How to Cite:
Alfin, F., Nuniek Nugraheni, S., Sari, D. I., Tinduh, D., & Melaniani, S. (2022). Effects of high-intensity interval training treadmill with changes in inclination to body fat mass percentage of overweight men. *International Journal of Health Sciences*, *6*(S2), 8431–8441. https://doi.org/10.53730/ijhs.v6nS2.7283

Effects of high-intensity interval training treadmill with changes in inclination to body fat mass percentage of overweight men

Fauza Alfin
Department of Physical Medicine and Rehabilitation, Airlangga University/Dr. Soetomo Academic Medical Center Hospital, Surabaya, Indonesia
Corresponding author email: fauzaalfin@gmail.com

Nuniek Nugraheni S.
Department of Physical Medicine and Rehabilitation, Airlangga University/Dr. Soetomo Academic Medical Center Hospital, Surabaya, Indonesia

Dyah Intania Sari
Department of Physical Medicine and Rehabilitation, Airlangga University/Dr. Soetomo Academic Medical Center Hospital, Surabaya, Indonesia

Damayanti Tinduh
Department of Physical Medicine and Rehabilitation, Airlangga University/Dr. Soetomo Academic Medical Center Hospital, Surabaya, Indonesia

Soenarnatalina Melaniani
Department of Epidemiology, Biostatistics, Population Studies, and Health Promotion, Faculty of Public Health, Airlangga University, Surabaya, Indonesia

***Abstract*---**A higher body fat percentage reflects an increased risk of comorbidities. High-Intensity Interval Training (HIIT) is a more efficient and effective form of exercise in reducing body fat mass. This study aimed to determine the effects of HIIT treadmill with changes in inclination to body fat mass percentage of overweight men. Twenty-two overweight subjects who met the study criteria were randomly assigned to the intervention group and the control group. The intervention group did HIIT using a treadmill with incline changes for 4 weeks. Measurements of the anthropometrics such as weight, body mass index (BMI), waist and hip ratio (WHR), and body fat mass were performed pre and post the intervention in both groups. There was significant decrease in body fat mass percentage (p=0,000) and WHR (p=0,000) in intervention group and significant difference in body fat mass percentage (p=0,000) in the intervention group compared to the control group (p=0,00). However, there is no significant decrease in

BW (p=0.598) and BMI (p=0.592) in the intervention group after exercise. HIIT treadmill with changes in inclination is good to reduce body fat mass percentage of overweight men.

***Keywords*---**HIIT, treadmill, inclination changes, body fat mass, overweight men.

Introduction

The rate of overweight continues to increase in both developed and developing countries (Speiser et al., 2005). Consultation (2004) stated that the Asian population's BMI of 23 kg/m2 or more has a risk of comorbidity so public health interventions are needed to overcome them. Morbidity caused by a high BMI is closely correlated with a high percentage of body fat. Individuals with the same BMI but with a higher body fat mass percentagehave a higher tendency for morbidity. A higher body fat percentage also reflects an increased risk of disease (eg, Diabetes Mellitus and heart disease), risk factors for chronic disease, and death (WHO, 2000).

On average, individuals who are overweight have a sedentary lifestyle and do not have sufficient time to exercise, while for weight loss, long-term endurance training is recommended (Da Silva et al, 2019; Gueugnon et al., 2012; Buchan et al., 2012). Exercise with efficient use of time is needed to increase a person's compliance to do regular exercise. Currently being developed High-Intensity Interval Training (HIIT) which is a form of high-intensity physical exercise accompanied by low-intensity intervals that require more efficient time and is expected to be an effective form of physical exercise in reducing the risk of comorbidities (Ito, 2019).). HIIT will result in a significant reduction in total belly fat,

In a meta-analysis study by Maillard et al (2017), it was stated that HIIT is an efficient strategy to reduce body fat mass. In this meta-analysis, almost all significant studies in reducing body fat mass used long-term HIIT (more than 6 weeks), only three studies with significant results used short-term (4 weeks) and all three used stationary bicycles as the modality.

Several studies show the effectiveness of the treadmill is better in increasing fat oxidation than cycling modalities. Subjects who did HIIT treadmill exercise with changes in inclination could walk slowly but could increase the intensity of exercise using the incline of the treadmill. A study showed that walking at a relatively slow pace at a moderate incline is a potential exercise strategy that can reduce the risk of musculoskeletal injury while providing an appropriate cardiovascular stimulus in overweight adults (Kriel et al., 2018; Ehlen et al., 2011). Based on this, the purpose of this study was to test and analyze the effect of reducing body fat mass after 4 weeks (short-term) HIIT administration using a treadmill with a change in inclination.

Method

Study design

This study used a true experimental method with pre and post-test randomized control group design, intending to compare body fat mass in overweight men after high-intensity interval training with changes in inclination.

Sampling method

The place of research is in the outpatient Rehabilitation clinic at dr. Soetomo hospital Surabaya, Indonesia. The research subjects were overweight men who met the inclusion and exclusion criteria until the number of samples was met. Inclusion criteria of this research were male, overweight, Body Mass Index (BMI) 23 kg/m2, Age 18-55 years, normal cognitive function, systolic blood pressure < 140 mmHg, diastolic < 90 mmHg, willing to participate in this research voluntarily by signing the informed consent form.

Exclusion criteria of this research were erythema, sores, ulcers, or gangrene on one or both legs, peripheral neuropathy, joint range of motion of both ankles for plantar flexion < 45 degrees and dorsiflexion < 20 degrees, undergoing a regular aerobic exercise program, ischemic heart disease, restrictive or obstructive airway disease, vascular neuromusculoskeletal disease of the lower limbs that impairs ambulation function, visual disturbance, balance disorders, new stroke or transient ischemic attack, kidney failure, and coronary artery bypass surgery (< 4 weeks) or percutaneous intervention (< 3 weeks).

Dropout criteria were research subjects are not willing to continue the research for any reason, subjects were unable to complete the exercise according to the established research protocol if there are complaints of hypoglycemia, chest pain, or tightness during or after exercise if there are complaints of calf pain during or after exercise, symptoms of angina, shortness of breath, headache, dizziness, or other symptoms of hypoperfusion, O2 saturation<88%, increased blood pressure> 220/105mmHg, decreased systolic blood pressure >10mmHg from baseline during HIIT, decreased pulse when load increases or atypical arrhythmias are found

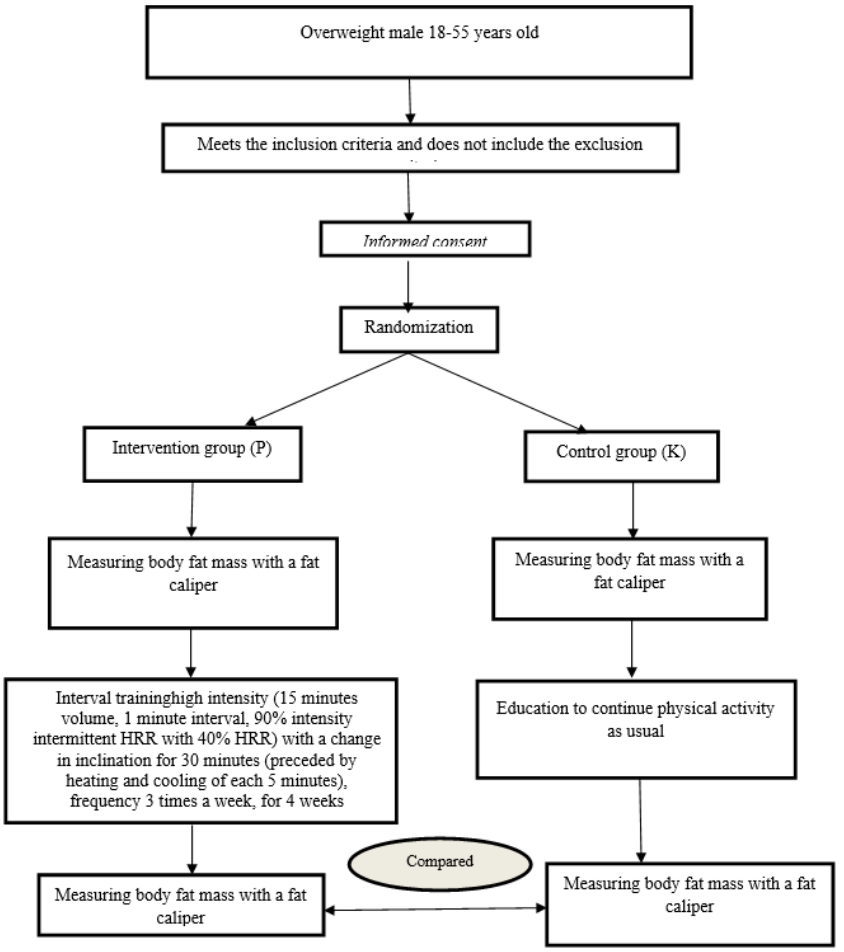

Figure 1. Research Flow

Intervention

Collecting data on the characteristics of the subject (name and age), subjective examination (history), and physical examination, as well as other examinations needed to determine the inclusion and exclusion criteria. Especially for the results of the ECG investigation, a cardiologist will be consulted as an initial screening to ensure the patient's condition. All data were recorded on the data collection sheet.

Research subjects included in the inclusion criteria were randomized using a lottery into 2 groups. Group P was the intervention group that received high-intensity interval training with THR = HR Rest + 80-90% low-intensity intermittent HRR THR = HR rest + 30-40% HRR with changes in inclination. Group K is a control group that does not get HIIT. In this study, treadmill exercise was performed with HIIT with a change in inclination. Before practice, there are a few things that need to be determined first. Target Heart Rate (THR). High intensity THR = HR Rest + 80-90% HRR, Low intensity THR = HR Rest + 30-40%

HRR. The THR obtained is used to determine the inclination of the exercise to be used.

The inclination was determined by asking the patient to do a treadmill exercise at a speed of 2.0 mph and then increasing the inclination by 1% every 1 minute until the low-intensity and high-intensity THR were achieved. The low-intensity inclination is the inclination when a low-intensity THR is reached. The high-intensity inclination is the inclination when the high-intensity THR is reached. After the THR and Inclination were determined, the treadmill program was adjusted using the Naughton method, each heating, and cooling for 5 minutes, intervals of 1 minute, and volume of 15 minutes (total exercise for 40 minutes).

Outcome measures

Anthropometric measurements of weight, height, then the body mass index value was determined using the formula for the weight (kg)/height (m2) when measuring the subject only used sports clothes without shoes. Measurement of subcutaneous fat mass on the hip, chest, and abdomen was measured using the HRM Body Fat Tester Caliper then the measurement results (mm) were entered in the formula

Data analysis

The data were analyzed computerized with SPSS version 26.0 using several tests. Shapiro-Wilk test to determine normality in each group P and K. Levene's Test to determine the homogeneity. The data are not normally distributed, the data are compared using the non-parametric Wilcoxon and Mann-Whitney u test. Ethical eligibility is submitted to the Ethics Commission for research and basic/clinical science at RSUD Dr. Soetomo Surabaya.

Results

The total subjects were 22 patients who met the inclusion criteria and did not include the exclusion criteria. Subjects were divided into 2 groups, consisting of 11 subjects in each group. Two subjects experience muscle soreness. There were no reported adverse events related to COVID 19 in this study. The following is the result of the statistical analysis of the characteristics of the research subjects and continued with the homogeneity test to show that there was no significant difference between the intervention and control groups with the following results:

Table 1. Characteristics and Homogeneity of Research Subjects in Both Groups

Variable	Intervention n =11 (Mean + SD)	Control n = 11 (Mean + SD)	Price p
Age (years)	30.36 + 2.58	34.64 + 2.98	0.492
Weight (kg)	81.00 + 12.51	77.81 + 11.43	0.831
Height (cm)	167.36 + 5.24	169.18 + 6.87	0.688
BMI (kg/m2)	28.81 + 3.37	27.04 + 2.27	0.444
WHR	0.89 + 0.04	0.87 + 0.031	0.247
% body fat mass (%)	19.16 + 4.73	16.30 + 2.99	0.067

Description: Levene's Test. figures for age, height, weight, BMI, WHR, and body fat mass percentage are the average ± standard deviation; *p-value indicates the probability or significance level of the initial data, significant or homogeneous data if p > 0.05 Based on the results of the homogeneity test of age, weight, height, BMI, WHR, and body fat mass percentage between the intervention group and the control group, it can be seen that the two groups of research subjects have homogeneous values.

Table 2. Characteristics of Body Fat Mass Percentage intervention Group

Group	Condition	N	Minimum	Maximum	mean	Std. Deviation
Intervention	Pre	11	10.69	25.57	19.16	4.73
	Post	11	8.82	23.59	16.64	4.80

Table 3. Anthropometric Difference Test Results and Body fat mass percentagein the Intervention Group

Group	Condition	Mean + SD	Mean Difference	*P*
Weight[a]	Pre	77.82+ 11.42	0.68	0.598
	Post	78.50+11.68		
BMI[a]	Pre	27.04+ 2.27	0.24	0.592*
	Post	27.28+ 2.38		
WH ratio[a]	Pre	0.89+0.44	0.02	0.000*
	Post	0.87+0.44		
Percentage of body fat mass[a]	Pre	19.16 + 4.73	2.52	0.000*
	Post	16.64+4.80		

Information: a: Paired T-Test; b: Wilcoxon test; *Significantly different at the significant level p<0.05

Based on Table 3 it can be seen that there are significant differences in BMI and WHR pre and post treatment (having a p-value < 0.05) while there is no significant decrease in weight (having a p-value > 0.05). The body fat mass percentagein the treatment group pre and post exercise had a p-value (0.000) <0.05 so there was a significant difference in the body fat mass percentagepre and post exercise in the treatment group. Where before practice (19.16 + 4.73) had a higher average body fat mass percentagethan after the intervention (16.64 + 4.80) with a mean difference of 2.52. This shows a decrease in body fat percentage after doing HIIT Treadmill exercises with changes in inclination.

The following is a descriptive description of the body fat mass percentageusing the lowest, highest, average, and value standard deviation:

Table 4. Characteristics of Body Fat Mass Percentage Control Group

Group	Condition	N	Minimum	Maximum	mean	Std. Deviation
Control	Pre	11	13.73	24.32	16.30	2.99

	Post	11	13.73	24.57	16.74 2.93

Table 5. Body Fat Mass Percentage Control Group

Group	Condition	Mean + SD	Mean Difference	*p*
Percentage of body fat mass[b]	Pre Post	16.30 + 2.99 16.74+2.93	0.44	0.028*

Information: a: Paired T-Test; b: Wilcoxon test; *Significantly different at the significant level p<0.05

The body fat mass percentagein the control group pre and post no exercise has a p-value (0.028) <0.05 so there is a significant difference in the body fat mass percentagepre and post in the control group. Where the measurement results before (16.30 + 2.99) have a lower average body fat percentage than after (16.74 + 2.93) with a mean difference of 0.44. This shows an increase in the percentage of body fat in someone who does not do HIIT.

In this study, the difference in the body fat mass percentageafter exercise was compared with the control group. The difference in the percentage change in body fat mass pre and post exercise is done by analyzing the difference in the percentage of final body fat mass with the body fat mass percentageat the beginning of the study compared to the difference in changes in body fat mass in the control group.

Table 6. Test Results Differences in Changes in Body Fat Mass Percentage Compared to Control

Condition	*Mean + SD*	Mean Difference	*P*
Pre-Post Intervention group[a]	2.52+1.41	2.97	0.00*
Pre-post Control group	-0.45 + 0.51		

Notes: a Mann Whitney test *Significantly different at significant level p<0.05

This shows that the hypothesis of this study is correct, namely that there is a difference in changes in body fat percentage after doing exercise in the intervention group compared to the control group.

Discussion

In the anthropometric results, there was a significant difference in WHR pre and post intervention (having a p-value of 0.000 < 0.05) while in weight (p = 0.598) and BMI (p = 0.592) there was no significant decrease (has a p-value > 0, 05). This is in accordance with the research of Ouerghi et al. (2017) who concluded that the HIIT program significantly affects body composition by reducing fat mass and lipid profile. Short-term high-intensity exercise can induce modest body composition improvements in overweight and obese individuals without changes in weight (Wewege et al., 2017).

This is in line with other studies which show that HIIT maximizes fat burning even though it takes 15-30 minutes. The release of hormones such as epinephrine and norepinephrine, which increase with exercise, also increases fat burning. In particular, subcutaneous adipose tissue (belly fat) was significantly degraded. The reason for this is the very high number of adrenaline receptors in the abdominal fat tissue. Simultaneously, the production of hormones such as epinephrine, norepinephrine, and dopamine promotes muscle development while fat is constantly being broken down. Short-term and extreme stress on muscle fibers leads to increased muscle development. This can explain why short-term high-intensity exercise can induce improvements in body composition without being accompanied by changes in weight because a decrease in fat mass is followed by an increase in muscle mass (Shehata and Mahmoud, 2018).

The meta-analysis conducted by Turk et al. (2017) stated that a significant reduction in weight and BMI occurred in HIIT with 8 to 12 weeks of exercise, whereas in 3 weeks of exercise there was no significant weight loss. A systematic review and meta-analysis by Wewege et al. (2017) mention that exercise is consistently reported to be relatively ineffective for managing overweight or obesity when not combined with dietary interventions. Thus, further research is needed to assess the effect of weight loss on HIIT exercise using a longer timeframe or in combination with dietary interventions (Turk et al. 2017; Wewege et al., 2017)

In this research body fat mass percentage intervention group after exercise decreased significantly with p (0.000)< 0.05. This is in accordance with research by Ahmadizad et al., (2015) who show a significant decrease in body fat mass percentage intervention group after the intervention for 6 weeks. Through the intense interaction of stress phases and active recovery, the body is pushed to its maximum limits. In this case, the body requires oxygen above average and the metabolism is encouraged to continue to increase (Ahmadizad et al., 2015; Shehata and Mahmoud, 2018).

A study says that when it comes to fat loss, HIIT is an effective and efficient way to promote the post-workout burning effect. HIIT can promote long-lasting fat loss even after a workout. One study showed that HIIT training not only burned calories during the workout but also up to 48 hours later. The results of this study are also in accordance with the systematic review conducted by Maillard et al. (2017) which states that HIIT significantly reduces abdominal fat and visceral fat deposits(Maillard et al., 2017; Shehata and Mahmoud, 2018).

The body fat mass percentage in the control group pre and post-test had a p-value (0.028) < 0.05 so there was a significant difference in the body fat mass percentage pre and post in the control group. The measurement result pre (16.30 + 2.99) had a lower average body fat percentage than the post (16.74 + 2.93) with a mean difference of 0.44 %. This shows an increase in the percentage of body fat in someone who does not do HIIT Treadmill exercises.

The underlying cause of being overweight is a long-term energy imbalance between too many calories consumed and too few calories expended. A study

conducted by Gollubic*et al*(2015) concluded that there is a two-way reciprocal relationship between body fat mass and decreased physical activity and a sedentary lifestyle. Increased BMI and fat mass were positively correlated with the occurrence of a sedentary lifestyle and negatively correlated with moderate-vigorous physical activity and conversely, a sedentary lifestyle increased fat mass (Manore et al., 2015; Golubic et al., 2015).

The body fat mass percentagein the intervention and control groups after the HIIT Treadmill exercise with a change in inclination had a p-value (0.898) > 0.05 so there was no significant difference in the body fat mass percentagebetween the intervention and control groups after 4 weeks. This is caused by pAt the beginning of the study, the mean body fat mass percentagein the intervention group (19.16 + 4.7) was found to be slightly higher than the mean in the control group (16.30 + 2.99). After 4 weeks, the average body fat mass percentagewas almost the same, in the intervention group (16.64 + 4.80) compared to the control group (16.74 + 2.93). This causes the difference in the mean difference at the beginning of the study (2.86) is greater than the difference in the mean after 4 weeks (0.1).

In this study, the difference in the percentage change in body fat mass compared to the control group showed significant results with p (0.00) <0.05. In the intervention group, there was a decrease in the body fat mass percentage(average decrease of 2.52%), in contrast to the control group, where there was a significant increase in the body fat mass percentagein the control group at the end of the study compared to the beginning of the study (an increase of 0.5%).). High-intensity interval training was able to improve physical fitness and metabolism (fat oxidation, glycemic control, reduction of triglycerides, mitochondrial biogenesis, reduction of visceral and subcutaneous fat) and cardiorespiratory benefits such as reduced blood pressure, increased volume and maximal oxygen uptake VO, factors consistent with the results. achieved in this study (Gomes et al., 2021).

The recommendation from the American College of Sports Medicine is 150 minutes per hour per week, at moderate intensity, and 120 minutes per week at high intensity. High-intensity interval training is a more attractive proposition for practitioners because of the presence of intervals after high intensity. This makes training more enjoyable when compared to training at the same intensity continuously. One of the most important factors for reducing fat percentage is the basal metabolic rate, which is also an advantage of high-intensity interval training, which contributes to metabolic functions, including EPOC (excess post-exercise oxygen consumption), thus corroborating the results shown in this study. Mitochondria can generate energy in their matrix via the Krebs cycle, given that resting metabolic rates can remain elevated for up to 48 hours (Shehata and Mahmoud, 2018; Gomes et al., 2021).

This study shows that high-intensity interval training is an exercise method that is effective in reducing the percentage of body fat mass. This is in accordance with a systematic review by Gomes et al. (2021) who described the role of HIIT in reducing fat percentage through increased lipolysis, and energy consumption

Limitations

This study has several limitations, including did not use double blinds so that the trainer and the subject knew the intervention they received and bias could occur. the intervention group is known to the research subject so that it can affect the subject's motivation when doing the exercise program. Researchers find it difficult to monitor daily physical activity and diet which can affect research results.

Conclusion

HIIT treadmill with a change in inclination for 4 weeks is an effective exercise to reduce the body fat mass percentagein overweight men. Considering adverse events in HIIT, strict screening and adequate education before exercise and supervision during exercise are very necessary.

Funding

The authors are applying for a research grant *"Penelitian Terapan Unggulan Perguruan Tinggi (PTUPT)"* provided by Dr. Soetomo Hospital, Surabaya, Indonesia.

Conflict of Interest
The authors declared no conflict of interest.

Author Contribution
All authors equally contributed to preparing this article.

References

Ahmadizad, S., Avansar, A. S., Ebrahim, K., Avandi, M., & Ghasemikaram, M. (2015). The effects of short-term high-intensity interval training vs. moderate-intensity continuous training on plasma levels of nesfatin-1 and inflammatory markers. Hormone molecular biology and clinical investigation, 21(3), 165-173.

Buchan, D. S., Ollis, S., Thomas, N. E., & Baker, J. S. (2012). Physical activity behavior: an overview of current and emergent theoretical practices. Journal of obesity, 2012.

Consultation, W. E. (2004). Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet (London, England)*, *363*(9403), 157-163.

da Silva, D. E., Grande, A. J., Roever, L., Tse, G., Liu, T., Biondi-Zoccai, G., & de Farias, J. M. (2019). High-intensity interval training in patients with type 2 diabetes mellitus: a systematic review. Current Atherosclerosis Reports, 21(2), 1-10.

Ehlen, K. A., Reiser, R. F., & Browning, R. C. (2011). Energetics and biomechanics of inclined treadmill walking in obese adults. Med Sci Sports Exerc, 43(7), 1251-1259.

Golubic, R., Wijndaele, K., Sharp, S. J., Simmons, R. K., Griffin, S. J., Wareham, N. J., ... & Brage, S. (2015). Physical activity, sedentary time, and gain in overall and central body fat: 7-year follow-up of the ProActive trial cohort. International journal of obesity, 39(1), 142-148.

Gomes, A. P. F., de Sousa Fernandes, M. S., de Lima Silva, J. R., Rino, M. J. C., Santos, G. C. J., dos Prazeres, T. M. P., ... & da Silva, M. A. C. (2021). Effects of High-Intensity Interval Training on Body Composition: a Review. Health Science Journal, 15(9), 1-7.

Gueugnon, C., Mougin, F., Simon-Rigaud, M. L., Nègre, V., Touati, S., & Regnard, J. (2011). Intérêt d'un réentraînement à l'effort intermittent individualisé chez l'adolescent obèse. Science & sports, 26(4), 229-232.

Ito, S. (2019). High-intensity interval training for health benefits and care of cardiac diseases-the key to an efficient exercise protocol. World journal of cardiology, 11(7), 171.

Kriel, Y., Askew, C. D., & Solomon, C. (2018). The effect of running versus cycling high-intensity intermittent exercise on local tissue oxygenation and perceived enjoyment in 18–30-year-old sedentary men. PeerJ, 6, e5026.

Maillard, F., Pereira, B., & Boisseau, N. (2018). Effect of high-intensity interval training on total, abdominal and visceral fat mass: a meta-analysis. Sports Medicine, 48(2), 269-288.

Manore, M. M. (2015). Rethinking energy balance: Facts you need to know about weight loss and management. ACSM's Health & Fitness Journal, 19(5), 9-15.

Ouerghi, N., Fradj, M. K. B., Bezrati, I., Khammassi, M., Feki, M., Kaabachi, N., & Bouassida, A. (2017). Effects of high-intensity interval training on body composition, aerobic and anaerobic performance and plasma lipids in overweight/obese and normal-weight young men. Biology of Sport, 34(4), 385.

Shehata, A., & Mahmoud, I. (2018). Effect of high-intensity interval training (HIIT) on weight, body mass index, and body fat percentage for adults. Science, Movement, and Health, 18(2), 2018.

Speiser, P. W., Rudolf, M. C., Anhalt, H., Camacho-Hubner, C., Chiarelli, F., Eliakim, A., ... & Hochberg, Z. (2005). Childhood obesity. *The journal of clinical endocrinology & metabolism*, *90*(3), 1871-1887.

Türk, Y., Theel, W., Kasteleyn, M. J., Franssen, F. M. E., Hiemstra, P. S., Rudolphus, A., ... & Braunstahl, G. J. (2017). High intensity training in obesity: a Meta-analysis. Obesity science & practice, 3(3), 258-271.

Wewege, M., Van Den Berg, R., Ward, R. E., & Keech, A. (2017). The effects of high-intensity interval training vs. moderate-intensity continuous training on body composition in overweight and obese adults: a systematic review and meta-analysis. Obesity Reviews, 18(6), 635-646.

World Health Organization. (2000). The Asia-Pacific perspective: redefining obesity and its treatment.