitness (CRF) is inversely related to many metabolic diseases, and is considered the primary health fitness component for exercise programming (15). Therefore, it is essential to establish guidelines for HIIT training in regard to maximizing benefits associated with aerobic exercise for recreational runners. However, while HIIT training proves a beneficial exercise protocol for increasing cardiorespiratory fitness, there is extreme inconsistency regarding program variables, namely interval intensity, which may compromise the efficacy of HIIT programming.

It is important to note that current HIIT protocols and guidelines typically employed are generally aimed towards the training of specific energy systems. General interval training guidelines have been established regarding work: rest/recovery ratio, interval duration, intensity and total time, primarily in regard to training of specific energy systems (2,5,10). In regard to work and recovery within HIIT design is further inconsistency in the employment of active or passive recovery. Thus, the subsequent recovery intensities and durations have been mixed among the current literature. Generally, in order to determine training variables for exercise prescription, the American College of Sports Medicine (ACSM) utilizes the FITT-VP framework. FITT-VP, or Frequency, intensity, time, type, as well as exercise volume, pattern and progression are the major program variables. Due to the novel nature of HIIT training guidelines, exercise programming variables are relatively mixed with the current body of research. Additionally, The National Strength & Conditioning Association (NSCA) and American College of Sports Medicine (ACSM) have established general guidelines in regard to interval training, but is primarily limited to interval duration and rest/recovery ratios. Both organizations, however, characterize several



categories of interval training into energy systems of aerobic, anaerobic or Phosphagen system. Aerobic HIIT bouts, often referred to as prolonged HIIT, are generally 2-5 minutes long and include work/recovery ratios of 1:1 or 2:1. Anaerobic HIIT bouts are typically 1-2 minutes long, and incorporate work/recovery ratios of 1:2 or 1:5. Lastly, Phosphagen repeated sprint training (RST) or sprint interval training (SIT) bouts are generally 10-15 seconds, with work/rest ratios of 1:5 or greater (2,15).

However, while bout duration and rest/recovery guidelines of interval training are relatively consistent in regard to training for specific energy systems, intensity for these stages, as well as the average intensity margins between intervals is extremely mixed amongst the current body of literature. Based on these current guidelines from recent publications, or the lack thereof, it is essential to establish clear guidelines regarding these variables during HIIT training, namely interval intensity of both work and recovery bouts for Aerobic HIIT programs.

**Table 1.** Review of Literature

Study	High Intensity (Work)	Low Intensity (Rest/Recovery)
1	P1: 90-95% HRmax (1x/week) P2: 6-10 Mile Fartleks @ ~10km Pace (2x/week)	P1: Passive Rest to <120 bpm P2: Active Recovery <10km Pace
3	EG: 6 x 3 min @ 90% $\dot{V}O_{2max}$ CG: 50min @ 70% $\dot{V}O_{2max}$	EG: 6x3min @ 50% $\dot{V}O_{2max}$
5	EG1: 5-8 x 60% Tmax (3.5±.7 min) @ $v\dot{V}O_{2max}$ EG2: 7-12 x 30s @ 130% $v\dot{V}O_{2max}$ CG: 60 min @ 75% $v\dot{V}O_{2max}$ Both: 60 min @ 75% $v\dot{V}O_{2max}$	EG1: Active 60% Tmax (3.5±.7 min) @ 50% $v\dot{V}O_{2max}$ EG2: Active 4.5 Minute @ 50% $v\dot{V}O_{2max}$
6	P1: 20 x 30s @ 120-130% $v\dot{V}O_{2max}$ P2: 2 x 4 x 400m @ 103-110% $v\dot{V}O_{2max}$ P3: 7 x 2 minutes @ 100-105% $v\dot{V}O_{2max}$ P4: 4-6 x 30s sprint	P1: Passive 30s Rest P2: Passive 90s & 3min Set Rest P3: Passive 120sRest P4: Passive 3min Rest
8	6 x 94% PTS for 60% Tmax (2.7±.5 min)	Passive Rest 1/2 of 60% Tmax (1.1-1.6 min)
10	EG1: 10 x 1 min @ $v\dot{V}O_{2max}$ EG2: 5 x 2min @ $v\dot{V}O_{2peak}$ CG: 20 min CRT @ 75% $v\dot{V}O_{2peak}$	EG1: 10 x 1 min @ 50% $v\dot{V}O_{2peak}$ EG2: 5 x 2 min @ 50% $v\dot{V}O_{2peak}$
14	EG1: 6 @ $v\dot{V}O_{2max}$ for 60% Tmax (133.4 ± 4 sec) EG2: 5 @ $v\dot{V}O_{2max}$ for 70% Tmax (154 ± 13 sec) CG: Maintain	EG1: Passive 50% of 60%Tmax EG2: Passive 50% of 60%Tmax

**Note. 1.** P: Protocol, EG: Experimental Group, CG: Control Group, PTS: Peak Treadmill

Speed,  $\dot{V}O_{2max}$ : rate of maximal oxygen consumption,  $\dot{V}O_{2peak}$ : highest oxygen consumption value obtained during incremental exercise test,  $v\dot{V}O_{2max}$ : Maximum speed required to elicit  $\dot{V}O_{2max}$

Based on the review of literature, HIIT protocols of different intervals and durations appear to result in different acute and chronic physiological responses. Aerobic HIIT treadmill running when compared with work matched supramaximal HIIT or Moderate Intensity Continuous Training (MICT) has shown superiority in regard to improvements (i)

Physiological Parameters related to Health and Fitness, (ii) Exercise Tolerance and Performance, and (iii) Decrease Training Volume and/or Duration.

Based on the review of literature, HIIT training structures implementing 5-8 interval sets of 2 minute bouts, utilizing the minimum running speed required to elicit  $\dot{V}O_{2max}$  for high intensity bouts, for a total of no more than 30 minutes or 400 kilocalories per exercise session appear a reasonable stimulus for Aerobic HIIT training in recreational runners. Furthermore, Aerobic Interval Training constructs established by the National Strength & Conditioning Association (NSCA) and the American College of Sports Medicine (ACSM) appear an adequate work to active recovery ratio (1:1) for programming and maximizing recovery capacities. Moreover, based on the review of the literature, active recovery bouts roughly at 60% of  $\dot{V}O_{2max}$  appear to be a practical recovery bout intensity for recreational runners to maximize training stimulus and simultaneous interval bout completion.

There is extensive research on the benefits of multimodal high intensity interval training (HIIT) programs in a plethora of modes for cardiovascular fitness and performance in all training statuses. However, HIIT prescriptions are stifled by a lack of guidelines and research regarding intensities and associated interval margins. Based on the current literature, there is no study examining interval intensity and subsequent recovery margins as a training variable impacting exercise duration. Thus, the primary purpose of this study is to investigate the effect of interval intensity on exercise duration during HIIT running in recreational runners. A secondary purpose of this study is to investigate the effects of interval intensity on various metabolic and physiological variables. Further, results are aimed to provide insight regarding prescription of High Intensity Interval Training (HIIT) guidelines for the purpose of ease of application and implementation for future exercise programming, specifically regarding recreational male runners. We hypothesized that total

Run Time to Exhaustion ( $T_e$ ) will be different among the 4 running protocols of the same average intensity (80% of  $\dot{V}O_{2\max}$ ).

## METHODS

### Experimental Approach to the Problem

Participants were randomly allocated to 3 experimental HIIT sessions, and 1 continuous running session, and instructed to run until exhaustion/volitional fatigue (Figure 4). Participants initially completed a BRUCE protocol Graded Exercise Test (GXT) to measure the rate of maximal oxygen consumption ( $\dot{V}O_{2max}$ ). Running speeds were determined by converting  $\dot{V}O_{2max}$  values to constant running speed via the ACSM running equation for exercise metabolism (see below).

#### ACSM Metabolic Running Equation for Gross $VO_2$ in Metric Units

$$vo_2 \text{ ( ml/kg/min )} = ( 0.2 \times S ) + ( 0.9 \times S \times G ) + 3.5 \text{ ml/kg/min}$$

S: speed in m/min, G: the percent grade expressed as a fraction

### Experimental Running Sessions

Three of the protocols were HIIT running, and one protocol was continuous, with all running sessions being of the same average intensity (80%  $\dot{V}O_{2max}$ ). Protocol 1 (110% & 50%  $\dot{V}O_{2max}$ ), Protocol 2 (100% & 60%  $\dot{V}O_{2max}$ ), Protocol 3 (90% & 70%  $\dot{V}O_{2max}$ ) were HIIT running sessions, and Protocol 4 (80%  $\dot{V}O_{2max}$ ) was a continuous running trial. HIIT trials implemented bout durations of 2 minutes each, utilizing a work to active rest/recovery ratio of 1:1. Warm up for all tests and trials consisted of 5 minutes of running at 50% of  $\dot{V}O_{2max}$  or roughly 5-6 miles per hour (mph), preceding a 5-minute rest period before beginning. Cool down for all trials consisted of walking at 2-4 mph for 5-10 minutes. Participants were provided verbal encouragement and instructed to run until exhaustion/volitional fatigue. Termination guidelines for exercise included least two of the following characteristics occurring simultaneously: (a) RER value exceeding 1.2 (b) heart

rate at 95% of estimated heart rate maximum (HRmax), Rate of Perceived Exertion (RPE) of at least 18 for consecutive intervals.

### Subjects

Ten healthy adult male recreational runners (Age= $22.9 \pm 2.5$  yr., Height= $1.72 \pm 0.1$  m, Body Mass= $74.1 \pm 7.4$  kg) measured the rate of maximal oxygen consumption ( $\dot{V}O_{2\max}$ ) ( $52.4 \pm 6.1$  ml/kg/min) with a graded exercise test (GXT). Individual running speed was determined based on GXT results using ACSM running equations for exercise metabolism (see above). This study was approved by the Institutional Review Board (IRB) of the Humboldt State University for the use of human subjects. Prior to participation, all subjects completed a Physical Activity Readiness Questionnaire (PAR-Q), Medical History Form and Informed Consent Documentation (Appendix). Subjects were informed about their participation, potential risks and benefits, and ability to withdraw at any time. Participants refrained from caffeine or alcohol consumption within 24hrs of testing, and intense exercise for 48 hours before testing. Participants were excluded from the study if they had any cardiovascular, metabolic or renal diseases, and any recent history of musculoskeletal injury/surgery within 1 year.

**Table 2.** Participants and Descriptive Baseline Data (n = 10)

Age (yrs.)	Height (m)	Weight (kg)	$\dot{V}O_{2\max}$ (ml/kg/min)	Classification
$22.9 \pm 2.5$	$1.72 \pm 0.1$	$74.1 \pm 7.4$ kg	$52.4 \pm 6.1$	Excellent

**Note. 2.** Results reported in mean  $\pm$  SD

## Equipment

The Graded Exercise Test (GXT) was performed on a Quinton treadmill (Q-Stress TM55, Quinton Treadmill Systems, CA, USA), and all 4 experimental running sessions were on a motorized treadmill (Platinum Club Series, Life Fitness, Rosemont, IL, USA). Half of the subjects (n=5) recorded metabolic data and physiological variables in addition to duration. Heart Rate (HR) and Stride Frequency (SF) was measured using a wearable device (CX800 & S3+, Polar, Finland). Ratings of Perceived Exertion (RPE) were asked following each interval bout (Borg, 6-20 Scale). Expired oxygen, carbon dioxide, and ventilation were measured using a metabolic cart (MMS-2400, Parvo Medics, UT, United States). Respiratory Exchange Ratio (RER) was calculated from metabolic measurements.

## Statistical Analyses

Prior to parametric testing, data was analyzed using a box plot to identify outliers. A Kolmogorov-Smirnov test was performed to analyze the normality of data distribution, and a Levene's test was used to verify the homogeneity of variance among recorded variables. All statistical analysis was completed using STATISTICA software version 7.1 (StatSoft, Inc. Tulsa, OK, USA). A one way repeated measures analysis of variance (ANOVA) was performed to compare differences in total Run Time to Exhaustion (Te) between the 4 running conditions. When a significant F-ratio was observed, a Tukey's Honestly Significant Difference test was used to determine source of differences. Statistical significance was set at a p value  $\leq 0.05$ . All data is presented as the mean  $\pm$  SD. Separate repeated measures ANOVA tests were performed to compare differences in between protocols and mean variables ( $\dot{V}O_2$ , RER, SF, HR & RPE) overall and during High Speed and Low Speed interval bouts for half of the subjects (n = 5).

## RESULTS

### Run Time to Exhaustion

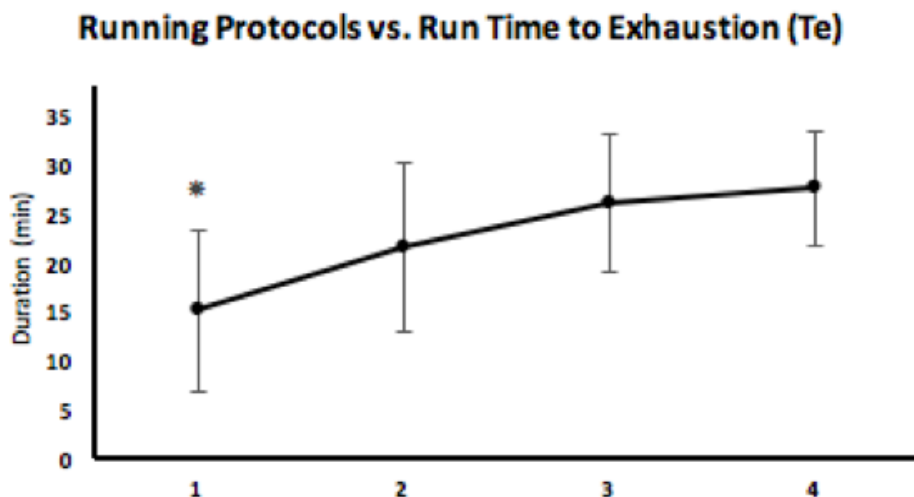
Mean Run Time to Exhaustion (Te) differed significantly between the 4 protocols of the same average intensity ( $F(3, 27) = 23.407, p \leq 0.05$ ). Post hoc analysis revealed that P-1 (110% VO<sub>2</sub>max & 50% VO<sub>2</sub>max) elicited a significant reduction in mean TE when compared to all conditions (Figure 1, Table 3). P-1, on average, was 7.4 ( $\pm 4.0$ ) minutes less than P-2, 9.4 ( $\pm 3.5$ ) minutes less than P-3, and 11 ( $\pm 0.4$ ) minutes less than P-4 ( $p \leq 0.05$ ).

**Table 3.** The Relationship Between Running Protocols and Time to Exhaustion (n = 10)

Protocols	P-1 (HIIT)	P-2 (HIIT)	P-3 (HIIT)	P-4 (Cont.)
% of VO <sub>2</sub> max	110% & 50%	100% & 60%	90% & 70%	80%
Duration (min)	14.9 $\pm$ 5.9*	22.3 $\pm$ 5.5	24.4 $\pm$ 5.6	25.9 $\pm$ 5.5

**Note. 3.** Results reported in mean + SD

**Figure 1.** Running Protocols vs. Run Time to Exhaustion (Te)



**Note. 4.** \*  $p < 0.05$ , significantly different from other conditions



### **Oxygen Consumption ( $\dot{V}O_2$ ), Heart Rate (HR) & Rate of Perceived Exertion (RPE)**

No significant differences in mean oxygen consumption ( $\dot{V}O_2$ ) was observed between conditions ( $F(3, 12) = 0.321, p = .062$ ). Mean  $\dot{V}O_2$  was significantly different between protocols during High Speed (HS) bouts ( $F(3, 12) = 22.073, p \leq 0.05$ ) and Low Speed (LS) bouts ( $F(3, 12) = 5.538, p \leq 0.05$ ). Post hoc analysis indicated that during HS bouts, mean  $\dot{V}O_2$  in P-1 was significantly greater than P-2 ( $p = .004$ ), P-3 ( $p = .000$ ) & P-4 ( $p = .000$ ). During LS bouts, mean  $\dot{V}O_2$  in P-4 was significantly greater than P-1 ( $p = .008$ , Table 4).

No significant differences in mean Heart Rate (HR) was observed between protocols ( $F(3, 12) = 0.157, p = .923$ ). Mean HR was significantly different between protocols during HS bouts ( $F(3, 12) = 4.664, p \leq 0.05$ ) and LS bouts ( $F(3, 12) = 3.613, p \leq 0.05$ ). Post hoc analysis indicated that mean HR in P-1 was significantly different than P-4 during HS bouts ( $p = .018$ ), and P-4 was significantly different than P-1 during LS bouts ( $p = .044$ , Table 4).

No significant differences in mean Rate of Perceived Exertion (RPE) was observed between conditions ( $F(3, 12) = 0.947, p = .291$ ). Mean RPE was significantly different between conditions during HS bouts ( $F(3, 12) = 4.735, p \leq 0.05$ ), but not LS bouts ( $F(3, 12) = 2.989, p = .073$ ). Post hoc analysis indicated mean RPE during HS bouts in P-1 differed statistically to P-3 ( $p = .027$ ) & P-4 ( $p = .037$ ), with no difference observed between P-1 & P-2 ( $p = .113$ , Table 4).

**Table 4.** Mean  $\dot{V}O_2$ , HR and RPE by Interval Stage during HIIT Conditions (n=5)

	Protocols	P-1 (HIIT)	P-2 (HIIT)	P-3 (HIIT)	P-4 (Cont.)
$\dot{V}O_2$	High Speed	46.4 $\pm$ 8.3*	43.9 $\pm$ 7.2	42.7 $\pm$ 8.1	42.3 $\pm$ 8.6
	Low Speed	38.5 $\pm$ 5.4	40.1 $\pm$ 7.1	40.0 $\pm$ 6.9	42.3 $\pm$ 8.6†
	Mean	42.9 $\pm$ 7.4	42.1 $\pm$ 7.2	41.3 $\pm$ 7.4	42.3 $\pm$ 8.6
HR	High Speed	183.3 $\pm$ 6.6☆	179.1 $\pm$ 7.0	176.6 $\pm$ 8.2	174.4 $\pm$ 10.1
	Low Speed	163.8 $\pm$ 10.1	166.5 $\pm$ 8.7	170.1 $\pm$ 6.5	174.4 $\pm$ 10.1†
	Mean	174.5 $\pm$ 6.3	173.1 $\pm$ 7.6	173.9 $\pm$ 7.4	174.4 $\pm$ 10.1
RPE	High Speed	16.8 $\pm$ 1.2‡	15.9 $\pm$ 1.2	15.6 $\pm$ 1.3	15.7 $\pm$ 1.1
	Low Speed	14.5 $\pm$ 1.6	13.6 $\pm$ 2.0	15.2 $\pm$ 1.2	15.7 $\pm$ 1.1
	Mean	15.8 $\pm$ 1.5	14.8 $\pm$ 1.6	15.4 $\pm$ 1.2	15.7 $\pm$ 1.1

**Note. 5.** Results reported in mean + SD, \*  $p < 0.05$ , significantly different than all other conditions, †  $p < 0.05$ , significantly different than P-1, ☆  $p < 0.05$ , significantly different than P-4, ‡  $p < 0.05$ , significantly different than P-3 & P-4

### Respiratory Exchange Ratio (RER) & Stride Frequency (SF)

Significant differences in mean Respiratory Exchange Ratio (RER) were observed (F (3, 12) = 12.086,  $p \leq 0.05$ , Figure 3). Post hoc analysis indicated that the average RER in P-1 was significantly different than P-3 ( $p = .018$ ) and P-4 ( $p = .001$ ). Mean RER in P-2 was significantly different than P-4 ( $p = .03$ ), but no differences were observed between P-1 and P-2 ( $p = .08$ ). No significant differences in RER was observed between conditions during HS bouts (F (3, 12) = 0.609,  $p = .622$ ), but significant differences were observed during LS bouts (F (3, 12) = 28.321,  $p \leq 0.05$ ). Post hoc analysis indicated mean RER in P-

4 during LS bouts was significantly different than P-1 ( $p = .137$ ), P-2 ( $p = .079$ ), and P-3 ( $p = .041$ , Table 5).

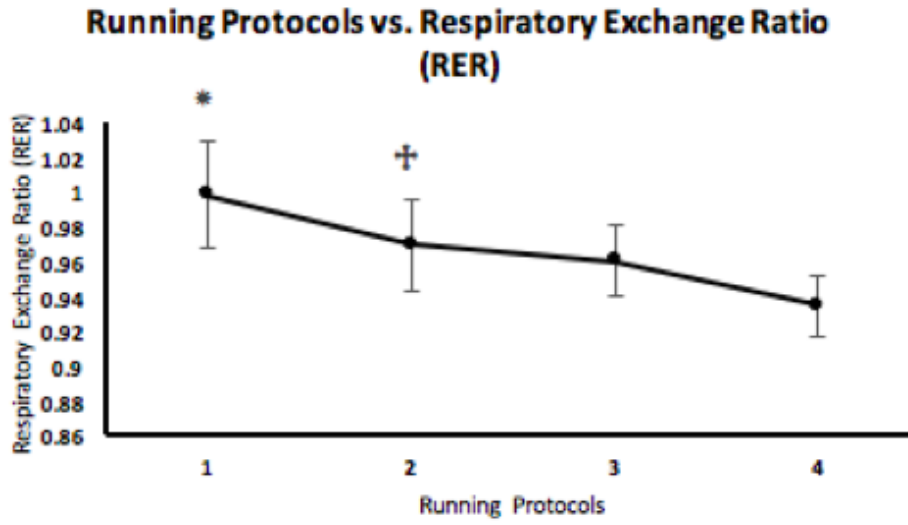
Significant differences in mean Stride Frequency (SF) were observed ( $F(3, 12) = 10.659$ ,  $p \leq 0.05$ , Figure 4). Post hoc analysis indicated that the mean SF was significantly higher in P-1 when compared to P-3 ( $p = .006$ ) and P-4 ( $p = .001$ ), with no differences observed between P-1 and P-2 ( $p = .141$ ). Mean SF was significantly different among protocols during HS bouts ( $F(3, 12) = 16.191$ ,  $p \leq 0.05$ ) but not LS bouts ( $F(3, 12) = 0.609$ ,  $p = .394$ ). Post hoc analysis indicated that the mean SF in P-1 was significantly different than P-3 ( $p = .013$ ) and P-4 ( $p = .02$ ), but no significant differences observed between P-1 and P-2 ( $p = .10$ , Table 5).

**Table 5.** Mean RER, SF and SL by Interval Stage during HIIT Conditions (n=5)

Protocols		P-1 (HIIT)	P-2 (HIIT)	P-3 (HIIT)	P-4 (Cont.)
RER	High Speed	.94 ± .02	.93 ± .03	.94 ± .04	.93 ± .02
	Low Speed	1.07 ± .05	1.01 ± .03	.98 ± .01	.93 ± .02†
	Mean	1.0 ± .03‡	.97 ± .03☆	.96 ± .02	.93 ± .02
SF	High Speed	91.1 ± 5.8‡	88.4 ± 6.6	85.3 ± 5.9	82.7 ± 4.7
	Low Speed	83.4 ± 4.4	81.8 ± 3.7	82.0 ± 4.1	82.7 ± 4.7
	Mean	87.6 ± 4.9‡	85.4 ± 5.1	83.6 ± 4.8	82.7 ± 4.7

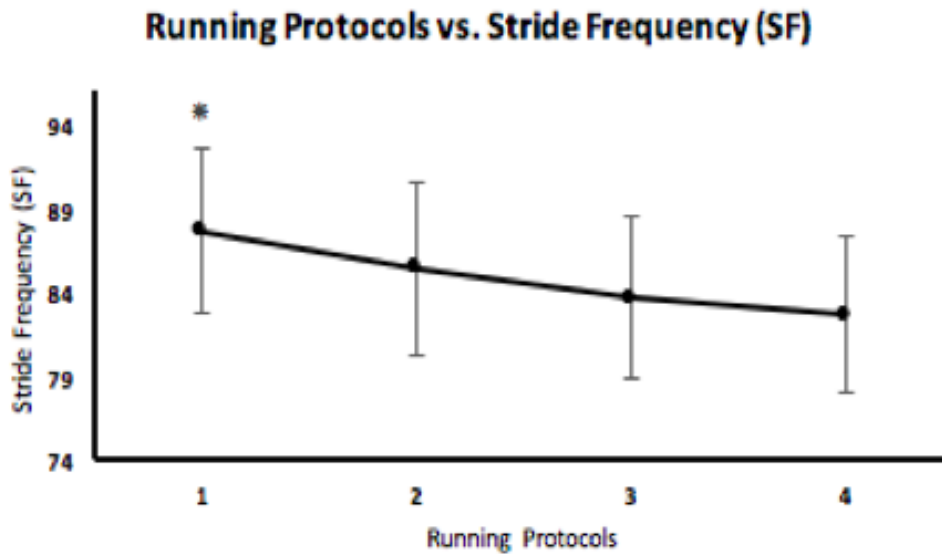
**Note. 6.** Results reported in mean + SD, \*  $p < 0.05$ , significantly different than all other conditions, †  $p < 0.05$ , significantly different than P-1, ☆  $p < 0.05$ , significantly different than P-4, ‡  $p < 0.05$ , significantly different than P-3 & P-4

**Figure 2.** Running Protocols vs. Respiratory Exchange Ratio (RER)



**Note. 7.** \*  $p < 0.05$ , significantly different than P-3 & P-4, †  $p < 0.05$ , significantly different than P-4

**Figure 3.** Running Protocols vs. Stride Frequency (SF)



**Note. 8.** \*  $p < 0.05$ , significantly different than P-3 & P-4

## DISCUSSION

This is the first study to investigate the effect of interval intensity on run time to exhaustion during HIIT running in recreational males. Protocol 1 (110% & 50%  $\dot{V}O_{2max}$ ) elicited a significant reduction in total Run Time to Exhaustion (Te) when compared to all conditions of the same average exercise intensity. Based on the results, intensity margins established during Protocol 1 will result in a statistically significant reduction in total Run Time to Exhaustion when compared to other HIIT protocols of the same average intensities (80%  $\dot{V}O_{2max}$ ). Subsequent analysis of the metabolic and physiological variable data from half of the subjects ( $n = 5$ ) may provide an explanation for these differences.

While no significant differences in oxygen consumption ( $\dot{V}O_2$ ), Heart Rate (HR) and Rate of Perceived Exertion (RPE) were observed among the 4 conditions, significant differences in Respiratory Exchange Ratio (RER) and Stride Frequency (SF) were observed (Table 5). These findings suggest mean RER and SF may explain the some of the differences in total Run Time to Exhaustion (Te) during HIIT running in recreational male runners. While no significant differences in RER and SF were observed between Protocol 1 & 2, greater mean values were observed in Protocol 1, which may have negatively contributed to exercise economy or exercise tolerance during high intensity running sessions. The RER values observed during Protocol 1 and 2 support the findings of Van Loon et al. (2001), in which greater RER values indicate increased reliance on anaerobic metabolism, generally associated with high intensity exercise (19). However, as  $\dot{V}O_2$  values were not significantly different between conditions, increased mean RER during Protocol 1 indicates an increased reliance on anaerobic energy production. Further, this decreased reliance on aerobic energy systems may possibly contribute to a decrease in total run time

to exhaustion during aerobic style HIIT running bouts. These results support findings by Robergs et al. (2004), in which reliance on anaerobic energy production results in the production of protons which contribute to metabolic acidosis (17). Metabolic acidosis as a result of increased proton production from anaerobic energy production contributes to peripheral fatigue by impacting muscular contraction and enzymatic function (2).

Moreover, in agreement with the findings of Smith and colleagues (2003) regarding total bout completion when running at the velocity of  $\dot{V}O_{2\max}$  ( $v\dot{V}O_{2\max}$ ), duration appears to be limited to a roughly 2-3-minute bout threshold (18). Protocol 1 may surpass aerobic thresholds necessary for consecutive 2-minute bout completion, thus contributing to decreased bout completion as a result of high intensity running at the velocity of  $\dot{V}O_{2\max}$  or greater. These observations also support the findings of Robergs et al. (2004), in which Higher intensity energy demands (2-3 minutes) surpass oxidative capacity, which may further explain the differences in total Run Time to Exhaustion seen in Protocol 1 (17).

Furthermore, increased average stride frequency during Protocol 1 and Protocol 2 may be a contributing factor to increased anaerobic energy reliance and decreased run time to exhaustion. Greater stride frequency as a result of increased muscular contraction speed is associated with increased fast twitch muscle fiber recruitment (2). Therefore, an increased reliance on fast twitch motor unit recruitment for muscular contractions while running may negatively impact exercise economy by increasing reliance on anaerobic energy production for faster relative muscle contractions during high intensity running (19). Therefore, similar to the findings of Robergs and colleagues (2004), increased anaerobic energy production via phosphagen and glycolytic energy system may indicate a change in predominant energy system contributions during aerobic style HIIT running sessions which may explain the differences in total Run Time to Exhaustion ( $T_e$ ) (17).

In agreement with the findings of Bartlett et al 2011, Esfarjani et al. 2007, Garcia-Pinillos et al. 2006, Kohn et al. 2011, Perry et al. 2008, Smith et al. 2003 regarding bout duration and total exercise volume, different HIIT protocols resulted in different total durations and energy expenditures (2,7,8,11,14,18). Significant reductions in mean Te were observed in Protocol 1, decreasing total kilocalorie energy expenditure for an exercise session. As previously mentioned, ACSM recommends a given exercise session energy expenditure to range from 150 to 400 kilocalories (15). Additionally, ACSM recommends HIIT training sessions to be completed in under 30 minutes (15, ACSM Health & Fitness Journal, 2018). Using the ACSM equation for caloric cost (see below), mean energy expenditure for all protocols was calculated. All HIIT protocols and continuous running conditions, with the exception of Protocol 1, averaged nearly 25 minutes or roughly 350 kilocalories of energy expenditure. Conversely, Protocol 1 averaged roughly 225 kilocalories. Based on these calculations, exercise guidelines established in Protocol 1 negatively contributed to overall energy expenditure, ultimately decreasing bout completion and volume in agreement with the previous research (2,7,8,11,14,18).

#### **ACSM Metabolic Equation for Caloric Cost**

$$\text{Net Caloric Cost(kilocalories)} = \text{Net METs} \times 1 \text{ MET} \times \left(\frac{\text{kg}}{200}\right)$$

1 MET: 3.5 ml/kg/min, Net METs = Exercise METs - 1 MET, kg: BW in kilograms

The primary limitations of this study include the previous lack of defined HIIT program guidelines. While there are current established guidelines for bout durations and work to recovery ratios regarding energy system training, subsequent guidelines for intensity prescriptions and interval margins of current HIIT program structures have been extremely mixed (Table 1). The major limitation of this study is that all subjects (n=5) did not complete running sessions with metabolic/physiological variable data being recorded

due to laboratory/equipment feasibility. Another limitation of this study is the limited access to a large sample size of recreational runners due to rural location in Northern California. Moreover, accessing a large group of recreational runners with exposure or experience with high intensity exercise is similarly difficult in rural locations. Therefore, Rates of Perceived Exertion (RPE) and ultimately duration during this HIIT running protocol may be more variable due to these factors including running experience, exercise tolerance, and buffering/clearance capacity. Furthermore, only male participants were recruited, similarly related to rural location and subject accessibility. Selected margins for exercise intensity were slightly higher than much of literature in order to ensure maximal effort and complete exhaustion in subjects. For example, implementing average intensities of  $\leq 70-75\%$  of  $\dot{V}O_{2\max}$  may significantly increase exercise duration, potentially exceeding the 30-minute duration and energy expenditure guidelines established by the American College of Sports Medicine regarding HIIT/exercise training (ACSM Health & Fitness Journal, 2018).

Future research should incorporate psychological variables as another means of providing insight into differences in total Run Time to Exhaustion. For high intensity/maximal exercise, psychological factors regarding motivation, effort, and perceived safety should be considered as contributors to performance and should be included. Similarly, the effect of verbal encouragement or awareness of total time or duration within bouts should be examined as factors potentially contributing to exercise duration. Lastly, different maximal aerobic capacity tests should be explored during baseline testing. Testing for velocity of  $\dot{V}O_{2\max}$  ( $v\dot{V}O_{2\max}$ ) would be necessary for more experienced runners or athletes/elite/trained runners, as the BRUCE GXT protocol may be



over/under representing maximal aerobic capacity in non-general population individuals and recreational runners.

### **Practical Applications**

The goal of this project is to establish intensity guidelines for Aerobic High Intensity Interval Training exercise sessions for recreational runners. Access to metabolic testing is limited in recreational athletes subsequently impacting assignment of training intensities. Using information obtained from this study, recreational athletes can use various field testing methods, such as the Cooper 1.5 mile run test to estimate maximal oxygen consumption and calculate training intensity or associated running speeds. Moreover, using the information from this study regarding heart rate during interval bouts, recreational runners can either monitor variables or prescribe intensities based on heart rate to maximize economy and efficiency of implementation. Based on the mean heart rate values obtained during HS/LS bouts, runners can use this information to modify HIIT training variables more efficiently (Table 5). Furthermore, based on this data during HS/LS bouts, runners can assess their stride frequency associated with their maximal/near maximal oxygen consumption speed (90-100% of  $\dot{V}O_{2max}$ ). Ultimately, runners can use this information to subsequently maintain/improve running economy during Aerobic HIIT running to further satisfy exercise session energy expenditure guidelines (150 kcal - 400 kcal) and HIIT duration guidelines (<30 minutes) established by the American College of Sports Medicine (15).

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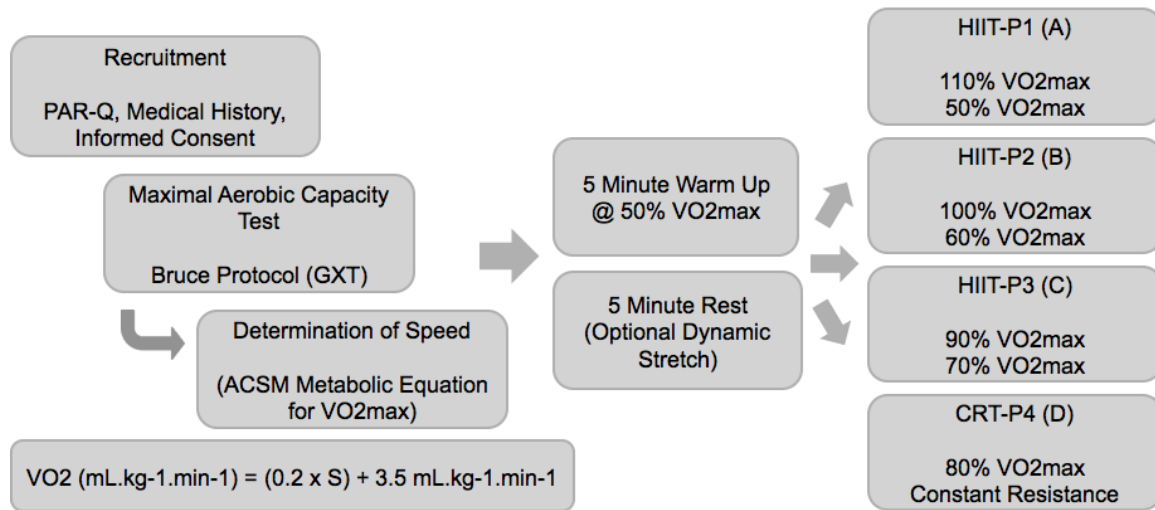
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## APPENDIX

### APPENDIX A. Experimental Design

**Figure 4.** Experimental Design



**Note. 9.** Maximal oxygen consumption ( $\dot{V}O_{2\max}$ ), Physical Activity Readiness  
Questionnaire (PAR-Q)

**APPENDIX B. Medical History Documentation**

Humboldt State University Health and Wellness Institute Medical Information and History  
and Release of Liability

Name:

Address:

Home Phone:

Work Phone:

Age:

Date of Birth:

Gender:

*The following questions are designed to help us tailor the health and fitness assessment and follow-up counseling to your personal situation. It is extremely important for us to know if you have any medical conditions which may affect your testing process or your progress in our program. Please take the time to answer these questions accurately.*

### Medical History

YES	NO	<u>In the past five years have you had:</u>
(     ) (     )	(     ) (     )	1. Pain or discomfort in chest, neck, jaw, or arms
(     ) (     )	(     ) (     )	2. Shortness of breath/difficulty breathing at rest or mild exertion/walking
(     ) (     )	(     ) (     )	3. Dizziness or fainting
(     ) (     )	(     ) (     )	4. Ankle edema (swelling)
(     ) (     )	(     ) (     )	5. Heart palpitations (forceful or rapid beating of heart)
(     ) (     )	(     ) (     )	6. Pain, burning, or cramping in leg with walking
(     ) (     )	(     ) (     )	7. Heart murmur
(     ) (     )	(     ) (     )	8. Unusual fatigue with mild exertion

### Have you ever had:

(     ) (     )	(     ) (     )	9. Heart disease, heart attack, and/or heart surgery
(     ) (     )	(     ) (     )	10. Abnormal EKG
(     ) (     )	(     ) (     )	11. Stroke
(     ) (     )	(     ) (     )	12. Uncontrolled metabolic disease (diabetes/thyrototoxicosis/ myxedema)
(     ) (     )	(     ) (     )	13. Asthma or any other pulmonary (lung) condition
(     ) (     )	(     ) (     )	14. Heart or blood vessel abnormality (e.g., suspected/known aneurysm)
(     ) (     )	(     ) (     )	15. Liver or kidney disease
(     ) (     )	(     ) (     )	16. Are you currently under the care of a physician?
(     ) (     )	(     ) (     )	17. Do you currently have an acute systemic infection, accompanied by a fever, body aches, or swollen lymph glands?
(     ) (     )	(     ) (     )	18. Do you have a chronic infectious disease (mononucleosis, AIDS)
(     ) (     )	(     ) (     )	19. Do you have a neuromuscular, musculoskeletal, or rheumatoid disorder that is made worse by exercise?
(     ) (     )	(     ) (     )	20. Do you have an implantable electronic device (e.g. pacemaker)?
(     ) (     )	(     ) (     )	21. Do you know of any reason why you should not do physical activity?

If you answered yes to any of these questions, please explain.

## Risk Factors

YES	NO	DON'T KNOW	
(    )	(    )	(    )	1. Are you a male 45 years of age or older?
(    )	(    )	(    )	2. Are you a female 55 years of age or older?
(    )	(    )	(    )	3. Do you have a father or brother who had a heart attack or heart surgery before age 55?
(    )	(    )	(    )	4. Do you have a mother or sister who had a heart attack or heart surgery before age 65?
(    )	(    )	(    )	5. Do you smoke or have you quit in the past 6 months?
(    )	(    )	(    )	6. Do you have frequent secondhand smoke exposure?
(    )	(    )	(    )	7. Do you know your blood pressure? ____/____
(    )	(    )	(    )	8. What is your total cholesterol? _____mg/dL
(    )	(    )	(    )	9. Are you taking cholesterol lowering medication?
(    )	(    )	(    )	10. Do you know your HDL cholesterol? ___mg/dL-Date
(    )	(    )	(    )	11. Is your HDL cholesterol > 60mg/dL?
(    )	(    )	(    )	12. What is your fasting blood glucose? ____mg/dL – D
(    )	(    )	(    )	13. Do you exercise regularly? If so, explain.

If you answered yes to any of these questions, please explain.

### Office Use

BMI: SBP: DBP: TC:

LDL: HDL: FBG:

Family History:      Smoking:      Sedentary:



## Health-Related Questions

**YES**    **NO**

- |        |        |  |
|--------|--------|--|
| (    ) | (    ) | 1. Are you pregnant?   |
| (    ) | (    ) | 2. Are you allergic to isopropyl alcohol (rubbing alcohol) or latex?       |
| (    ) | (    ) | 3. Do you have any allergies to medications, bees, foods, etc.? If so list |
| (    ) | (    ) | 4. Do you have any skin problems?  |
| (    ) | (    ) | 5. Do you have any other medical condition(s)/surgeries?                   |
| (    ) | (    ) | 6. Have you had any caffeine, food, or alcohol in the past 3 hours?        |
| (    ) | (    ) | 7. Have you exercised today?   |
| (    ) | (    ) | 8. Are you feeling well and healthy today?                                 |
| (    ) | (    ) | 9. Do you have any other medical concerns that we should be aware of?      |

**If you answered yes to any of these questions, please explain.**



HUMBOLDT STATE UNIVERSITY RELEASE OF LIABILITY, PROMISE NOT TO SUE,  
ASSUMPTION OF RISK AND AGREEMENT TO PAY CLAIMS

I have read this form, and I understand the test procedures that I will perform and the attendant risks and discomforts. Knowing these risks and discomforts, and having had an opportunity to ask questions that have been answered to my satisfaction, I consent to participate in this test.

In consideration for being allowed to participate in this Activity, on behalf of myself and my next of kin, heirs and representatives, I **release from all liability and promise not to sue** the State of California, the Trustees of The California State University, California State University, Humboldt State University and their employees, officers, directors, volunteers and agents (collectively “University”) from any and all claims, **including claims of the University’s negligence**, resulting in any physical or psychological injury (including paralysis and death), illness, damages, or economic or emotional loss I may suffer because of my participation in this Activity, including travel to, from and during the Activity.

I am voluntarily participating in this Activity. I am aware of the risks associated with traveling to/from and participating in this Activity, which include but are not limited to physical or psychological injury, pain, suffering, illness, disfigurement, temporary or permanent disability (including paralysis), economic or emotional loss, and/or death. I understand that these injuries or outcomes may arise from my own or other’s actions, inaction, or negligence; conditions related to travel; or the condition of the Activity location(s). **Nonetheless, I assume all related risks, both known or unknown to me,**

of my participation in this Activity, including travel to, from and during the Activity.

I agree to **hold** the University **harmless** from any and all claims, including attorney's fees or damage to my personal property that may occur as a result of my participation in this activity, including travel to, from and during the Activity. If the University incurs any of these types of expenses, I agree to reimburse the University. If I need medical treatment, I agree to be financially responsible for any costs incurred as a result of such treatment. I am aware and understand that I should carry my own health insurance.

Date:

Signature of Subject:

Date:

Signature of Witness:

## **APPENDIX C. Informed Consent Documentation**

### **Humboldt State University Department of Kinesiology**

#### **Consent to Participate in Research**

The Effects of Interval Intensity on Time to Exhaustion During High Intensity Interval Training  
(HIIT) Running in Recreational Males

#### **Purpose and General Information**

You are being asked to participate in a research study conducted by Andrew Hahn (Principal Investigator), and Young Sub Kwon, Ph.D. (supervising staff member). The purpose of this study is to investigate the effects of 3 different High Intensity Interval Training (HIIT) running protocols and 1 continuous running protocol of the same average intensities on running performance. Specifically, this study aims to determine the optimal interval intensity/margin, and metabolic profile of the (1:1) 2-minute interval HIIT program in recreationally trained runners. This form will explain the study, including possible risks and benefits associated with participation, so you can make an informed choice about whether or not to participate. Please read this consent form carefully, and feel free to ask the investigator or supervising staff member to explain any unclear information.

#### **What will happen if I participate?**

This proposed project was developed based on science and theory in the fields of Exercise Science. All testing will take place in the Human Performance Lab (HPL). When scheduling takes place, you will be asked to refrain from using caffeine and alcohol for 24 hours before each

testing session. If you agree to be included in this study, you will be asked to read and sign this consent form. Upon signing, the following will occur:

The study will be described in detail and your questions will be answered, then you will fill out all pre-screening forms in a private room in the Human Performance Lab. You will be introduced to the study, the purposes and procedures, and the risks and benefits. Following this introductory information, a Medical History and Physical Activity Questionnaire will be completed. The investigators will provide a detailed description of the protocol both verbally and in writing. You will be encouraged to ask questions.

The period of this study is from May 1, 2018 thru April 1, 2019. Your cardiorespiratory fitness will be assessed in this time period. Cardiorespiratory endurance assessments in a laboratory test will be completed, and anthropometric assessments will be completed.

The risk of breaching confidentiality will be minimized by using only professional personnel to perform all study activities, identification numbers instead of names, and rooms at times when others will not need access. A private room is available for discussion and testing, and all study data will be kept in a file cabinet in the P.I.'s office. All data will continue to be coded so that your identity is not revealed throughout the duration of the research.

All participants will be asked to complete 5 total sessions. Since the participants can withdraw at any time without penalty, they cannot be required to complete 5 sessions. Each session will last for approximately 30-60 minutes. The rest period will be at least 48 hours between each session.

**What are the possible risks or discomforts of being in this study?**

Every effort will be made to protect the information you give us. Every effort will also be made to minimize any risk by allowing proper warm-up. As with any research, there may be unforeseeable risks. These risks include muscle soreness, muscle fatigue, and common injuries and issues associated with exercise.

For more information about risks, please contact the Principal Investigator:

Andrew Hahn, NSCA-CSCS

(805) 452-1112

Andrew.Hahn@humboldt.edu

**How will my information be kept confidential?**

Your name and other identifying information will be maintained in files, available only to authorized members of the research team for the duration of the study. For any information entered into a computer, the only identifier will be a unique study identification (ID) number. Any personal identifying information and record linking that information to study ID numbers will be destroyed when the study is completed. Information resulting from this study will be used for research purposes and may be published; however, you will not be identified by name in any publications.

**Will I be paid for taking part in this study?**

There will be no compensation.

**Can I stop being in the study once I began?**

Yes, you can withdraw from this study at any time without consequence.

**Protected health information (PHI)**

By signing this consent document, you are allowing the investigators and other authorized personnel to use your protected health information for the purposes of this study. This information may include: resting blood pressure, height, weight, age, %body fat, and health and fitness related items on the questionnaires. In addition to researchers and staff at the Human Performance Lab (HPL) at Humboldt State University (HSU) and other groups listed in this form, there is a chance that your health information may be shared (re-disclosed) outside of the research study and no longer be protected by federal privacy laws. Examples of this include disclosures for law enforcement, judicial proceeding, health oversight activities and public health measures.

**Right to Withdraw**

Your authorization for the use of your health information shall not expire or change unless you withdraw or change that information. Your health information will be used as long as it is needed for this study. However, you may withdraw your authorization at any time provided you notify the Humboldt State University investigators in writing. To do this, please contact:

Andrew Hahn, NSCA-CSCS

(805) 452-1112

Andrew.Hahn@humboldt.edu



Please be aware that the research team will not be required to destroy or retrieve any of your health information that has already been used or shared before your withdrawal is received.

### **Refusal to Sign**

If you choose not to sign this consent form, you will not be allowed to take part in the project.

### **What if I have questions or complaints about this study?**

If you have any questions, concerns, or complaints about this study, please contact Young Sub Kwon, Ph.D. (faculty advisor) at 707.826.5944 from Monday thru Friday 8am-5pm. (or at 505-350-4345 after hours). If you would like to speak with someone other than the research team, if you have any concerns with this study or questions about your rights as a participant, contact the Institutional Review Board for the Protection of Human Subjects at [irb@humboldt.edu](mailto:irb@humboldt.edu) or (707) 826-5165. You may email the Institutional Review Board (IRB) at [irb@humboldt.edu](mailto:irb@humboldt.edu). The IRB is a group of people from Humboldt State University and the community who provide independent oversight of safety and ethical issues related to research involving human subjects.

### **Liability**

No compensation for physical injury resulting from participating in this research is available.

### **Consent and Authorization**

THE EFFECTS OF INTERVAL INTENSITY ON TIME TO EXHAUSTION DURING  
HIGH INTENSITY INTERVAL TRAINING (HIIT) RUNNING IN RECREATIONAL  
MALE RUNNERS

You are making a decision whether to participate in this study. Your signature below indicates that you read the information provided (or the information was read to you). By signing this Consent Form, you are not waiving any of your legal rights as a research subject.

Sincerely,

Andrew Hahn, NSCA-CSCS

(805) 452-1112

Andrew.Hahn@humboldt.edu

I have read and had the opportunity to ask questions and all questions have been answered to my satisfaction. By signing this consent form, I agree to participate to this study and give permission for my health information to be used or disclosed as described in this consent form. A copy of this consent form will be provided to me.

Signature of participant:

Date:

APPENDIX D. Physical Activity Readiness Questionnaire (PAR-Q) Documentation

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

# PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
<input type="checkbox"/>	<input type="checkbox"/>	1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
<input type="checkbox"/>	<input type="checkbox"/>	2. Do you feel pain in your chest when you do physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	3. In the past month, have you had chest pain when you were not doing physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	4. Do you lose your balance because of dizziness or do you ever lose consciousness?
<input type="checkbox"/>	<input type="checkbox"/>	5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
<input type="checkbox"/>	<input type="checkbox"/>	7. Do you know of any other reason why you should not do physical activity?

If you answered

### YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

### NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active — begin slowly and build up gradually. This is the safest and easiest way to go.

- take part in a fitness appraisal — this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

### DELAY BECOMING MUCH MORE ACTIVE:

- If you are not feeling well because of a temporary illness such as a cold or a fever — wait until you feel better; or
- If you are or may be pregnant — talk to your doctor before you start becoming more active.

**PLEASE NOTE:** If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

**No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.**

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME \_\_\_\_\_

SIGNATURE \_\_\_\_\_

DATE \_\_\_\_\_

SIGNATURE OF PARENT or GUARDIAN (for participants under the age of majority) \_\_\_\_\_

WITNESS \_\_\_\_\_

**Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.**



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APPENDIX A.1

## APPENDIX E. Institutional Review Board (IRB) Documentation



### MEMORANDUM

**Date:** 5/10/2018  
**To:** Young S Kwon  
Andrew Hahn  
**From:** Susan Brater  
Institutional Review Board for the Protection of Human Subjects  
**IRB #:** IRB 17-215  
**Title:** Optimal Interval and Metabolic Profile of the 1:1 HIIT Program during Treadmill Run to Exhaustion in Recreational Runners

Thank you for submitting your application to the Committee for the Protection of Human Subjects in Research. I am able to provide expedited review of your proposal because your research:

*will involve the collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves.*

The Expedited approval of your research will expire **05/9/2019**. By Federal Regulations, all research related to this protocol must stop on the expiration date and the IRB cannot extend a protocol that is past the expiration date. In order to prevent any interruption in your research, please submit a renewal application in time for the IRB to process, review, and extend the Expedited designation (at least one month).

#### Important Notes:

- Any alterations to your research plan must be reviewed and approved by the IRB prior to implementation.
  - Change to survey questions
  - Number of subjects
  - Location of data collection,
  - Any other pertinent information
- If Expedited approval is not extended prior to the expiration date, investigators must stop all research related to this proposal.
- Any adverse events or unanticipated problems involving risks to subjects or others must be reported immediately to the IRB (irb@humboldt.edu).

cc: Faculty Adviser (if applicable)  
Institutional Review Board for the Protection of Human Subjects

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