Central European Journal of Sport Sciences and Medicine | Vol. 35, No. 3/2021: 49–56
ISSN (print): 2300-9705 | ISSN (online): 2353-2807 | DOI: 10.18276/cej.2021.3-05

EFFECT OF MODIFIED HIGH INTENSITY INTERVAL TRAINING ON FAT LOSS

Dobson Dominic[A, B, C, D]

Department of Sports Medicine & Sports Science, Saveetha Institute of Medical And Technical Sciences, Thandalam, Chennai, India
ORCID: 0000-0002-0924-6184

Sai Kishore[A, B, C, D]

Department of Sports Medicine & Sports Science, Saveetha Institute of Medical And Technical Sciences, Thandalam, Chennai, India
ORCID: 0000-0002-7656-6380 | e-mail: sai.theking@yahoo.co.in

[A] Study Design; [B] Data Collection; [C] Statistical Analysis; [D] Manuscript Preparation

Abstract Exercise has multiple health benefits and is a critical component in managing overweight and obesity. High Intensity Interval Training (HIIT) involves brief high-intensity anaerobic exercise followed by rest or very low intensity exercise. 24 men and women (age 18–60 years) volunteered to participate in a 6 weeks of modified HIIT exercises program where whole body functional training exercises was provided. Their body weight, body mass index, waist to hip ratio and skin fold fat were measured at the beginning and at the end of the 6 weeks duration . Statistical significance was found between the variables at $p < 0.05$. The results showed that a Modified HIIT exercise Program based on Body weight training results in considerable decrease in level of sub-cutaneous adiposity up to 77.8%. Obesity and overweight have become complex pandemic disorders where in physical inactivity and lack of time to exercise plays a major role leading to various complications. Reduction in adiposity through structured exercises protocols will improve body composition and Cardio-metabolic health . Novel interventions such as modified HIIT serve as the perfect pathway to address the time factor and enhancement of physical activity as well.

Key words Modified HIIT, Functional Training, Obesity, Fat Loss

Background and aims

In a clinical context, the term ‘overweight’ usually connotes adiposity, an excess of body fat (Billewicz, Kelsey, Thomson, 1962). WHO defines obesity as abnormal or extensive fat accumulation that negatively affects health (Stenholm, Harris, Rantanen, Visser, Kritchevsky, Ferrucci, 2008). Obesity is a complex chronic disorder that results from the interaction of genotypic and environmental factors and involves multifaceted interactions among numerous potential determinants such as humoral, neural, metabolic, psychological etc. (Poirier, Despres, 2001).

The incidence of obesity and its related diseases has dramatically increased worldwide in the last few decades, mainly as a result of a physically inactive lifestyle and exercise. Currently, along with behavioral and nutritional counseling, involvement in regular physical activity serves as the first line of defense in preventing obesity (Zhang, Tong, Qiu, Wang, Nice, He, 2015). There is robust evidence that long term exercise at moderate intensity could improve body composition, cardiovascular fitness and other health-related parameters including insulin sensitivity and lipid profile in healthy and obese people (Donnelly et al., 2009); (McInnis, Franklin, Rippe, 2003). Despite the well-established benefits of routine physical activity for improving such cardio-metabolic health, it remains difficult for health care professionals to get individuals to adhere to current physical activity guidelines of at least 30 min per day of moderate intensity exercise 5 days per week or vigorous exercise for 20 min per day 3 days a week (Trost, Owen, Bauman, Sallis, Brown, 2002). Therefore, given that 'lack of time' is the most commonly cited barrier to exercise adherence, more recent studies have focused on identifying a more time-efficient mode of exercise training (Fisher, Brown, Brown, Alcorn, Noles, Winwood, Resuehr, George, Jeansonne, Allison, 2015). A high-volume, moderate-intensity continuous training (MICT) protocol has been shown to be a powerful strategy for inducing loss of abdominal fat, including visceral fat (Irwin et al., 2003; Ross, Dagnon Jones, Smith, Paddags, Hudson, Jenssen 2000).

However, in recent years, a growing body of literature has shown that high-intensity interval training (HIIT) could induce similar favorable metabolic adaptations associated with MICT (Nybo et al., 2010). HIIT involves brief high-intensity anaerobic exercise followed by brief but slightly longer bouts of very low intensity exercise (Trapp, Chisholm, Freund, Boutcher, 2008) or separated by a short rest interval (Gibala, McGee., 2008). Such high intensity training provides fitness and health improvements in less time per week than the recommended exercises guidelines (Heinrich, Patel, O'Neil, Heinrich, 2014). HIIT exercises significantly reduce subcutaneous fat, total body mass while improving VO2 max and insulin sensitivity (Shiraev, Barclay, 2012). This apart, many studies have examined the effects of HIIT in fat loss and health of special population such as overweight adolescents, older adults, diabetic individuals, paraplegics, intermittent claudication, chronic obstructive pulmonary disease and cardiac rehabilitation patients (Boutcher, 2011). Though authors have reported fat loss due to HIIT exercises, yet, such reports do not isolate the amount of adiposity lost due to these exercises. Moreover, the efficacy of such exercises responsible for loss in adiposity is a point to ponder.

Currently, the world is experiencing an extraordinary, life altering challenge with COVID-19 (Hall, Laddu, Phillips, Lavie, Arena, 2020), where self-isolation and quarantine requirements are leading to decreased physical activity. Sustained physical inactivity and sedentary behaviour can be deleterious; for example, a 2 weeks reduction in daily steps from 10,000 to 1,500 steps leads to impaired insulin sensitivity, lipid metabolism, increased visceral fat and decreased fat free mass and cardiovascular fitness in healthy individuals (Pinto, Dunstan Owen, Bonfa, Gualano, 2020). Interestingly a bout of moderate intensity exercises does not counteract the detrimental effects of even 4 days of physical inactivity, suggesting that individuals can become 'resistant' to well-known exercise induced metabolic adaptations (Akins, Crawford, Burton, Wolfe, Vardarli, Coyle, 2019).

Considering all these factors, we aimed to induce a home based exercise program where a modified HIIT exercise involving whole body functional training was prescribed.

Material and methods

A total of 12 men and 12 women participated in this study. Participants (n = 24) were recruited from Saveetha Medical College & Hospital, SIMATS and surrounding community to participate in our exercise program. General screening guidelines were used. A detailed medical diagnosis was performed. Parameters such as history of symptoms, recent illness, familial history of disease and illness, orthopaedic problems, lifestyle habits, exercise history, work history and usage of medications and drug allergies were assessed for each of the participants. The study was ethically cleared by the institutional ethical committee of SIMATS, Chennai.

People who were overweight and obese were considered for the study. Unhealthy people with co-morbids(such as musculo-skeletal injuries, cardiac patients, etc.) and unwilling participants were excluded from our study. All participants participated voluntarily and adequate knowledge regarding the study setting was explained to them. Information about the level of physical activity and health condition was obtained using a Physical Activity Readiness questionnaire (PAR-Q). Participants were stratified on a median age of 18 to 60 years and a BMI of ≥26. They were prescribed HIIT exercise for four days per week until six weeks. The participants (both females and males) characteristics included age (M = 37.63 ±12.79 years), height (M = 163.42 ±10.04) weight (M = 80.58 ±12.90 kg), Body Mass Index (30.30 ±2.62 kg/m^2), waist to hip ratio (M = 1 ±0.10) and sum of skin folds fat (M = 160.08 ±24.65). Overall subject characteristics of pre-test and post-test values on individual variables of the participants (both men and women) had significant changes as seen on Tables 2 and 3 respectively.

Skin folds were measured using a Harpenden skin fold caliper and a seven-site ISAK method (biceps, triceps, subscapular, abdomen, supra iliac, mid-thigh and calf) was used to calculate the sum of skin fold fat value. All the population were considered as overweight/ obese according to the BMI and skin fold measurements.

The exercises consisted of floor based high intensity functional exercises followed by a short period of complete rest. Each participant underwent a series of exercises protocol as follows:

1. Warm up = 5 minutes.
2. Modified HIIT exercises = 15 minutes.
3. Stretching and cool down = 5 minutes.

The modified HIIT exercises were designed as whole body functional workouts. After completing the warm up session, the participants would perform a series of whole body modified HIIT exercises comprising of jumping jacks, squats, pushups, crunches, triceps dips, plank, same spot high knee running, lunges, side plank, v-sit hold, mountain climber and burpees. These are short, rapid series of exercises using one’s own body weight. The participants performed these exercises for a time period of 30 seconds followed by 15 seconds of rest interval throughout the exercise regimen time of 15 minutes, for 4 days per week for 6 weeks. As the week progressed the participants were encouraged to repeat this exercise cycle as many as possible within the maximum stipulated time of 15 minutes.

A rating of perceived exertion was measured using the modified Borg scale, so as to ensure that the participants were within the exercise tolerance limits, as devised by the scale. The participants were given the right to stop the exercise session if they felt the intensity was reaching beyond their limit.

As this was an exercise intervention based study, participants were counselled to take a nutrient rich food intake not giving particular emphasis to their daily caloric intake, nor calculating macro/micro nutrient levels. However, participants were strictly advised to avoid junk food and processed food.

Data Analysis

At the end of six weeks, all participants were measured with a post data comprising of weight, BMI, WHR and skin fold fat levels. Data was analyzed using SPSS statistical software. Paired t-test was performed to identify the intergroup comparison. The significance level was considered at $\alpha = 0.05$.

Results

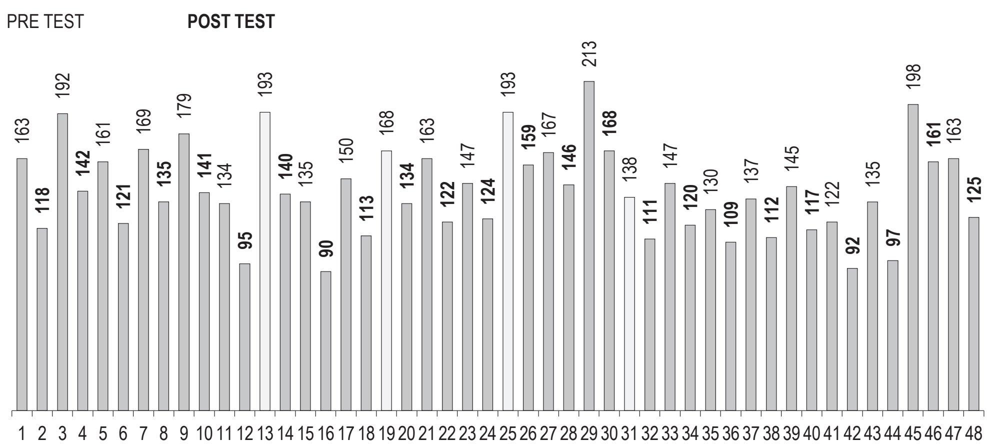
The aim of this study was to implement a home based effective weight loss program through whole body functional exercises. As can be seen in Table 1, the variables such as body weight, waist-hip ratio (WHR), body mass index (BMI) and sum of skin folds were analysed for an inter group comparison. Statistical significance was found between the variables of BMI, WHR, body weight and sum of skin fold values.

Table 1. Subject's anthropometric variables (mean ± standard deviation) before and after exercise intervention

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		mean	std. deviation	std. error mean	95% confidence interval of the difference				
					lower	upper			
Pair 2	Weight_1–Weight_2	3.83333	1.00722	0.20560	3.40802	4.25865	18.645	23	0.000
Pair 3	WHR_1–WHR_2	0.02958	0.02836	0.00579	0.01761	0.04156	5.111	23	0.000
Pair 4	BMI_1–BMI_2	1.72292	1.30812	0.26702	1.17055	2.27529	6.452	23	0.000
Pair 5	Sum_SF_1–Sum_SF_2	35.41667	8.84119	1.80470	31.68336	39.14997	19.625	23	0.000

* $p = \leq 0.05$ significance of pre-test vs post-test.
For age and height, t-test cannot be computed because the standard error of the difference is 0.

The results showed that after exercise interventions there is considerable decrease in the level of adiposity and body weight as well. Moreover, we noticed that there was 77.8% decrease (Figure 1) in the subcutaneous skin fold fat levels after the completion of 6 weeks of exercise regimen.



The total participants are n = 24; combined data of pretest data and post test for sum of skin fold equals to n = 48.

Figure 1. Shows the decrease in the sum of skin fold fat after the exercise regimen in all the participants

Discussion

The results of the current study showed that six week modified high intensity interval training led to a significant decrease in the body's adiposity. There was a considerable reduction in the BMI, WHR and the sum of skin folds post the six weeks of our exercise protocol. The direct effect of exercise on level of adiposity is unknown still. Yet, studies have made successful attempts in identifying the amount of fat lost due to exercise. Boudou et al. (2003) and Mourier et al. (1997), showed 18% reduction of subcutaneous fat. Similarly, Trapp et al. (2008), found 10% decrease and Tremblay et al. (1994), found 15% decrease in adiposity. Our study showed 77.8% decrease in subcutaneous fat levels. However our result was interpreted using the sum of skin folds rather than using any kind of radiological imaging source as supported by some of these authors.

Majority of our research goal was focused on estimating the amount of fat lost due to HIIT exercises than identifying the right pattern of exercise. Many authors have devised exercise strategies based on aerobic and anaerobic exercises (Tjønna et al., 2008; Park et al., 2003; Johnson, Sachinwalla, Walton, Smith, Armstrong, Thompson, George, 2009). Some authors used different exercises forms to combat obesity (Strasser, Schobersberger, 2011; Schoenfeld, 2011). We narrowed our approach towards HIIT exercises that covered whole body rather than isolated set of muscular exercises. This apart, several studies have proved the advantages of HIIT exercise (Zhang et al., 2015; Heinrich et al., 2014; Kordi, Choopani, Hemmatinafar, Choopani, 2013), of which, short term HIIT exercises have found to produce better results in fat reduction than any other form of exercise (Lanzi et al., 2015; Panissa, Alves, Salermo, Franchini, Takito, 2016). Such short term exercise of high intensity pattern, if delivered accurately, has shown better results in losing adiposity.

All the HIIT exercises mentioned in our study are compound multi-dimensional workouts. They provide collective benefit to the participant rather than focusing on individualizing the muscle/body part worked. There are no consensus literature available as to what constitutes a true HIIT protocol (Hood, Little, Tarnopolsky, Myslik, Gibala, 2011). Thus, we designed a modified HIIT protocol which would be realistic for our participants to complete, and also is evidence based (Chandler, Stringer, 2020) .

Adiposity is a complex multifactorial mechanism involving genetic, metabolic, physiological, psycho-social and environmental cross links. The adipose tissue, though considered a 'toxic tissue' is found fundamental to the primary life-history functions of the human body (Wells, 2012). Hence, identifying the accurate ways to enhance such functions is essential. Though HIIT exercises provided ways to reduce excess adiposity, the efficacy of such exercises are still a point to ponder. One way to identify such efficacy was by estimating the aerobic capacity through Vo2 max, which in turn might be a costly factor. There is sufficient evidence to prove the effectiveness of HIIT on aerobic and cardiovascular factors (Garcia-Hermoso, Cerrillo-Urbina, Herrera-Valenzuela, Cristi-Montero, Saavedra, Martinez-Vizcaino, 2016). We however aimed at estimating the adiposity alone, cost effectively, rather than measuring aerobic or cardio vascular factors that require usage of various technology and gadgets. Hence, the anthropometric indices such as BMI, skin fold fat and WHR served as a better feedback in estimating the acute responses to HIIT exercises. We found considerable difference in the BMI and WHR post our exercises regimen.

Decrease in body composition can be considered as a key factor in delivering HIIT programs. Though there is sufficient evidence on reduction of body composition in young and adolescent participants (Costigan, Eather, Plotnikoff, Taaffe, Lubans, 2015), this study presents a diversified age group (Table 2 and Table 3) showing variance in body composition measures post the exercise period.

Table 2. Men Group Comparison – Pre and Post Test

	AGE	HEIGHT	WEIGHT	BMI	WAIST	HIP	WHR	BICEPS	TRICEPS	SUBSCAPULAR	ADBOMEN	SUPRA ILIAC	THIGH	CALF	SUM OF SKF
MEN – PRE TEST VALUE															
MEAN	36.90	171.70	89.80	30.50	41.08	40.50	1.01	13.30	20.80	24.66	37.75	29.33	24.00	18.50	168.41
SD	12.85	5.97	7.34	2.36	4.14	3.26	0.05	2.70	4.06	4.18	8.83	5.61	3.41	3.26	25.38
MEN – POST TEST VALUE															
MEAN	36.90	171.70	85.60	29.10	37.33	37.70	0.98	9.00	15.08	19.08	30.16	23.90	18.33	15.08	130.66
SD	12.85	5.97	6.86	2.48	3.51	3.28	0.04	2.20	3.14	3.15	6.68	4.77	3.66	3.20	20.07

Table 3. Women Group Comparison – Pre and Post Test

	AGE	HEIGHT	WEIGHT	BMI	WAIST	HIP	WHR	BICEPS	TRICEPS	SUBSCAPULAR	ADBOMEN	SUPRA ILIAC	THIGH	CALF	SUM OF SKF
WOMEN – PRE TEST VALUE															
MEAN	38.33	155.04	71.33	30.10	38.16	39.50	0.97	13.00	18.08	22.75	27.08	27.91	23.00	19.90	151.75
SD	12.71	4.52	9.91	2.83	2.63	4.51	0.13	3.46	3.45	3.24	3.61	5.49	2.97	4.73	20.87
WOMEN - POST TEST VALUE															
MEAN	38.33	155.04	67.83	28.10	34.41	36.60	0.94	9.66	13.16	17.41	21.25	22.91	18.41	15.80	118.66
SD	12.71	4.52	9.57	3.11	2.88	3.83	0.11	3.22	3.46	3.77	3.29	5.54	2.95	3.50	21.05

Various studies have utilized the option of diet interventions in their program (Clark, 2015; Arad, DiMenna, Thomas, Tamis-Holland, Weil, Geliebter, Albu, 2015). We did not recommend any nutritional or dietary recommendations to our participants. All our participants were advised to follow their regular dietary pattern without any specific caloric intake recommendations/restrictions. This served as a highlight to determine the effectiveness of our program specifications which was devoid of any diet prescription. Our present study may be used as a preliminary research in estimating the level of adiposity loss using modified HIIT exercises.

Limitations

The key limitation of our study is the mode of measuring the level of adiposity. Though it is a proven fact that radiological imaging provides congruent evidence in estimation of body fat, we chose a cost effective way through measuring the skin fold fat levels. It did precisely provide body's adiposity levels, yet, specific adaptations to the exercise demands are unknown. Another limitation is the estimation of the effectiveness of the modified HIIT exercises offered to the participants. The exercises mentioned were scientifically proven/accepted list of exercises used by various researchers. However, individual efficacy of these exercises looks immeasurable. This is mainly due to the multi-dimensional benefit of each exercise. For example, doing a plank not only improves the core muscle strength, also, it provides equal support to the arms, elbows, back and toes. Hence, analyzing the micro effect of such multi-dimensional exercise is impractical. The diversified age group did show significant decrease in adiposity levels. Yet, age wise classification was harder to achieve without radiological investigations. Considering the technological advancement in today's world, we believe that these sustained adaptations such as fat loss due to modified HIIT exercises would become a handy tool in the days to come.

Conclusion

This preliminary study suggests that supervised six weeks of high intensity interval training connotes in achieving loss of adiposity among a diversified age group. The subcutaneous fat lost due to modifications in musculoskeletal parameters through six weeks of exercise training was firmly supported by significant decrease in anthropometric parameters as well. A multi-dimensional exercise regimen such as this could pave way for more time saving yet result oriented protocols in controlling obesity in the near future.

References

Akins, J.D., Crawford, C.K., Burton, H.M., Wolfe, A.S., Vardarli, E., Coyle, E.F. (2019). Inactivity induces resistance to the metabolic benefits following acute exercise. *Journal of Applied Physiology, 126* (4),1088–1094.

Arad, A.D., DiMenna, F.J., Thomas, N., Tamis-Holland, J., Weil, R., Geliebter, A., Albu, J.B. (2015). High-intensity interval training without weight loss improves exercise but not basal or insulin-induced metabolism in overweight/obese African American women. J*ournal of Applied Physiology*, *119* (4), 352–362.

Billewicz, W.Z. Kelsey, W.F.F., Thomson, A.M. (1962). Indices of adiposity. British journal of preventive & social medicine, *16* (4), 183.

Boudou, P., Sobngwi, E., Mauvais-Jarvis, F., Vexiau, P., Gautier, J.F. (2003). Absence of exercise-induced variations in adiponectin levels despite decreased abdominal adiposity and improved insulin sensitivity in type 2 diabetic men. *European Journal of Endocrinology*, *149* (5), 421–424.

Boutcher, S.H. (2011). High-intensity intermittent exercise and fat loss. *Journal of Obesity*.

Chandler, R.M., Stringer, A.J. (2020). A Comprehensive Exploration into Utilizing High-Intensity Interval Training (HIIT) in Physical Education Classes. *Journal of Physical Education, Recreation & Dance*, *91* (1), 14–23.

Clark, J.E. (2015). Diet, exercise or diet with exercise: comparing the effectiveness of treatment options for weight-loss and changes in fitness for adults (18–65 years old) who are overfat, or obese; systematic review and meta-analysis. *Journal of Diabetes & Metabolic Disorders*, *14* (1), 31.

Costigan, S.A., Eather, N., Plotnikoff, R.C., Taaffe, D.R., Lubans, D.R. (2015). High-intensity interval training for improving health-related fitness in adolescents: a systematic review and meta-analysis. *British Journal of Sports Medicine*, *49* (19), 1253–1261.

Donnelly, J.E., Blair, S.N., Jakicic, J.M., Manore, M.M., Rankin, J.W., Smith, B.K.(2009). Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults. *Medicine & Science in Sports & Exercise*, *41* (2), 459–471.

Fisher, G., Brown, A.W., Brown, M.M.B., Alcorn, A., Noles, C., Winwood, L., Resuehr, H., George, B., Jeansonne, M.M., Allison, D.B. (2015). High intensity interval-vs moderate intensity-training for improving cardiometabolic health in overweight or obese males: a randomized controlled trial. *PloS One*, *10* (10), 0138853.

García-Hermoso, A., Cerrillo-Urbina, A.J., Herrera-Valenzuela, T., Cristi-Montero, C., Saavedra, J.M., Martínez-Vizcaíno, V. (2016). Is high-intensity interval training more effective on improving cardiometabolic risk and aerobic capacity than other forms of exercise in overweight and obese youth? A meta-analysis. *Obesity Reviews*, *17* (6), 531–540.

Gibala, M.J., McGee, S.L. (2008). Metabolic adaptations to short-term high-intensity interval training: a little pain for a lot of gain? *Exercise and Sport Sciences Reviews*, *36* (2), 58–63.

Hall, G., Laddu, D.R., Phillips, S.A., Lavie, C.J., Arena, R. (2020). A tale of two pandemics: How will COVID-19 and global trends in physical inactivity and sedentary behavior affect one another? *Progress in Cardiovascular Diseases*.

Heinrich, K.M., Patel, P.M., O'Neal, J.L., Heinrich, B.S. (2014). High-intensity compared to moderate-intensity training for exercise initiation, enjoyment, adherence, and intentions: an intervention study. *BMC Public Health*, *14* (1), 789.

Hood, M.S., Little, J.P., Tarnopolsky, M.A., Myslik, F., Gibala, M.J. (2011). Low-volume interval training improves muscle oxidative capacity in sedentary adults. *Medicine and Science In Sports and Exercise, 43* (10),1849–1856.

Irwin, M.L., Yasui, Y., Ulrich, C.M., Bowen, D., Rudolph, R.E., Schwartz, R.S., Yukawa, M., Aiello, E., Potter, J.D., McTiernan, A. (2003). Effect of exercise on total and intra-abdominal body fat in postmenopausal women: a randomized controlled trial. *Jama*, *289* (3), 323–330.

Johnson, N.A., Sachinwalla, T., Walton, D.W., Smith, K., Armstrong, A., Thompson, M.W., George, J. (2009). Aerobic exercise training reduces hepatic and visceral lipids in obese individuals without weight loss. *Hepatology*, *50* (4), 1105–1112.

Kordi, M., Choopani, S., Hemmatinafar, M., Choopani, Z. (2013). The effects of the six week high intensity interval training (HIIT) on resting plasma levels of adiponectin and fat loss in sedentary young women. *J Jahrom University of Medical Sciences*, *11* (1), 20–27.

Lanzi, S., Codecasa, F., Cornacchia, M., Maestrini, S., Capodaglio, P., Brunani, A., Fanari, P., Salvadori, A., Malatesta, D. (2015). Short-term HIIT and Fatmax training increase aerobic and metabolic fitness in men with class II and III obesity. *Obesity*, *23* (10), 1987–1994.

Lee, S.J., Tjønna, A.E., Rognmo, Ø., Stølen, T.O., Bye, A., Haram, P.M. (2008). Aerobic interval training versus continuous moderate exercise as a treatment for the metabolic syndrome. *Circulation*, *118* (4), 346–54.

McInnis, K.J., Franklin, B.A., Rippe, J.M. (2003). Counseling for physical activity in overweight and obese patients. *American Family Physician*, *67* (6), 1249–1256.

Mourier, A., Gautier, J.F., De Kerviler, E., Bigard, A.X., Villette, J.M., Garnier, J.P., Duvallet, A., Guezennec, C.Y., Cathelineau, G. (1997). Mobilization of visceral adipose tissue related to the improvement in insulin sensitivity in response to physical training in NIDDM: effects of branched-chain amino acid supplements. *Diabetes Care*, *20* (3), 385–391.

Nybo, L., Sundstrup, E., Jakobsen, M.D., Mohr, M., Hornstrup, T., Simonsen, L., Bülow, J., Randers, M.B., Nielsen, J.J., Aagaard, P., Krustrup, P., (2010). High-intensity training versus traditional exercise interventions for promoting health. *Medicine & Science in Sports & Exercise*, *42* (10), 1951–1958.

Panissa, V.L.G., Alves, E.D., Salermo, G.P., Franchini, E., Takito, M.Y. (2016). Can short-term high-intensity intermittent training reduce adiposity? *Sport Sciences for Health*, *12* (1),.99–104.

Park, S.K., Park, J.H., Kwon, Y.C., Kim, H.S., Yoon, M.S., Park, H.T. (2003). The effect of combined aerobic and resistance exercise training on abdominal fat in obese middle-aged women. *Journal of Physiological Anthropology and Applied Human Science*, *22* (3), 129–135.

Pinto, A.J., Dunstan, D.W., Owen, N., Bonfá, E., Gualano, B., 2020. Combating physical inactivity during the COVID-19 pandemic. *Nature Reviews Rheumatology*, 1–2.

Poirier, P., Després, J.P. (2001). Exercise in weight management of obesity. *Cardiology Clinics*, *19* (3), 459–470.

Ross, R., Dagnone, D., Jones, P.J., Smith, H., Paddags, A., Hudson, R., Janssen, I. (2000). Reduction in obesity and related comorbid conditions after diet-induced weight loss or exercise-induced weight loss in men: a randomized, controlled trial. *Annals of Internal Medicine*, *133* (2), 92–103.

Schoenfeld, B, (2011). Does cardio after an overnight fast maximize fat loss? *Strength & Conditioning Journal*, *33* (1), 23–25.

Shiraev, T., Barclay, G., 2012. Evidence based exercise: Clinical benefits of high intensity interval training. *Australian Family Physician*, *41* (12), 960.

Stenholm, S., Harris, T.B., Rantanen, T., Visser, M., Kritchevsky, S.B., Ferrucci, L. (2008). Sarcopenic obesity-definition, etiology and consequences. *Current Opinion in Clinical Nutrition and Metabolic Care*, *11* (6), 693.

Strasser, B., Schobersberger, W. (2011). Evidence for resistance training as a treatment therapy in obesity. *Journal of Obesity*, 2011.

Tjønna, A.E., Lee, S.J., Rognmo, Ø., Stølen, T.O., Bye, A., Haram, P.M., Loennechen, J.P., Al-Share, Q.Y., Skogvoll, E., Slørdahl, S.A., Kemi, O.J. (2008). Aerobic interval training versus continuous moderate exercise as a treatment for the metabolic syndrome: a pilot study. *Circulation*. *118* (4). 346–354.

Trapp, E.G., Chisholm, D.J., Freund, J., Boutcher, S.H. (2008). The effects of high-intensity intermittent exercise training on fat loss and fasting insulin levels of young women. *International Journal of Obesity*, *32* (4), 684–691.

Tremblay, A., Simoneau, J.A., Bouchard, C. (1994). Impact of exercise intensity on body fatness and skeletal muscle metabolism. *Metabolism*, *43* (7), 814–818.

Trost, S.G., Owen, N., Bauman, A.E., Sallis, J.F., Brown, W. (2002). Correlates of adults' participation in physical activity: review and update. *Medicine & Science in Sports & Exercise*, *34* (12), 1996–2001.

Wells, J.C. (2012). The evolution of human adiposity and obesity: where did it all go wrong? *Disease Models & Mechanisms*, *5* (5), 595–607.

WZ, B., WF, K., AM, T. (1962). Indices of adiposity. *British Journal of Preventive & Social Medicine*, *16*, 183–188.

Zhang, H., K Tong, T., Qiu, W., Wang, J., Nie, J., He, Y. (2015). Effect of high-intensity interval training protocol on abdominal fat reduction in overweight Chinese women: a randomized controlled trial. Kinesiology: *International Journal of Fundamental and Applied Kinesiology*, *47* (1), 57–66.

Cite this article as: Dominic, D., Kishore, S. (2021). Effect of Modified High Intensity Interval Training on Fat Loss. *Central European Journal of Sport Sciences and Medicine*, *3* (35), 49–56. DOI: 10.18276/cej.2021.3-05.