

Comparison of Short-Term Effects of High-Intensity Interval Training vs Moderate Intensity Continuous Training on Anthropometric Characteristics of Overweight Young Women

MUHAMMAD SARFRAZ¹, AZADEH SHADMEHR², ERUM NAZ³, MAZHAR ALI⁴, ANILA RAHIM⁵

¹Physical Therapy Department, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran

²Assistant Professor, DIPMR, Dow University of Health Sciences Karachi, Pakistan

³Senior Lecturer, DIPMR, Dow University of Health Sciences Karachi, Pakistan

⁴Associate Professor, Nazeer Hussain University Karachi, Pakistan

⁵Assistant Professor, DIR, Dow University of Health Sciences Karachi, Pakistan

Corresponding author: Azadeh Shadmehr, Email: shadmehr@tums.ac.ir, Cell: +982177528468

ABSTRACT

Objectives: To conduct a comprehensive research work in order to find out the (time bound) efficient way to bring about changes in anthropometric measures with weight/fat reduction.

Methods: In this study the effects of high intensity interval training (HIIT) and moderate intensity continuous training (MICT) were compared to see the reduction in body fat percentage in young university girls age between 20 to 25 years.

Thirty subjects were recruited in HIIT (n=15) and MICT group (n=15) for 8 weeks. Pre and post fat percentage was assessed to see the changes before and after work out of two different exercise regimens.

Results: Statistically significant improvement was found in both groups for weight (Mean difference = 3.04, P value = 0.00), However in the same manner other factors also showed significant improvement, BMI (Mean difference = 1.20, P value = 0.00), Waist circumference (Mean difference = 1.67, P value = 0.001), Hip circumference (Mean difference = 1.73, P value = 0.00) and body fat (Mean difference = 2.92, P value = 0.00). Therefore, all anthropometric measures showed differences but HIIT group showed maximum reduction in weight after regime (P value < 0.00)

Conclusion: Eight weeks of HIIT and MICT resulted in improvements in anthropometric measures along with changes in dietary habit intake. HIIT appears to be the predominant strategy for controlling weight because of its adherence and time efficiency.

Keywords: Overweight Young women, Moderate intensity continuous training, Weight reduction,

Abbreviations: High intensity interval training (HIIT), Moderate intensity continuous training (MICT), Maximum Heart Rate (MHR), Body Mass index (BMI), Body Fat (BF)

INTRODUCTION

The frequency/ incidence of obesity and the diseases associated with obesity have been spiked shockingly throughout the world in recent decades and in general Pakistani population prevalence of overweight and obesity, weighted 25% and highest, 42.8%, among women aged 35–54 years but was also high among those aged 15–24 years, at 12.4% for men and 13.8% for women weighted prevalence of overweight and obesity according to various BMI cut off values [1]. According to WHO define criteria for Asian population [2]. As it is known that obesity is clearly related with higher percentage of fat in the body which in turn is related to many complications and diseases like type 2 diabetes, cancers and cardiovascular diseases [3]. This adiposity is responsible for the health issues and more appropriately the crisis because of the fat deposition in different anatomical locations (in male's abdominal area, in females hips and thighs) which can be named as metabolic obesity leading to metabolic syndrome too [4]. There have been many practices throughout the world in the attempt to reduce obesity including high intensity interval training (HIIT), moderate intensity continuous training (MICT), pyramid training, low intensity prolonged training, etc. But, a very strong data is evident that high-volume, MICT exercises [5] as well as HIIT [6] with MICT utilizing more duration (less than 45 min) is very effective in decreasing body fat percentage and fat mass [7–9] with marked improvement in the body composition and cardiovascular fitness [10,11]. It is interesting to see that, high-intensity interval training (HIIT), is different from MICT in its execution as it utilizes anaerobic system and aerobic system simultaneously working with bouts of high intensity workout followed by a recovery period of some time to induce metabolic adaptations in both healthy [10] and diseased population [13–14]. Many authors assume interval training method to be a superior way for weight reduction in comparison to continuous endurance training as HIIT is way more time efficient training and a better strategy when it comes to deal with obesity [15]. However, the comparison for more efficient way either HIIT or MICT in decreasing body fat percentage in this part of the world and population is not cleared and that's the reason to conduct this research in Karachi, Pakistan. There has been difference

regarding percentage of fat reduction in previous studies on the basis of training composition, frequency, intensity and duration along with BMI difference and gender [16–21]. In 2015, a study showed the superiority of HIIT in terms of time (less time high efficiency) in lowering down the body fat percentage of overweight young women. The main comparison in this was between continuous training regimen (comprising of 33 minute exercise sessions) with HIIT [21]. This work concluded the effects of 12 weeks HIIT versus MICT training for over all body, abdominal and abdominal subcutaneous fat, assessed through DEXA and CT in obese Chinese women. An RCT was performed for the comparison of specific HIIT adaptations with those resulting from a traditional MICT program with exercise sessions greater or equal than 45 min and with those of non-exercising opponents. Subjects in both the groups were asked to consume 300 kJ per exercise session. Our study addresses a gap between high volume and high intensity, time efficient fat reduction in order to establish more efficient way of fat reduction with busy schedule of modern world.

MATERIALS AND METHODS

This study is an experimental study. The rationale of the study is to conduct a comprehensive research work in order to find out the (time bound) efficient way to bring about changes in anthropometric measures with weight/fat reduction. A sample size of 30 overweight young female students from a university of Karachi, Pakistan, was taken by simple random sampling and was randomly allocated to HIIT and MICT training groups with 15 subjects in each group. Confidence interval was set at 95%. Informed consent was obtained prior to data collection, with participants been informed of the purpose of the study. Duration of the study was two months.

Inclusion Criteria for study was Female students with age between 20-25 years (sedentary lifestyle) and BMI between 25 to 29.9 kg/m² (overweight), where subjects with any known cardiovascular, respiratory, orthopedic or metabolic disorders were excluded from the study.

Training Protocol: Physical Activity readiness questionnaire was filled by every participant at the start of study. The clients were

assessed for their fat percentage through bioelectric impedance analyzer and were assigned to either HIIT or MICT groups randomly with following exercise regimen:

The HIIT group was trained for 5 days a week with the intensity between 85-90% of maximum heart rate. This group was supervised for 25 minutes high intensity interval training comprising of 3 min of warm up followed by 6 bouts (or 18 min) of 1 min HIIT and 2 min recovery period comprising of comparatively moderate intensity paced exercise of 75-80% Maximum Heart Rate (MHR) and ultimately 4 minutes cool down.

The MICT group was also trained for 5 days a week but with comparatively less intensity that is 60-70% which was constant unlike the HIIT group. The participants were supervised for 3 min warm up followed by 40 min walk with 60-70% MHR with final step of cool down for 2-3 min.

Diet: All the participants were assessed for their diets and their daily caloric requirement was calculated. Afterwards all were given 500 kcal deficit diet plans according to their daily caloric requirements.

Fat analysis: fat analysis was conducted using Bioelectric impedance analyzer (BIA), Omron 508, with the following pre requisites

- o Avoid eating or drinking within 4 hours of the test
- o Try to relax completely before the assessment
- o Avoid alcohol for 48 hours before the test
- o Avoid diuretic agents (caffeine) before the test
- o Repeat the test at the same time of the day and the same circumstances to improve accuracy
- o Avoid the test during menstruation.

Statistical analysis: Since we had a small sample size, determining the distribution of variables of HIIT and MICT was important for choosing an appropriate statistical method. So a Sapiro-Wilk test was performed and showed that distribution was

significantly normal for all the variables of both groups. A paired t-test was run on a sample of 30 participants to determine whether there was a statistically significant mean difference between HIIT exercises as compared to MICT exercise.

RESULTS

Adherence to training in HIIT and MICT groups was 100% and no any adverse events were recorded during this study. Baseline characteristics for each group are presented in Table 1. While average age in HIIT and MICT groups are 22.4 and 22.8 respectively. There was no significant difference between the two groups for body mass Index (BMI) prior to the training program. Other demographic data reveals significant result (as mentioned in Table1), Group HIIT weight post reveal (W=.458 inches ,P> .05),BMI h post(W0.404 inches =.,P> .05),waist h post(W inches =.119,P> .05),hip h post (W=.851 inches),BF h post (W=.921 %,P> .05) while MICT group weight post (W=.547inches ,P> .05),BMI h post(W=0.217inches> .05),waist h post(W=.056inches> .05),hip h post (W=.702 inches),BF h post (W=.226 inches> .05) . However results reveal that there is significant difference in mean after training.

Table 1: Demographic characteristics of both groups

Parameters	Interventions Mean ± SD	
	HIIT Mean ± SD	MICT Mean ± SD
Age(years)	22.4±1.72	22.8±1.56
Height (inch)	5.2±0.1	4.9±0.5
Weight (kg)	63.2±3.2	65.2±7.6
BMI* (kg/m2)	25.6±0.99	26.8±2.1
Waist (inches)	34.8±1.65	31.9±4.7
HIP (inches)	39.6±1.8	38.3±4.9
BF (percentage)	35±2.2	46.3±7.3
Hip /waist Ratio	1,1±0.06	1.2±0.07

Table 2: Paired T-test pre and post measurement of outcome variables for both groups

HIIT	Pre	Post	Mean Difference	t-test score	CI	P-value
Weight (kg)	66.2±3.5	63.2±3.2	3.04	14.10	(2.58,3.54)	0.00
BMI (Kg/m2)	26.8±0.96	25.6±0.99	1.20	14.70	(1.02,1.36)	0.00
Waist (inches)	36.5±1.6	34.8±1.65	1.67	3.95	(0.76,2.57)	0.001
HIP (inches)	41.3±1.8	39.6±1.8	1.73	6.98	(1.2 , 2.23)	0.00
BF (Percentage)	37.9±2.6	35±2.2	2.92	16.06	(2.5 , 3.3)	0.00
MICT	Pre	Post	Mean Difference	t-test	CI	P-value
Weight (Kg)	67.1±7.8	65.2±7.6	1.91	3.57	(0.76,3.05)	0.003
BMI (Kg/m2)	27.5±2.2	26.8±2.1	0.77	3.34	(0.27,1.26)	0.005
Waist (inches)	33.4±4.5	31.9±4.7	1.47	6.81	(1.0,1.92)	0.000
HIP (inches)	39.9±4.9	38.3±4.9	1.67	5.29	(0.99,2.34)	0.00
BF (Percentage)	47.6±8.0	46.3±7.3	1.34	4.21	(0.65,2.02)	0.001

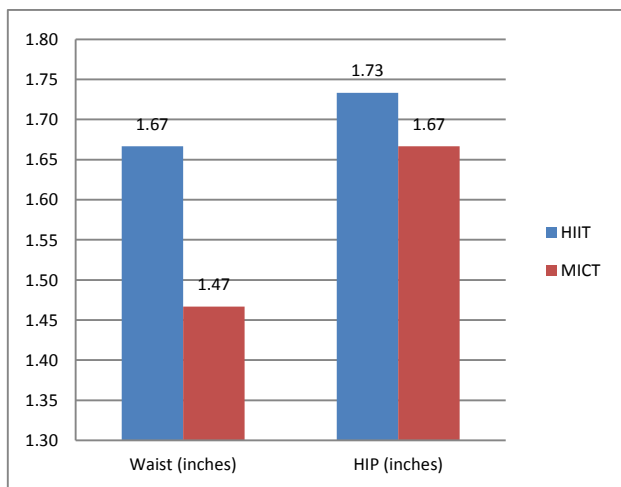


Figure 1: Mean difference in Anthropometric measure of both group (n=15) in Inches

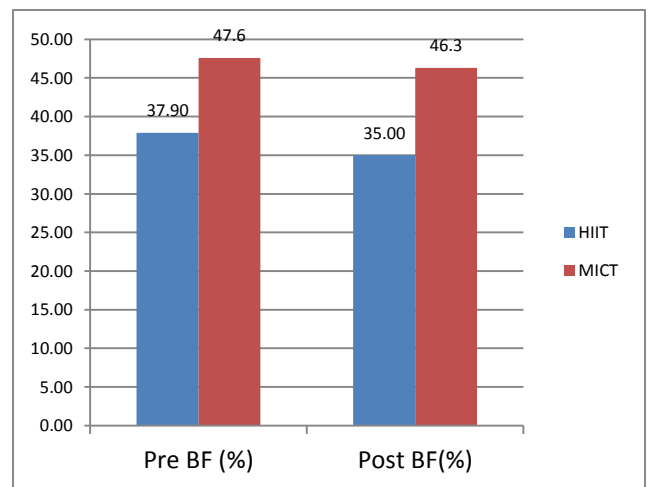


Figure 2: Pre and Post comparison of BF % (n=15)

Participants receiving HIIT reduce body weight significant average difference between the pre and post scores in all the anthropometric measure (table 2). On average the weight score is 3.04 kg after the HIIT exercise, pre HIIT exercise (66.2±3.5) as post HIIT exercise (63.2±3.2) while there is significant average difference between the pre and post scores in all the indicators. On average the weight score is 1.91 kg after the MICT exercise, pre MICT exercise (67.1±7.8) as post MICT exercise (65.2±7.6) a statistically significant maximum reduction of weight in HIIT exercise 3.04 kg shown in Table2 and 3 .

Anthropometric Measures The HIIT groups significantly decreased weight $t(14.10)=3.04, P < 0.00$ (95%CI2.58,3.54).BMI SCORE is more significant in HIIT exercise group $t(14.70)=1.20, P < 0.00$ (95%CI1.02,1.36) as compare to MICT exercise group . Waist,Hip and BF in HIIT exercise group shown significant reduction in fat mass in oppose to MICT.(Table 2) .

Table 3: Independent Sample t- test on outcome variables

Parameter	HIIT mean±SD	MICT mean±SD	F test	p-value
Weight (kg)	63.2±3.2	65.2±7.6	5.963	0.021
BMI (Kg/m ²)	25.6±0.99	26.8±2.1	3.193	0.085
Waist (inches)	34.8±1.65	31.9±4.7	25.069	0.000
HIP (inches)	39.6±1.8	38.3±4.9	12.72	0.001
BF (Percentage)	35±2.2	46.3±7.3	4.99	0.034

Table 3 shows that there is significant difference between the mean of BMI, Waist, HIP and BF. P-value also indicates the significant difference between them. However the weight shows insignificant difference between them.

DISCUSSION

To the best of our knowledge, this is the first study to compare the effects of HIIT and MICT on anthropometric measures overweight sedentary lifestyle in young females with caloric reduction in this region. The major findings of this study were that HIIT exercise group is significant ($P=0.00$) and time efficient in reducing total body weight as compared to MICT exercise group of young overweight females . Also BMI was significantly improved after HIIT. However, waist, hip, and fat mass reduction are also highly significant in both groups. Our results suggest that 8 weeks of HIIT and MICT improve markers of body fatness and weight reduction with 500Kcal changes in dietary intake. However, our results suggest that the HIIT protocol is more efficient than the MICT protocol as a greater reduction in weight and fat can be achieved in less time. In addition, study result found dominance of BMI outcome in the HIIT exercise group .As a study suggested "lack of time", a common obstacle to regular exercise adoption [15,16] HIIT and MICT exercise group both shows 100% adherence although the general recommendations suggest a minimum of 150min of moderate aerobic activity or vigorous exercise for 75min per week [17], we found that with only 25min of HIIT exercise group performed five times per week, it is possible to decrease body weight as compare to sit train found in previous studies involving protocols with longer durations of 12weeks [18]. MICT Exercise group of this study highly significant result body weight reduction ($P=0.003$), BMI ($p=0.005$), BF ($p = 0.001$), and Hip circumference ($p = 0.00$) with 45min duration in contrast to another study significant done on of Moderate-Intensity Intermittent Circuit Training in Obese and Overweight Individuals shows in BW ($p = 0.004, \eta^2 = 0.002$), BMI ($p = 0.008, \eta^2 = 0.002$), BF% ($p = 0.001, \eta^2 = 0.004$), BF (Kg) ($p = 0.004, \eta^2 = 0.004$), and Hip circumference ($p = 0.012, \eta^2 = 0.001$).[19] these are mentioned previously

The weight reduction is observed in the present study which indicates that HIIT exercise group involving running with caloric reduction provide efficient inducement in weight reduction (63.2±3.2, $P=0.00$) to those reported in previous HIIT exercise group interventions 14.5 ± 22.9%($P < 0.001$) [18]

Both types of Interval Trainings promoted reduction in waist circumference in young group as compare to 10weeks duration 3times/week expose in systemic review disclose in weweg 2017 systemic review[20,21]. There were no significant differences between HIIT and MICT body composition measure except weight , but HIIT required 55% less training time commitment in contrast result reveal in Weweg 2017 systemic review while Running training showed large effects on whole-body fat mass in is in agreement with the results of HIIT(standardized mean difference 0.82) [18,19,20,21]. In addition, justify Astorino and Schubert in 2018 suggest that cycling training did not induce fat loss of subcutaneous fat (skinfolts) and waist circumference alike HIIT and SIT increase whole-body fat oxidation[22]. An important aspect of the present study is that the participants did not present a statistically significant difference between the groups in the pre-intervention period as well as in Pakistan fat mass analyses done on bioelectrical impedance analyzer use in this study.

In addition, our results were similar to those of João Pedro A. Vianain 2018, reported that 8 weeks of a running HIIT protocol with no changes in dietary intake of similar intensity and duration 72.3 ± 7.8 $P < 0.001$ to the one used in our intervention reduced 34.8±1.65 $P < 0.001$ with changes in dietary intake as well as Irene-Chrysovalanto Themistocleous study result shows weight reduction with MICT with different protocol[18,19].

Study done by Maillard et al. in 2016 Previous using different forms of IT with longer periods of training also found fat loss in postmenopausal women with type II diabetes Trapp et al in 2008 on inactive young women while Panissa et al. in 2016 , Heydari et al., 2012; Higgins et al., 2016 studied overweight men and women[23,24,25,26,27].Viana et al. in 2018, comparing different IT protocols and compared the effects of SIT and HIIT in reducing abdominal visceral fat in 46 obese women[18].

However, one important aspect that limits the generalization of this study results is that our training sessions were thoroughly supervised. Considering that previous studies show that the results of an exercise intervention depend on supervision [28,29], the current outcomes might not be reproducing in unsupervised situations. Another apparent limitation is that our study did not evaluate at the same phase of the menstrual cycle, In addition, seasonal variation are questionable to have been able to vary the results. Instead of fat analysis is done on fat analyzer (bioelectrical impedance analyses) as suggest in study [18].It is suggested to use more suitable on markers of body fatness to access the changes induced by an intervention.

CONCLUSION

Both HIIT showed significant reduction in body weight as compare to MICT protocols and both exercise protocols decrease the fat mass which is analyzed on bioelectric impedance analyzer . Moreover, HIIT showed weight reduction, waist, hip and BMI in sort duration, promoted reductions in adiposity indicators in healthy young women 500 caloric dietary changes Considering the low physical activity among young female and no doubt short time duration in HIIT exercise protocol increase adherence in weight reduction. In addition, one advantage of HIIT is that it does not need complex tests to define the intensity of the exercise, which might contribute to its use in cases where no clinical contraindications exist.

REFERENCES

- 1 Tazeen H. Jafar, Nish Chaturvedi, Pappas G Prevalence of overweight and obesity and their association with hypertension and diabetes mellitus in an Indo-Asian population. Canadian Medical Association Journal. 175(9). 2006
- 2 Girdhar S, Sharma S , Chaudhary A, Bansal P, An Epidemiological Study of Overweight and Obesity Among Women in an Urban Area of North India, Indian Journal of Community Medicine 41(2):154-7, 2016
- 3 B. J. Nicklas, B. W. J. H. Penninx, M. Cesari et al., "Association of visceral adipose tissue with incident myocardial infarction in older men and women: the Health, Aging and Body Composition Study,"

- American Journal of Epidemiology, vol. 160, no. 8, pp. 741–749, 2004.
- 4 O. Hamdy, S. Porratikul, and E. Al-Ozairi, “Metabolic obesity: the paradox between visceral and subcutaneous fat,” *Current Diabetes Reviews*, vol. 2, no. 4, pp. 367–373, 2006.
 - 5 H. Hong, J. Jeong, J. Kong et al., “Effect of walking exercise on abdominal fat, insulin resistance and serum cytokines in obese women,” *Journal of Exercise Nutrition and Biochemistry*, vol. 18, no. 3, pp. 277–285, 2014.
 - 6 D’Amuri A, Sanz JM, Capatti E, et al. Effectiveness of high-intensity interval training for weight loss in adults with obesity: a randomised controlled non-inferiority trial. *BMJ Open Sport & Exercise Medicine* 2021;7:e 001021. doi:10.1136/bmjsem-2020-001021
 - 7 Astorino, T. A., Heath, B., Bandong, J., Ordille, G. M., Contreras, R., Montell, M., et al. Effect of periodized high intensity interval training (HIIT) on body composition and attitudes towards hunger in active men and women. *J. Sports Med.* 2018
 - 8 Zhang H, Tong T. K, Qiu W, Comparable Effects of High-Intensity Interval Training and Prolonged Continuous Exercise Training on Abdominal Visceral Fat Reduction in Obese Young Women. *Journal Diabetes and Research*. 2017
 - 9 E. Miyamoto-Mikami, K. Sato, T. Kurihara et al., “Endurance training-induced increase in circulating irisin levels is associated with reduction of abdominal visceral fat in middle-aged and older adults,” *PLOS ONE*, vol. 10, no. 3, Article ID e0120354, 2015.
 - 10 M, Effect of diet with or without exercise on abdominal fat in postmenopausal women – a randomised trial. *Journal of physiology*, vol. 19, 2019
 - 11 J. E. Donnelly, S. N. Blair, J. M. Jakicic, M. M. Manore, J. W. Rankin, and B. K. Smith, “Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults,” *Medicine & Science in Sports & Exercise*, vol. 41, no. 2, pp. 459–471, 2009.
 - 12 L. Nybo, E. Sundstrup, M. D. Jakobsen et al., “High-intensity training versus traditional exercise interventions for promoting health,” *Medicine and Science in Sports and Exercise*, vol. 42, no. 10, pp. 1951–1958, 2010.
 - 13 A. E. Tjønnå, S. J. Lee, Ø. Rognmo et al., “Aerobic interval training versus continuous moderate exercise as a treatment for the metabolic syndrome: A Pilot Study,” *Circulation*, vol. 118, no. 4, pp. 346–354, 2008.
 - 14 J. P. Little, J. B. Gillen, M. E. Percival et al., “Low-volume high intensity interval training reduces hyperglycemia and increases muscle mitochondrial capacity in patients with type 2 diabetes,” *Journal of Applied Physiology*, vol. 111, no. 6, pp. 1554–1560, 2011.
 - 15 T. Sijie, Y. Hainai, Y. Fengying, and W. Jianxiong, “High intensity interval exercise training in overweight young women,” *Journal of Sports Medicine and Physical Fitness*, vol. 52, no. 3, pp. 255–262, 2012.
 - 16 J Weston, K. S., Wisløff, U., and Coombes, J. S. (2013). High-intensity interval training in patients with lifestyle-induced cardiometabolic disease: a systematic review and meta-analysis. *Br. J. Sports Med.* Vol. 48, 1–9. 2013
 - 17 World Health Organization (2010). *Global Recommendations on Physical Activity for Health*. Geneva: World Health Organization.
 - 18 R B. Viana, Ana C. S. Rebelo et al, “Effects of High-Intensity Interval Training vs. Sprint Interval Training on Anthropometric Measures and Cardiorespiratory Fitness in Healthy Young Women” *frontier in physiology* vol. 9, 2018.
 - 19 Themistocleous I C, Agathangelou P and Stefanakis M, Effects of Moderate-Intensity Intermittent Circuit Training in Obese and Overweight Individuals international journal of sports and exercise medicine, 7:194. doi.org/10.23937/2469-5718/151019
 - 20 H. Zhang, T. K. Tong, W. Qiu, J. Wang, J. Nie, and Y. He, “Effect of high-intensity interval training protocol on abdominal fat reduction in overweight Chinese women: a randomized controlled trial,” *Kinesiology*, vol. 47, no. 1, pp. 57–66, 2015.
 - 21 M Weuge, R van den Berg, R E Ward, A Keech 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 April 2017 DOI: 10.1111/obr.12532 2017
 - 22 Astorino, T. A., and Schubert, M. M. (2018). Changes in fat oxidation in response to various regimes of high intensity interval training (HIIT). *European Journal of Applied Physiology*. 118, 51–63. doi: 10.1007/s00421-017-3756-0
 - 23 Maillard, F., Rousset, S., Pereira, B., Traore, A., de Pradel Del Amaze, P., Boirie, Y., et al. (2016). High-intensity interval training reduces abdominal fat mass in postmenopausal women with type 2 diabetes. *Diabetes and Metabolism Journal*. 42, 433–441. 2016.
 - 24 Trapp, E. G., Chisholm, D. J., Freund, J., and 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, 684–91. 2008
 - 25 Panissa, V. L. G., Alves, E. D., Salerno, G. P., Franchini, E., and Takito, M. Y. Can short-term high-intensity intermittent training reduce adiposity? *Sport Science for Health* 12, 99–104. 2016
 - 26 Heydari, M., Freund, J., and Boutcher, S. H. The effect of high-intensity intermittent exercise on body composition of overweight young males. *Journal of Obesity*. 2012.
 - 27 S. E. Keating, E. A. Machan, H. T. O’Connor et al., “Continuous exercise but not high intensity interval training improves fat distribution in overweight adults,” *Journal of Obesity*, vol. 2014, Article ID 834865, 12 pages, 2014.
 - 28 Higgins, S., Fedewa, M. V., Hathaway, E. D., Schmidt, M. D., and Evans, E. M.. Sprint interval and moderate-intensity cycling training differentially affect adiposity and aerobic capacity in overweight young-adult women. *Applied Physiology, Nutrition, and Metabolism*. 41, 1177–1183. 2016
 - 29 Gentil, P., and Bottaro, M. Influence of supervision ratio on muscle adaptations to resistance training in non trained subjects *Journal of strength and conditioning research* 24, 639–643. 2010
 - 30 Ramírez-Campillo, R., Martínez, C., de La Fuente, C. I., Cadore, E. L., Marques, M. C., Nakamura, F. Y., et al. (2017). High-speed resistance training in older women: the role of supervision. *Journal of Aging and Physical Activity*. 25, 1–9. 2010