

The Effect of a Sprint Interval and Resistance Training Program on Body Composition, Aerobic Fitness, and Self-regulation in Young Women

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ABSTRACT

Background: Exercise has positive effects on overall health and reduces risk for several chronic diseases. Diverse program modalities are growing as a potential intervention to improve physiological and psychological outcomes. **Purpose:** The present study examines the effect of a 10-week sprint interval training (SIT) and resistance training program on physiological and psychological variables in young women.

Methods: 37 women (M Age = 24.9±4.3, BMI = 24.7±4.3) participated in a 10-week exercise intervention, consisting of a SIT treadmill protocol and resistance training three times a week for a total of 30 sessions. Participants were randomly assigned to one of two SIT programs (0% incline and 6% incline) and assessed at baseline and post testing for body composition, muscular strength and aerobic fitness. Enjoyment was assessed via a semi-structured interview following the intervention.

Results: There were no significant group by time interactions. There was a significant reduction in body fat percentage ($p<0.001$, Δ 2.23% & 2.52% respectively), as well as a significant increase in lean mass ($p<0.001$, Δ 2.59 kg & 2.56 kg, respectively), bench press ($p<0.001$, Δ 25.87 kg & 24.4 kg, respectively), back squat ($p<0.001$, Δ 69.7 kg & 64.3 kg, respectively) following the intervention for both groups. There were no significant changes in aerobic fitness, kcal intake, and body fat mass. Overall participants reported enjoying the protocol but expressed apprehension of continuing the exercise on their own.

Conclusions: Our current data suggest that a SIT and resistance program accounts for positive changes on physiological and psychological variables like percentage of body fat reductions and lean mass increments, muscular strength and exercise enjoyment.

Keywords: Concurrent exercise program, SIT, Resistance training, Strength training.

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I. INTRODUCTION

The benefits of daily physical activity have been highly documented (Warburton & Bredin, 2017). Current recommendations include at least 150 minutes of moderate intensity physical activity and/or 75 minutes of vigorous intensity per week, as well as, two sessions of muscular strengthening per week (American College of Sports Medicine, 2021). A meta-analysis, further suggested that greater frequencies of resistance training (3 or 4 times per week) would have better results on muscular strength (Grgic *et al.*, 2018). According to the Center for Disease Control and Prevention and United Health Foundation, in 2019, approximately 23% of the United States adult population self-reported participated in 150 minutes or more of moderate aerobic physical activity, or 75 minutes of vigorous aerobic activity, and two days of muscle strengthening per week in the last 30 days (CDC, 2020). The Spring 2018 National College Health Assessment, indicates that only 46.2 % of college-aged men and women met the physical activity recommendations based on self-report (American College Health Association, 2018). This lack of daily physical activity is also related to the increment in chronic diseases including cardiovascular disease, diabetes and early mortality (American College of Sports Medicine, 2021; Dempsey *et al.*, 2014; Hamer *et al.*, 2014). Physical activity and exercise rates appear to be lowest among women, who consistently show lower physical activity rates than men across the lifespan (Edwards & Sackett, 2016; WHO, 2020).

People often adduce a lack of time as the principal barrier to meeting exercise recommendations (Gaesser & Angadi, 2011). Conversely, self-regulation in the form of time management is associated with adherence to exercise for women (Gell & Wadsworth, 2014). Sprint interval training (SIT), short, high intensity sprints at all out efforts followed by a recovery period (Burgomaster *et al.*, 2006), may be a viable solution for

individuals to overcome time constraints because the overall time to induce sufficient physiological responses is reduced. Furthermore, in contrast to a low to moderate exercise program, SIT is a time-efficient modality (Sökmen *et al.*, 2018; Weweg *et al.*, 2017) that induces similar or greater improvements in aerobic capacity (MacInnis & Gibala, 2017), total body fat (Keating *et al.*, 2017), total absolute fat mass (Borges *et al.*, 2019) and reduces the risk of chronic diseases (Gillen *et al.*, 2016). As SIT may provide greater or comparable health benefits in shorter time compared to continuous training, SIT may reduce common barriers such as a lack of time that people often cite as reasons why they do not exercise (Vollaard & Metcalfe, 2017). Within the SIT literature, running can induce high intensity and incline running is a popular modality used in athletes to increase performance. Adding elevation, would allow higher intensities while at a lower treadmill speed. For trained populations a variety of biomechanical (Swanson & Caldwell, 2000), kinematic (Roberts & Belliveau, 2005), running economy (Ferley *et al.*, 2014) and increased time to fatigue (Ferley *et al.*, 2013; Ferley *et al.*, 2014) have been shown with incline running. However, inclined running within a SIT training has not been deeply investigated in untrained females.

Along with a SIT program, resistance training can increase muscle mass and effectiveness for processing energy, favoring greater energy expenditure leading to positive changes in body composition, and up-regulating several key signaling pathways directly affecting fat metabolism (Vechetti *et al.*, 2021). Also, strength training increases bone mass producing a significant osteogenic stimulus, and this cannot be achieved just by performing a SIT protocol alone (Nybo *et al.*, 2010).

It is important to consider that high intensity exercise is often associated with adverse affective responses (Hall *et al.*, 2002; Parfitt *et al.*, 2006), higher intensities can produce a negatively effect on continued behavior due to the significant homeostasis disruption (Kilpatrick *et al.*, 2007). People increase negative affect for exercise when it exceeds the limits of enjoyment (Aaltonen *et al.*, 2012). This is concerning because enjoyment is a mediator of the effectiveness of exercise interventions (Chen *et al.*, 2020; Schneider & Cooper, 2011; Williams *et al.*, 2006), and enjoyment of exercise is associated with continued exercise behavior (Teixeira *et al.*, 2012). However, little data exist on the effect of SIT and resistance training on enjoyment.

As limited data exist on the effectiveness of a SIT and resistance training program on physiological outcomes such as body composition, aerobic fitness, strength and psychological outcomes such as enjoyment, the purpose of this study was to examine the effect of 10-week SIT program on physiological and enjoyment variables in young women.

II. METHODS

A. Participants

A total of 50 recreational active women (M Age= 24.95±4.3 yrs., height= 1.63±0.075 m.) participated in a 10-week exercise intervention, consisting of a SIT treadmill protocol and resistance training, three times a week for a total of 30 sessions. Prior to participation, participants completed an informed consent, which was approved by the University's human subject's review board. To qualify for the study, all participants identified as ready to start an exercise program, as assessed by the Physical Activity Readiness Questionnaire (PAR-Q) and did not participate in a regular schedule of exercise more than two times a week prior to the study.

A total of 50 participants consented and were enrolled in the study. Participants were excluded from the analysis if they missed more than three training sessions (n=7). In addition, 2 participants withdrew for medical reasons not related to the study and 4 did not complete all the post measures, resulting in a sample size of 37 participants (Fig. 1).

B. Study Design

The exercise intervention included a 10-week program consisting of high intensity interval treadmill running and resistance training three times a week for a total of 30 sessions, as shown in Fig. 1.

Prior to the intervention, participants completed the following baseline measures: height, weight, iDXA scan to assess body composition and a maximum oxygen consumption test (VO₂max). The following week the participants were oriented to the program for three sessions. During the first two orientation sessions, participants practiced the SIT and resistance training protocols. The research team gave feedback on form and techniques during these sessions. During the third orientation, session participants completed a 3-repetition max lift for back squat and bench press. Three RM values were utilized to estimate 1 RM values through the Wathen equation (Jiménez-Gutiérrez & De Paz, 2008).

After completing preliminary assessments, participants were pair-matched by baseline VO₂ and randomly assigned to one of two experimental groups: concurrent resistance exercise and SIT flat running (n=25) on the treadmill or concurrent resistance exercise and SIT with incline (n = 25) at 6% gradient on the treadmill. After the 30 sessions, participants completed an iDXA scan, VO₂max, 3-repetition max lift for bench and squat and a semi-structured interview to examine enjoyment.

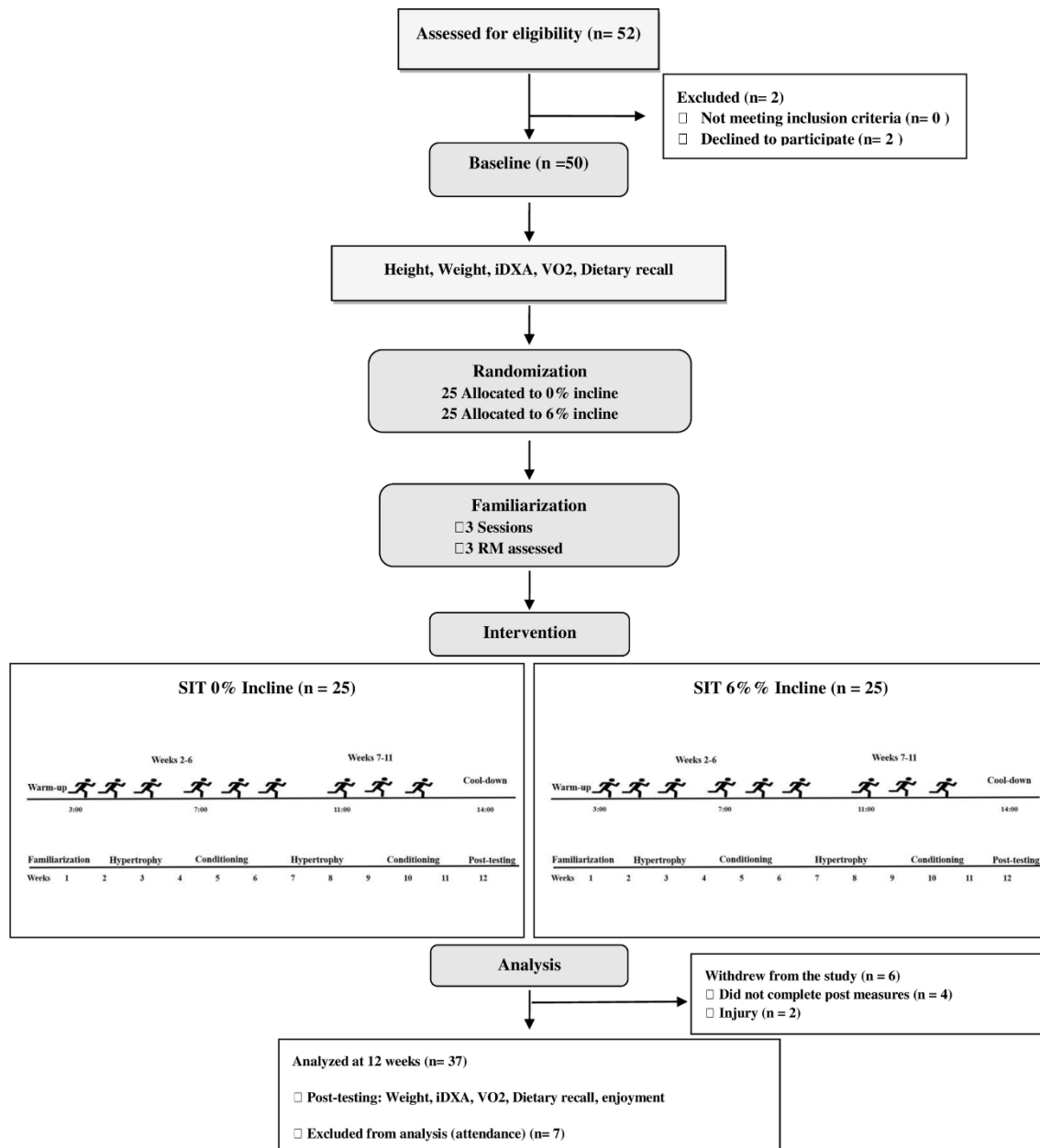


Fig. 1. Protocol for a 10-week SIT and resistance training intervention.

C. SIT Protocol

The SIT running protocol consisted of two (first 5 weeks) -to- three (last 5 weeks) sets of three 40-second sprints with 20 seconds of passive recovery between each sprint and one additional minute of recovery after each set. For example, at the beginning of minute 3, 4, and 5 the participant would sprint for 40 seconds, followed by 20 seconds of passive rest by straddling the treadmill belt. The participant would then rest for a full minute (minute 6), followed by one to two more sets of sprints. Sprint sets were preceded by a warming up phase of three minutes at 4.83 km/h. At the end of the sprints, participants walked on the treadmill at 4.83 km/h for 3 minutes to cool down. The SIT program was set to induce cardiovascular responses $\sim 95\%$ of maximal heart rate achieved during the VO2max test, therefore speed was adjusted throughout the program to maintain this intensity. Both groups completed the same protocol, with the exception of those randomized to the incline group complete the SIT protocol at 6% incline and those randomized the 0% completed the protocol without incline.

D. Resistance Protocol

The resistance training program consisted of two alternating workouts: A. back squat, bench press, and bent-over row, and B. squat jumps, lunges, standing shoulder press, back extensions, and sit-ups. The resistance exercise training program, based on undulating periodization, was set to impose fluctuating stimuli and in turn, neuromuscular overload. Undulating training model targets volume based on two principles, accumulation which meets high volume training: higher repetitions, more sets, more exercises, and so on; and intensification, the opposite, based on heavier weights, lower repetitions, and emphasis on

adding more weight to the workout. The training model utilized in this study was: 1 week of orientation, 3 weeks of hypertrophy, 2 weeks of muscular strength, 1 week of power, 2 weeks of muscular strength, 2 weeks of hypertrophy. The hypertrophy phase encompassed 3 sets of 10 repetitions at 65%, 70% and 75% of each participant's 1RM for the Back Squat and Bench Press, whereas the strength phase was composed of 3 sets of 6 repetitions at 75%-80%-85% of calculated 1 RM for each of the lifts. The muscular power phase consisted of 3 sets of 5 repetitions at 70, 75 and 85% of calculated 1RM. As participants improved, weight was increased throughout the intervention.

For the first five weeks the workout consisted of: 1) dynamic warm-up, 2) SIT protocol 2-sets of 3 sprints, 3) resistance workout A 4) cool-down or 1) dynamic warm-up, 2) resistance workout B, 3) SIT protocol 2-sets of 3 sprints, 4) cool-down. Starting week six the exercise session consisted of: dynamic warm-up, 2) SIT protocol 3-sets of 3 sprints, 3) resistance workout B 4) cool-down or 1) dynamic warm-up, 2) resistance workout A, 3) SIT protocol 3-sets of 3 sprints 4) cool-down. Both treadmill groups completed the same resistance protocol.

E. Measures

Body composition was assessed by dual-energy X-ray absorptiometry (iDXA) (GE Healthcare Lunar, Madison, WI). iDXA utilizes a fan beam x-ray and different photon energy levels with distinctive attenuation profiles to detect different body tissue, then creates high resolution images that identify their amounts specific distribution in the body (Toombs *et al.*, 2012). According to previous studies the precision error for total body mass 0.9%, total body lean mass 0.4 to 0.5%, fat mass 0.7 to 0.8%, and 0.6 to 0.9% percent body fat (Hind *et al.*, 2011; Rezzi *et al.*, 2009; Rothney *et al.*, 2012). Total and regional fat mass (FM), percent body fat (%Fat) lean body mass (LBM), body weight (BW), were measured by iDXA. All DXA measurements were carried out by certified research personnel.

Aerobic capacity was measured by a maximal Bruce Protocol (volitional fatigue) with a reported standard error of estimates (SEEs) range from ± 2.7 to ± 4.7 mL·Kg⁻¹·min⁻¹ (American College of Sports Medicine, 2018). Aerobic capacity was measured with indirect calorimetry by asking the participant to walk-jog, and/or run on a treadmill at stages of three minutes each one, beginning at:

1. 10% of incline and 2.74 km/h;
2. 12% incline and 4.02 km/h;
3. 14% incline and 5.5 km/h;
4. 16% incline and 6.76 km/h;
5. 18% incline and 8.05 km/h;
6. 20% incline and 8.85 km/h.

The test was terminated when the subject reached volitional fatigue. Maximal heart rate achieved during the test was used to determine 95% of heart rate max for the SIT protocol.

Muscular Strength (3-rep max): At baseline lower extremity muscular strength was assessed with Back Squat estimated 1 RM while upper extremities strength was gauged through the bench press estimated 1 RM. Study participants were instructed on and practiced proper lifting techniques and were spotted during all resistance tasks. Initial back squat 3 RM assessment began with 10 repetitions of a body weight squat followed by five back squats using a 20.5 kg. barbell. Participants were instructed to attain a 90-degree angle between the femur and tibia for squat depth. Foam barbell covers were available for the convenience of participants. A similar procedure was used for the bench press, starting with 10 repetitions of a light (4.1-5.45 kg) weighted bar, followed by five repetitions at a higher weight. For the bench press, participants were instructed to grip the bar such that the thumbs were at shoulder level when the bar was resting on the support props. Complete range of motion consisted of lowering the bar until it touched the chest and pressing it upward until locking of the elbows at the top of the press.

After the initial warm-up set for both the back squat and bench press a 2-minute break occurred followed by five additional repetitions at 50% of the participant's estimated 1RM. Following an additional 2-minute rest period, three repetitions were completed at an estimated 70% of 1RM. Subsequent sets of progressively increased weight were completed until three repetitions were performed with proper form at near maximal weight. Each of these sets was separated by a recovery period of 3 minutes. The maximum weight completed with correct form and three repetitions was used to estimate 1 RM values through the Wathen equation for both the back squat and bench press.

Dietary Recall was used to determine that the effects of the study were not due to dietary changes, participants were asked to complete a 3-day diet recall (two weekdays and one weekend day) during baseline of the intervention and one week after the intervention. Energy intake and diet components were analyzed by open-sourced software (www.nutritiondata.com). Average kcals, over the three days, is reported.

Exercise Enjoyment: After the exercise program, participants completed a brief semi-structured interview. The interviews focused on enjoyment of running/SIT training, enjoyment of resistance training, confidence for future exercise and intention to be active in the future. The flexible nature of the semi-

structured interviews allowed for exploration of emerging themes and was aimed to facilitate participants' accounts of their experiences with the SIT and resistance training. Utilizing this format versus an assessment via survey allows for enquiry into why participants enjoy or do not enjoy the exercise program. All interviews were conducted by one female researcher who is trained in qualitative methodology. Each interview lasted 5-15 minutes, was tape recorded and then transcribed verbatim.

F. Statistical Analysis

All quantitative analyses were performed with SPSS 26.0. A minimum sample size of 20 participants per group was determined with G power a priori to achieve 0.80 power with an alpha level of 0.05 and 0.30 effect size. The effects of the program on lean body mass, fat mass, VO₂, 1RM squat and 1RM bench press were analyzed using a mixed ANOVA with incline versus flat running as the between factor and time (pre and posttest) as the within factor. The significance level was set at $p < 0.05$. Interviews were analyzed by the seven steps of phenomenography described by Dahlgren and Fallsberg to determine emerging themes (Dahlgren & Fallsberg, 1991). These steps consist of familiarization and review of the transcripts, compiling the most significant answers, reducing the data to find centralized themes, determining borders of the themes and comparing and contrasting those themes.

III. RESULTS

A total of 37 women (M Age= 24.95 \pm 4.3 yrs., height= 1.63 \pm 0.075 m.) completed the 30 sessions within 10 weeks. Table I shows the descriptive information by group (incline versus flat running). There was no group*time interaction for body fat percentage, lean mass, relative VO₂max or total of kcals consumed. Both groups showed significant increases for lean mass ($p < 0.001$), body weight ($p = 0.008$) and BMI ($p = 0.006$), as well as significant decreases in body fat percentage ($p < 0.001$). There were no significant changes for fat mass ($p = 0.14$), VO₂max ($p = 0.53$) or changes in caloric intake ($p = 0.10$). Table I shows changes by group for lean mass, fat mass, body fat percentage, VO₂max, BMI and strength.

TABLE I: DESCRIPTION OF THE RESULTS BY GROUP AND BY PRE-TEST AND POST-TEST

| | Flat Running (n = 19) | | | Incline Running (n = 18) | | | Main Effect of Time | | | |
|-------------------------------|--------------------------|-------------------|----------|-----------------------------|--------------------|----------|---------------------|--------|------------------|-------|
| | Pre | Post | Δ | Pre | Post | Δ | F | p | Eta ² | Power |
| Weight Kg. * | 68.35 \pm 15.44 | 69.43 \pm 14.87 | 1.58 | 61.7 \pm 12.39 | 62.48 \pm 12.95 | 1.28 | 8.01 | 0.008 | 0.19 | 0.79 |
| BMI Kg/m ² * | 25.62 \pm 4.80 | 26.05 \pm 4.64 | 1.7 | 23.01 \pm 3.60 | 23.31 \pm 3.78 | 1.3 | 8.42 | 0.006 | 0.19 | 0.80 |
| Body Fat Kg. | 25.41 \pm 9.85 | 25.22 \pm 9.89 | 0.75 | 20.9 \pm 8.84 | 20.63 \pm 9.21 | 1.29 | 2.32 | 0.14 | 0.06 | 0.32 |
| Body fat % * | 37.27 \pm 6.36 | 36.44 \pm 6.44 | 2.23 | 33.78 \pm 7.01 | 32.93 \pm 7.14 | 2.52 | 24.42 | <0.001 | 0.41 | 0.99 |
| Lean Mass Kg. * | 40.99 \pm 5.90 | 42.05 \pm 5.67 | 2.59 | 39.14 \pm 4.35 | 40.18 \pm 4.54 | 2.66 | 31.21 | <0.001 | 0.47 | 0.99 |
| VO ₂ max mL/Kg/min | 35.73 \pm 5.91 | 35.52 \pm 6.09 | 0.59 | 37.22 \pm 5.47 | 36.72 \pm 5.55 | 1.34 | 0.399 | 0.53 | 0.01 | 0.09 |
| Kcals | 1751.4 \pm 285.8 | 1579 \pm 238.2 | 9.84 | 1743 \pm 202 | 1517.4 \pm 168.4 | 12.95 | 3.16 | 0.10 | 0.17 | 0.39 |
| Bench Press Kg. * | 34.21 \pm 7.52 | 43.06 \pm 17.43 | 25.9 | 32.58 \pm 6.52 | 40.53 \pm 7.53 | 24.4 | 98.99 | <0.001 | 0.74 | 1 |
| Back Squat Kg. * | 52.30 \pm 12.79 | 88.75 \pm 13.86 | 69.7 | 49.87 \pm 16.1 | 81.94 \pm 15.57 | 64.3 | 333.8 | <0.001 | 0.91 | 1 |

*Main effect of time: post-test statistically significant different from pre-test $p < 0.05$.

Enjoyment Results. Overall, the participants enjoyed SIT training and had confidence they would be able to continue the SIT training on their own. In terms of resistance exercises, all participants enjoyed the exercises but only 76% reported that they were confident using resistance training as a modality in the future. Results from the interviews and emergent themes are in Table II.

TABLE II: EMERGENT THEMES FROM SEMI-STRUCTURED INTERVIEWS

| Survey Question Responses | Interview Emergent Theme | Description |
|---|------------------------------------|--|
| Did you enjoy the SIT training? | | |
| 97% Yes | Sense of enjoyment | Participants expressed a sense of enjoyment from the SIT. <i>"It was fun to sprint, I felt so fast!"</i> |
| 3% No | Lack of Variety | Participants who did not enjoy the SIT training stated that the repetitive nature of the training was <i>"boring, it was the same exercise for 10 weeks."</i> |
| Do you have more confidence in your ability to do SIT training? | | |
| 86% Yes | Past Performance Accomplishments | Participants expressed that they felt more competent in terms of their ability to complete a SIT training regimen. <i>"I didn't think I would be able to do the sprints, but now I know that I can"</i> |
| 14% Yes | Lack of supervision/accountability | Participants felt that a lack of supervision or accountability would decrease their ability to be able to complete SIT on their own. <i>"I don't think I would have worked as hard if you guys weren't there to push me."</i> <i>"To work this hard (referring to the sprints) I need a partner or someone to push me"</i> |
| Did you enjoy the resistance training? | | |
| 100% Yes | Novelty | Participants stated that they have never done this type of resistance training. <i>"This was such a new experience for me, I really enjoyed it."</i> <i>"I have never done resistance training like this; I mean I have used dumbbells but not like this and I loved it!"</i> |

TABLE II: EMERGENT THEMES FROM SEMI-STRUCTURED INTERVIEWS

| | | |
|--|---------------------|--|
| | Competence | Participants agreed that the ability to show how much weight they could do added to their enjoyment. <i>"I have never lifted this much weight, I never thought I could do something like this. It was such a good experience."</i> |
| Did you have more confidence to do resistance training after this study? | | |
| 76% Yes | Knowledge | Participants stated that they knew how to do the resistance exercises and this increased their confidence. <i>"Before I would be too nervous to lift weights in a gym. But now, I know my form is amazing and I know what exercises to do."</i> |
| 24% No | Lack of supervision | Participants were nervous about having to do the exercises on their own. <i>"I really liked having you guys tell me if my form was wrong, or what I was doing right. I don't know if I will do this style of training if I don't have someone watching me. Even though I know how to do the exercises now"</i> . |
| | Access | Participants expressed a lack of accessibility to resistance equipment. <i>"I am graduating this semester and I would have to join a gym to do this type of training, I am not sure I will do that."</i> |

TABLE II: EMERGENT THEMES FROM SEMI-STRUCTURED INTERVIEWS (CONT.)

| | | |
|---|-----------------------|--|
| Do you intend to be active in the future? | | |
| 100% Own Exercise | Physiological Changes | Participants liked the physiological changes associated with the program. <i>"I have so much energy on the days I work out here"; "I really like the definition in my legs and arms" "I gained weight, but I looked and felt better it is such a motivator for me."</i> |
| | Confidence | Participants stated the study increased their confidence in terms of SIT and resistance training. <i>"I didn't know I could train this hard"; "I know how to exercise now"</i> |
| | Knowledge | Participants stated they didn't understand SIT training prior to the study. <i>"I didn't realize I could rest during exercise. I thought you just go run for 30 minutes and that's it!"; "I really liked the fact that we got to rest, I feel like I can do so much more after the 20second rest!"</i> |

IV. DISCUSSION

The purpose of this study was to examine the effect of a 10-week SIT and resistance training program on physiological and psychological variables in young women. The results showed statistically significant changes in lean body mass increments and overall enjoyment by the participants during the intervention.

The results for this study show a positive lean mass change. According to previous studies (Nybo *et al.*, 2010), it cannot be accounted as an effect of the SIT program itself. This change should be accounted for both, SIT and the resistance training program. When a resistance program is added to high intensity aerobic exercise, favorable changes in body composition may occur due to a greater amount of fat usage during the recovery phase (Hunter *et al.*, 1998; Stiegler & Cunliffe, 2006). It has been proposed that activating and building muscle, while participating in high intensity cardiovascular training improves metabolic system components (MacDougall *et al.*, 1998; MacInnis & Gibala, 2017). These improvements allow total energy expenditure increases, benefiting the reduction of body fat content (Atakan *et al.*, 2021; Skelly *et al.*, 2021).

We observed small changes in fat mass, and those, were not statistically significant. According to a recently meta-analysis, authors suggest that interval training is only effective to reduce small amounts of fat independently of the training protocol, intensity and duration, also, these findings suggest that focusing on greater volumes of exercise, instead of intensity, could be explored in order to see significant changes in fat mass (Steele *et al.*, 2021). Further research concluded that body fat may not show differences in fat reductions in interval training programs that include lower time execution and lower energy expenditure when compared to a moderate intensity continuous training; it may important to consider that an acceptable volume of energy expenditure is required for fat reduction (Keating *et al.*, 2017).

A meta-analysis found increments on aerobic exercise performance after a SIT program (Gist *et al.*, 2014; Sloth *et al.*, 2013). Interval training combined with concurrent training has shown positive effects in VO₂max in young adult women (Laird *et al.*, 2016), older women (Salom Huffman *et al.*, 2019), as well as the SIT training alone in diverse studies (Boullousa *et al.*, 2022; Sloth *et al.*, 2013). Our study did not result in significant changes in VO₂max, even though our subjects were not participating in a regular schedule of exercise. This could be due to the dose of our exercise program was insufficient to induce changes in VO₂max. This could also be due to the volitional fatigue of the subjects who ended the post VO₂max without meeting other VO₂max criteria (n=7). Moreover, the evidence is not clear as aspects of SIT programs, such as the length of the sprints and the total number of repetitions, necessary to show changes in VO₂max and further investigation is warranted (Vollaard & Metcalfe, 2017; Vollaard *et al.*, 2017). There was also no difference between the incline group and the flat running group. Based on our results, participants who participated in SIT training at a set percentage of heart rate have similar physiological results regardless of treadmill specifications.

Our study showed that young women significantly improved strength as measured by bench press and back squat, implying that for recreational active women a program combining SIT and strength training programs would allow women to improve physiological variables that could attenuate health and quality of

life. As shown by previous studies that combined SIT and concurrent resistance training, authors found positive effects on muscular performance in women (Laird *et al.*, 2016).

Enjoyment is a key factor in predicting exercise adherence (Parfitt & Hughes, 2009). If we operate under the assumption that people will avoid exercise if they find it too strenuous, then SIT training would have low adherence rates (Perri *et al.*, 2002). Previous literature is mixed on enjoyment associated with SIT training (Bartlett *et al.*, 2011; Ryan *et al.*, 2009), although there is a paucity of research in this area. Previous studies examined the affective response immediately after a high intensity interval (Bartlett *et al.*, 2011), and compared to moderate continuous exercise, found interval training was more enjoyable. Whereas, previous literature utilized scales, we interviewed subjects to gain a deeper perspective on their thoughts, feelings, and emotions over the 10-week process. The results from this study showed that this group of young recreational women enjoyed the SIT and resistance protocol over the course of the 10-week intervention. Feelings of enjoyment were based on competence and the ability to complete the protocol, as well as overall enjoyment of running the sprints. For example, “I would have never thought I could do sprints, I am not a runner, but doing them in this way I could complete a run! I felt so accomplished” and “I do not like to run, but I really enjoyed this type of training.” Competence was also a theme for enjoyment of resistance training exercises. “I was never taught how to lift weights. I would just go to the ‘girl section’ of the gym. But now, I know I am doing it right!” and “I didn’t realize that getting strong was so much fun, I feel that learning how to do the exercises correctly made such a difference”. According to self-determination theory fulfilling the needs of competence, autonomy and relatedness relate to intrinsic motivation, enjoyment and continuation in volitional behavior (Ryan *et al.*, 2009). Therefore, SIT training and resistance training programs should focus on competence for continued overall success. In addition, a lack of confidence in lifting techniques and resistance training, as well as a lack of knowledge about SIT training was discussed by 96% of the women interviewed. Although overall the participants felt more confident in completing a SIT training and resistance protocol, 14-24% felt that they would not do the protocols on their own. For example, “Although I enjoyed lifting weights and I think I know how to do it, I just don’t feel comfortable in a gym,” and “I would not do high intensity like this if I didn’t have someone to push me and keep me accountable.” Based on these responses, although enjoyment has been linked to exercise adherence, for SIT and resistance training, more educational efforts should be directed for women within the interventions themselves to encourage exercise after the intervention.

This study is not without limitations. First, this study utilized two experimental conditions versus a control group. Second, our results are limited to an inactive adult population and may not be applicable for other populations. Third, we purposefully used motor-driven treadmills that are accessible to the public and adjusted the speed throughout the study to maintain 95% of initial heart rate max, as well as adjusted the load of the resistance training regimen. In a real-world scenario, subjects would need to rely on their own motivation to maintain this intensity over time. Finally, the qualitative interviews focused on future intent to be active, and we were unable to measure actual activity that occurred following the study.

V. CONCLUSION

Based on the results of this study, a program of SIT and resistance training results in significant improvements in lean mass, percent body fat and strength, as well as small insignificant changes in fat mass. Most participants found this style of training enjoyable. As each session took approximately 45 minutes, including warm-up and cool down this might be a feasible solution to meeting exercise recommendations. Future research would benefit from identifying how to continue these styles of program overtime and identifying the effects on different populations.

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CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

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