JTS Journal of Taiji Science

Vol.4 Iss.1 / June / 2024
Digital Edition: ISSN 2832-062X
Print Edition: ISSN 2832-0611

Comparison of the Effects of HIIT and MICT on Weight Loss in Female College Students: A Meta-Analysis

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DOI: 10.57612/JS24.JTS.03.04

Abstract: High-Intensity Interval Training (HIIT) and Moderate-Intensity Continuous Training (MICT) have been widely studied for their effects on weight loss. Randomized controlled trials (RCTs) investigating the interventions of HIIT and MICT on overweight female college students were retrieved from PubMed, The Cochrane Library, Web of Science, Scopus, CNKI, and Wanfang databases up to September 1, 2023. According to the inclusion criteria, a meta-analysis was conducted. The results showed that HIIT significantly reduced and improved body weight (MD = -0.99, 95% CI = -1.82 to -0.17, P < 0.05), BMI (MD = -0.40, 95% CI = -0.69 to -0.11, P < 0.05), body fat percentage (MD = -0.82, 95% CI = -1.15 to -0.49, P < 0.05), waist-to-hip ratio (MD = -0.01, 95% CI = -0.02 to -0.00, P < 0.05), and waist circumference (MD = -1.76, 95% CI = -3.13 to -0.39, P < 0.05) in overweight female college students. The effect on hip circumference (MD = -0.45, 95% CI = -1.77 to 0.86, P = 0.50) was not statistically significant. HIIT showed overall superiority to MICT in weight loss activities aimed at overweight female college students, especially in reducing body weight and body fat percentage. It is recommended that overweight female college students with weight loss needs prioritize HIIT interventions based on weight loss efficiency and time effectiveness, with a program lasting 12 weeks, 3 times per week, and 20–30 minutes per session.

Keyboard: Female College Students, Weight Loss, HIIT, MICT, Randomized Controlled Trials

Introduction

The prevalence of overweight among female college students has been continuously rising, becoming a significant factor hindering their comprehensive physical and mental development [3]. Extracurricular physical activities positively impact the health of female college students [4] and should be a primary target for weight loss and weight control efforts among this population [5]. Since 2015, High-Intensity Interval Training (HIIT), known for its time efficiency and effectiveness, has gained increasing attention in studies promoting physical fitness among female college students [6]. The essential characteristic of HIIT involves various combinations of exercise intensities above or below the anaerobic threshold and maximal lactate steady state [7-8]. However, intervention strategies and methods for weight loss using Moderate-Intensity Continuous Training (MICT) remain inconsistent [9]. Therefore, this study conducts a comprehensive meta-analysis of domestic and international research on HIIT and MICT interventions for overweight female college students, aiming to provide a theoretical basis for selecting appropriate weight loss exercise methods for this population.

JTS Journal of Taiji Science
Vol.4 Iss.1 / June / 2024
Digital Edition: ISSN 2832-062X
Print Edition: ISSN 2832-0611

Materials and Methods

Inclusion and Exclusion Criteria

Inclusion criteria: (1) Subjects were overweight or obese female college students; (2) Intervention and comparison methods included HIIT, SIT, MICT, and ACT; (3) Outcome indicators included body weight, BMI, body fat percentage, waist circumference, and waist-to-hip ratio; (4) Master's or doctoral theses or full-text scientific papers; (5) Study design was randomized controlled trial; (6) Subjects had no diseases affecting the study other than obesity.

Exclusion criteria: (1) Duplicate articles after screening; (2) Review articles and systematic reviews; (3) Studies with data that could not be extracted or lacking relevant outcome indicators; (4) Studies involving drug or dietary interventions; (5) Subjects with other diseases such as metabolic disorders or cardiovascular diseases.

Literature Search

Keywords including female college students (), students, youth, high-intensity interval training, HIIT, aerobic training, moderate-intensity continuous training, MICT in both Chinese and English were used to search databases including CNKI, The Cochrane Library, PubMed, Web of Science, and Scopus. The search period was from database inception to April 1, 2022. Both Chinese and English language articles were included [8]. Citation searching of relevant articles was also performed.

Literature Screening and Data Extraction

Three researchers participated in literature selection. Two researchers independently screened papers based on inclusion and exclusion criteria by reading titles and abstracts, excluding unsuitable studies. Extracted information included basic characteristics (author, year, country, age, sample size, topic), experimental characteristics (exercise modality, frequency, duration), and outcome indicators. Discrepancies were resolved by a third researcher.

Risk of Bias Assessment

Risk of bias was assessed according to the Cochrane Handbook for Systematic Reviews [10], focusing on sample representativeness (randomization and blinding) and data completeness. Included studies were categorized as low, unclear, or high risk of bias [8].

Statistical Methods

Meta-analysis was conducted using Review Manager 5.4 software [8]. Heterogeneity was assessed by P value and I^2 statistic. If heterogeneity was low ($I^2 < 50\%$, $P > 0.05$), a fixed-effect model was used; otherwise, a random-effect model was applied. Continuous data were analyzed using mean difference (MD) and 95% confidence intervals (CI). Sensitivity analyses were performed by excluding studies one by one. When heterogeneity was significant, subgroup and descriptive analyses were conducted. Publication bias was assessed using tools in Review Manager 5.4 [9].

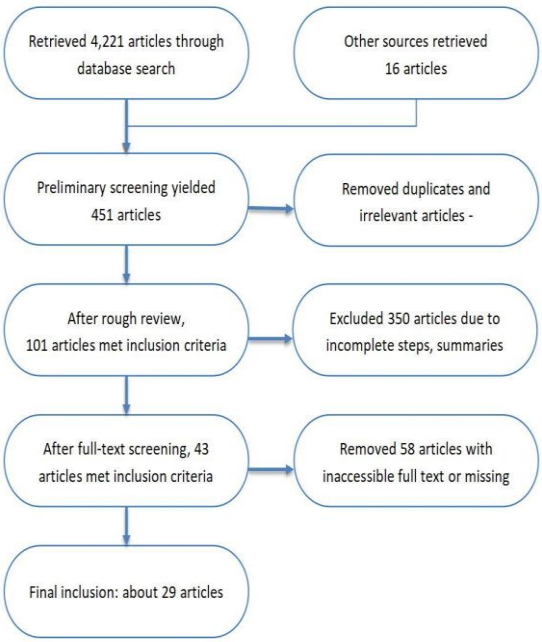

Figure 1. Literature Screening Flowchart

JTS Journal of Taiji Science
DOI: 10.57612/JS24.JTS.03.04

JTS Journal of Taiji Science
Vol.4 Iss.1 / June / 2024
Digital Edition: ISSN 2832-062X
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Basic Characteristics of Included Studies

A total of 29 studies were included, all involving overweight female college students who voluntarily participated in the interventions. The majority of exercise modalities were cycling

(power-based) and running. A total of 999 participants were extracted for analysis (see Table 1)

Table 1. Basic Characteristics of Included Studies

				Sample Size						Outco
		Age（Year）					Intervention			
First Author				(Exp/Ctrl)	Obesity					mes
(Year)	Country	Experiment	Control		Level					
						xercise	Frequency Duratio n			
		al Group	Group	(Exp) / (Ctrl)				(Exp)	(Ctrl)	
						Modality	(per week) (weeks)			
		(Exp)	(Ctrl)							
						Cycle	3 times/			
Jinlei Nie 2017[11]	Macao	21.0±1.1	20.9±1.6	16/13	Obese		12	HIIT	MICT	2.3
						Ergometer	week			
Simon Higgins						Cycle	1-2 week 5			
2016[12]	USA	20.4±1.5		23/29	Obese	Ergometer	tines/week 6	SIT	MICT	1.3
							3-4 周6 次/			
G. Racil 2013[13]	Tunisia	15.6±0.7	16.3± 0.52	11/11	Obese	Running	3 times/week 12	HIIT	MICT	1.3
G. Racil 2016[14]	Tunisia	14.2±1.2		17/16	Obese	Running	3 times/week 12	HIIT	MICT	1.3
						Cycle				
		21.5± 1.8	20.9± 1.4	14/14	Obese		3 times/week 12	HIIT	MICT	1.2
Shengyan						Ergometer				
	Macao									
Sun2018[15]						Cycle				
		21.4±1.1	20.9± 1.4	14/14	Obese		3 times/week 12	SIT	MICT	1.2
						Ergometer				
Ramin										
										1.2.
Eimarieskandari	Iran	22.29±0.89	21.37±0.5	7/7	Overweight	Running 机	3 times/week 8	HIIT	MICT	
										3.4
2012[16]										
						Cycle				
		21.4±1.0	20.9±1.4	16/16	Obese		3 times/week 12	SIT	MICT	1.2

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Mingzhu Hu						Ergometer					
	Macao										
2021[17]						Cycle					
		21.5±1.7	20.9±1.4	17/16	Obese		3 times/week	12	HIIT	MICT	1.2
						Ergometer					
Alexandre											1.2.
	巴西	28.7±4.9	28.3±6.8	14/11	Obese	Running	3 times/week	6	HIIT	MICT	
L.E.2019[18]											3.5
							1–2 weeks,				
							5times/week				
Michael V.						Cycle	3–4 weeks,				
	USA	20.2±1.8	20.3±1.6	21/23				6	HIIT	MICT	1.3
Fedewa2017[19]					Overweight	Ergometer	6 times/week				
							5–6 weeks,				
							7 times/week				
Krzystof						Cycle					1.2.
		Poland	19.5±0.6		24/22	Obese		3 times/week	8	A	
						CME					
Mazurek2014[20]						Ergometer					4.5
						Cycle			SIT		
		20.9±1.7		21.0±2.4	11/11	Obese	4 times/week	12		MICT	1.3
						Ergometer			all-out		
Haifeng Zhang						Cycle			SIT		
	China	19.7±1.3		21.0±2.4	12/11	Obese	4 times/week	12		MICT	1.3
2020[21]						Ergometer			120		
						Cycle					
		19.7±1.1		21.0±2.4	12/11	Obese	4 times/week	12	SIT 90	MICT	1.3
						Ergometer					
											1.2.
T.SUJIE 2012[22]	China	19.8±1.0		19.3±0.7	17/16		Treadmill	5 times/week	12	HIIT	MICT	
						Overweight					3.4
							1-3weeks				
Haifeng Zhang						Cycle	3 times/week				
	China		18-22		15/15	Obese		12	HIIT	MICT	1.3
2017[23]						Ergometer	4-12weeks				
							4time/weeks				
						Exercise					
XipengMa											1.2.3.
	China		—		14/15	Obese	Combination	4 times/week	12	HIIT	MICT	

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2020[24]												4.5.6
							/ Treadmill					
Xiaohong Peng												
	China	23.41±1.23		23.31±1.20	17/16	Obese	Running	3 times/week	12	HIIT	MICT	1.2.4
2020[25]												
Yugang Qi	China				20/20	Obese	Running	5 times/week	12	HIIT	MICT	1.2.3.4
2013[26]							Exercise					
Jianming Chen	China	20.36±1.12		20.80±1.03	12/12	Obese	/Running	3 times/week	4	HIIT	MICT	1.2.3.5
Miao Zhang2019[28]	China	20.1±1.4		20.6±1.7	12/13	Obese	Treadmill	4 times/week	10	HIIT	MICT	
												4.5.6
Yong Zhang												1.2.3.
	China	21.20±1.62		21.00±1.05	10/10	Obese	Treadmill	3 times/week	10	HIIT	MICT	
2018[29]												4.6
Zhaoquan	China	18±0.78		18±0.93	18/16	Obese	Exercise	3 times/week	12	HIIT	MICT	1.2
Li2019[30]							Combination					
		21.44±1.71		20.81±1.42	16/16		Cycle	1-2 weeks	12	HIIT	MICT	1.3
Xu Zhang	China					Overweight	Ergometer	3 times/week				
2016[31]		21.31±1.01		20.81±1.42	16/16		Cycle	1-2 weeks	12	SIT	MICT	1.3
						Overweight	Ergometer	3 times/week				
Han Han	China	21.31±1.01		21.07±1.49	16/14	Obese	Cycle	1-3 week	12	HIIT	MICT	3
2013[32]							Ergometer	3 times/week				
Hongfu Liu2016[33]	China			20-23	20/20	Obese	Cycle	3 times/week	12	HIIT	MICT	1.2.3.
							Ergometer					4.5.6
		20.9±1.7		21.0± 2.4	11/11		Cycle	1-4 week	12	SIT	MICT	1.3
						Overweight	Ergometer	3 times/week				
Ziwei Zheng	China	19.7±1.3		21.0± 2.4	12/11		Cycle	1-4 weeks	12	HIIT	MICT	3
2016[34]						Overweight	Ergometer	3 times/week		120		
		19.7±1.1		21.0± 2.4	12/11		Cycle	1-4weeks	12	HIIT	MICT	1.3
						Overweight	Ergometer	3 times/week		90		

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		21.5±1.7	20.9±1.4	15/15	Obese	Cycle	1-4 weeks	12	HIIT	MICT	1.3
Ling Wang	China					Ergometer	3 times/week				
2017[35]		21.3±1.0	20.9±1.4	16/15	Obese	Cycle	1-4 weeks	12	SIT	MICT	1.3
						Ergometer	3 times/week				
		20.6±1.8	21.0±2.4	12/11	Obese	Cycle	1-4 weeks	12	SIT	MICT	1.2.3
						Ergometer	3 times/week				
Xiangui Zhu	China	19.9±1.9	21.0±2.4	11/11	Obese	Cycle	1-4 weeks	12	HIIT	MICT	1.2.3
2019[36]						Ergometer	3 times/week		120		
		19.6±1.0	21.0±2.4	11/11	Obese	Cycle	1-4 weeks	12	HIIT	MICT	1.2.3
						Ergometer	3 times/week		90		
Jingjing Wang	China	21.0 ± 1.0	20.6±1.2	12/12	Obese	Treadmill	4 times	12	HIIT	MICT	1.2.3.
2015[37]							/week				4.5.6
Xu Song	China	21.90±2.23	22.20±1.55	10/10	Obese	Treadmill	3 times/week	8	HIIT	MICT	1.2.3.
2021[38]											4.5.6
Shuai Zeng	China	21.3±1.1	21.1±1.5	16/14	Obese	Cycle	1-3 week	12	HIIT	MICT	1.2.3
2014[39]						Ergometer	3 times/week				

Note. *In the table, 1 = body weight (kg), 2 = BMI (kg/m²), 3 = body fat percentage (%), 4 = waist-to-hip ratio (WHR), 5 = waist circumference (cm), and 6 = hip circumference (cm).*

All 29 studies included in this research adopted randomized controlled trials, with each group providing inclusion and exclusion criteria for both the experimental and control groups. None of the 29 studies provided specific details on the randomization methods; 28 studies reported the use of allocation concealment, while none of the 29 studies indicated whether a double-blind method was applied to participants and researchers. All studies did not use blinding for outcome assessment. Some bias was also present in the data analysis of the articles. Overall, all 29 studies were of moderate quality.

Meta-analysis Results

The Effect of HIIT vs. MICT on Body Weight in Overweight Female College Students

A total of 36 groups (from 27 studies) involving 928 participants in randomized controlled trials were analyzed to evaluate the effectiveness of HIIT and MICT in weight-loss interventions for overweight female college students. As shown in the forest plot in Figure 2, $I^2 = 0$, $P < 0.05$, thus the fixed-effect model was applied. The combined effect size was MD = -0.99, 95% CI = -1.82 to -0.17, indicating that HIIT was more effective than MICT in reducing body weight among overweight female college students.

DOI: 10.57612/JS24.JTS.03.04

JTS
Journal of Taiji Science

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Digital Edition: ISSN 2832-062X
Print Edition: ISSN 2832-0611

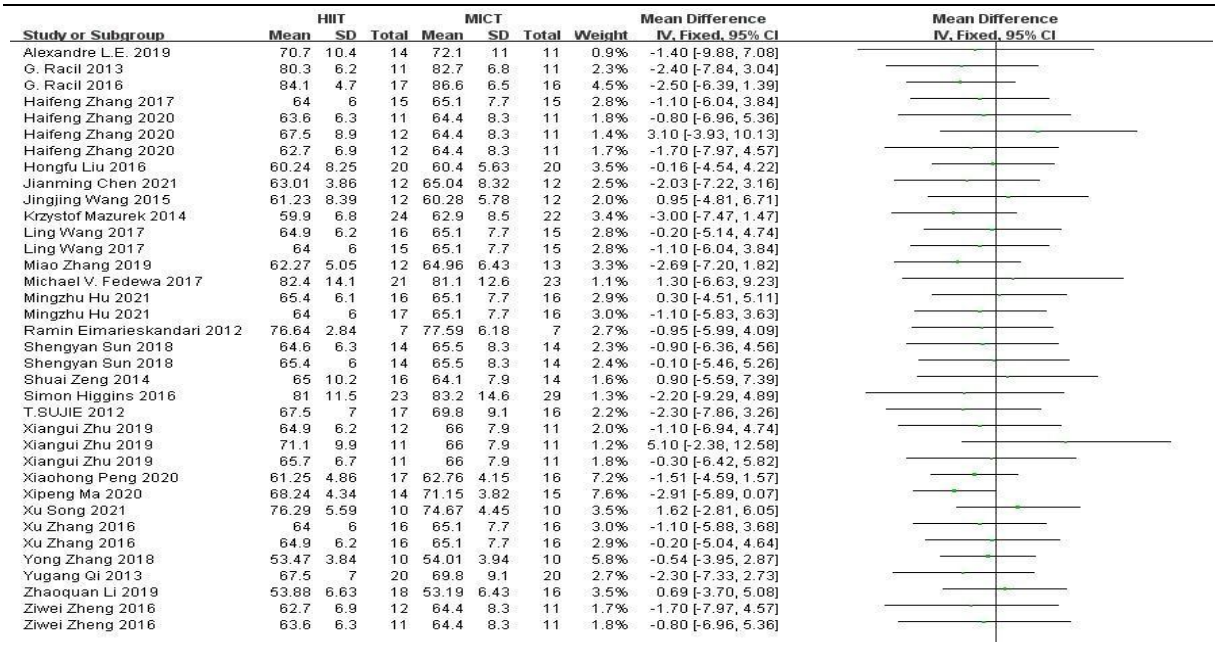

Figure 2. Meta-analysis of the effects of HIIT vs. MICT on body weight in overweight female college students

Effects of HIIT and MICT on BMI in Overweight Female College Students

A total of 23 groups (19 studies) involving 592 participants from randomized controlled trials were analyzed to evaluate the effectiveness of HIIT and MICT interventions on BMI in overweight female college students. As shown in the forest plot in Figure 3, I2=0I^2 = 0I2=0, P<0.05P < 0.05P<0.05, so the fixed-effect model was used. The pooled effect size was MD=−0.40MD = -0.40MD=−0.40, 95% CI −0.69-0.69−0.69 to −0.11-0.11−0.11, indicating that HIIT is more effective than MICT in improving BMI in overweight female college students.

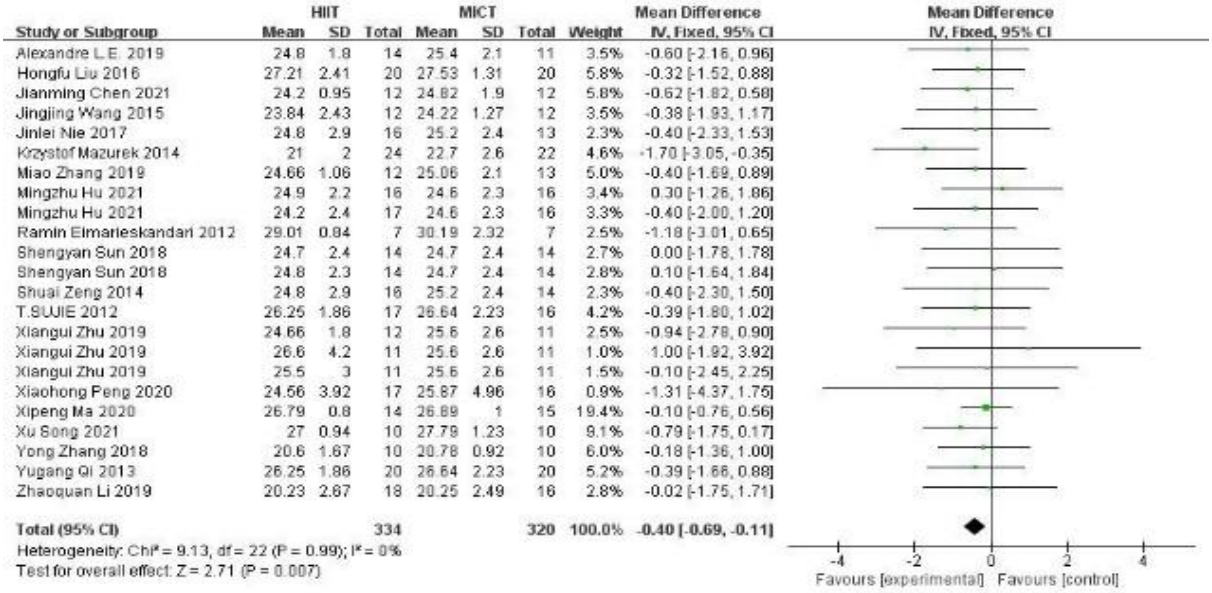

Figure 3. Meta-analysis of the effects of HIIT and MICT on BMI in overweight female college students

DOI: 10.57612/JS24.JTS.03.04

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Digital Edition: ISSN 2832-062X
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Results of HIIT and MICT Interventions on Body Fat Percentage in Overweight Female College Students

A total of 32 groups (24 studies) involving 795 participants from randomized controlled trials were analyzed to assess the effectiveness of HIIT and MICT in reducing body fat percentage among overweight or obese female college students. As shown in the forest plot in Figure 4, I2=33%I^2 = 33\%I2=33%, P<0.05P < 0.05P<0.05. Therefore, a fixed-effects model was applied for analysis. The pooled effect size was MD=−0.82MD = -0.82MD=−0.82, with a 95% CI of

−1.15-1.15 −1.15 to −0.49-0.49−0.49, indicating that HIIT was more effective than MICT in reducing body fat percentage in overweight female college students.

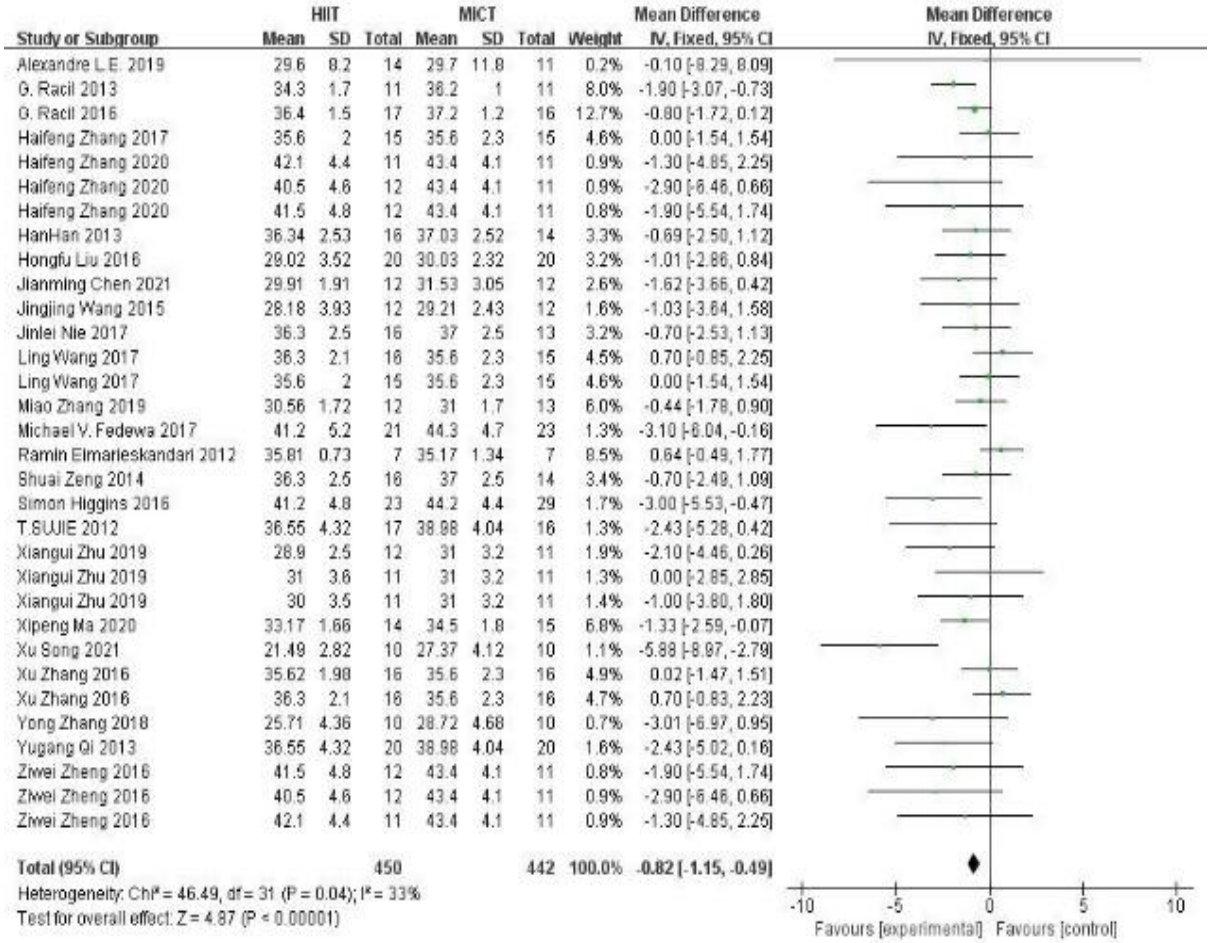

Figure 4. Meta-analysis of the Effects of HIIT and MICT on Body Fat Percentage in Overweight Female College Students

Effects of HIIT and MICT on Waist-to-Hip Ratio (WHR) and Waist Circumference in Overweight Female College Students

Seven randomized controlled trials (7 studies) with a total of 226 participants were analyzed to evaluate the effects of HIIT and MICT on WHR in overweight female college students. As shown in the forest plot in Figure 5, $I^2 = 0$, $P < 0.05$; therefore, a fixed-effect model was applied. The pooled effect size was MD = -0.01, 95% CI = -0.02 to -0.00.

Eight randomized controlled trials (8 studies) with a total of 233 participants were analyzed to assess the effects of HIIT and MICT on waist circumference in overweight female college students. As

JTS
Journal of Taiji Science
DOI: 10.57612/JS24.JTS.03.04

JTS Journal of Taiji Science
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Digital Edition: ISSN 2832-062X
Print Edition: ISSN 2832-0611

shown in the forest plot in Figure 6, $I^2 = 0$, $P < 0.05$; therefore, a fixed-effect model was used. The pooled effect size was MD = -1.76, 95% CI = -3.13 to -0.39, indicating that compared with MICT, HIIT can effectively reduce waist circumference and improve WHR in overweight female college student

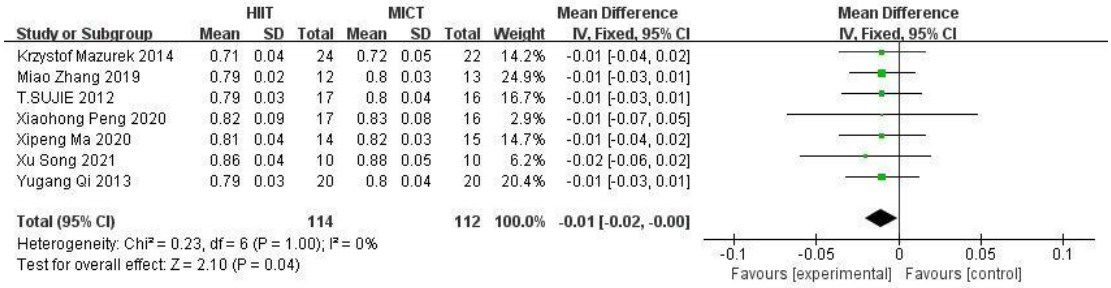

Figure 5. Meta-analysis of HIIT versus MICT on Waist-to-Hip Ratio in Overweight Female College Students

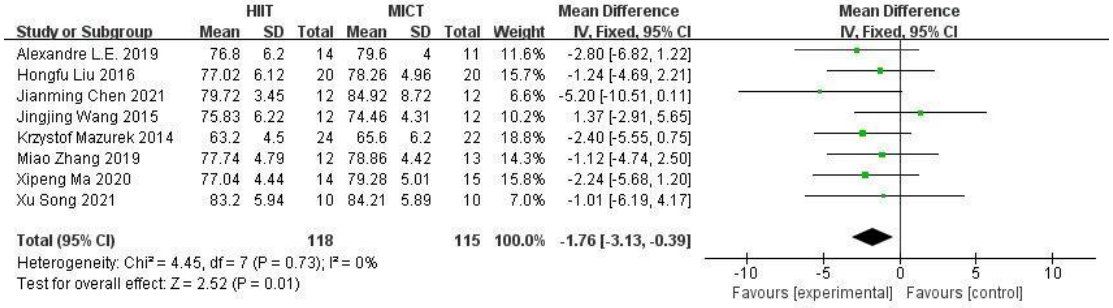

Figure 6. Meta-analysis of the effects of HIIT and MICT on waist circumference in overweight female college students

Discussion

Compared with traditional MICT training, HIIT features higher intensity, shorter training duration, and shorter intervention periods. The intermittent rest intervals in HIIT can better enhance participants' enjoyment and exercise adherence [40], making it more acceptable [41]. HIIT can also prevent a sharp decline in oxygen utilization of fat cells, making it particularly suitable for overweight students [10]. Generally, overweight female college students face various overweight-related problems due to a lack of appropriate exercise methods. Long-term continuous aerobic exercise can effectively reduce body weight and improve aerobic capacity, but moderate- and low-intensity aerobic exercise requires more time and tends to be monotonous, making it difficult for most overweight individuals to persist [42].

Hans Reindell, a German cardiologist, first proposed high-intensity interval training (HIIT) in 1959 based on interval training, and it has since been increasingly applied in athlete performance enhancement [43]. Chinese scholar Tian Maijiu defined high-intensity interval exercise in Sports Training Science. According to Tian, interval training involves repeated exercise without full recovery, with strict regulation of rest intervals; high-intensity interval training refers to training with relatively high load intensity, lasting 40–90 seconds per bout, and maintaining a heart rate of 170–180 beats per minute [38, 44].

The results of this study indicate that, compared with MICT, HIIT has a better effect on weight reduction in female college students. HIIT can increase brain-derived neurotrophic factor (BDNF) levels in young healthy women [45], improve leptin

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Digital Edition: ISSN 2832-062X
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resistance and insulin resistance [46], and thus reduce body weight. Research shows that HIIT provides a certain resistance stimulus to muscles [47], which can increase muscle mass and quality, boost resting metabolic rate, and promote healthy weight loss [48].

Our findings show that compared with MICT, HIIT more effectively reduces BMI and body fat. HIIT can significantly influence fat regulation in overweight young women [49], reducing both total body fat and abdominal visceral fat [50], and is superior to MICT in reducing body fat percentage [51]. Studies have found that after HIIT intervention, female college students' body fat percentage decreased by 5.4%–6.6%, and total body fat mass decreased by 8%–11.1% [31].

The meta-analysis in this study also demonstrates that HIIT produces better improvements in waist circumference and waist-to-hip ratio (WHR) than MICT. Following HIIT training, reductions in waist circumference and WHR among female college students were highly significant, indicating that HIIT is markedly more effective than MICT for these anthropometric outcomes [38].

Scientific evidence suggests that HIIT reduces body fat through three main mechanisms [9]:

Increased excess post-exercise oxygen consumption (EPOC) [52], leading to hiher energy expenditure [9];

Increased proportion of fat oxidation both before and after exercise [9]; Reduced appetite after exercise [53], leading to lower energy intake.

HIIT interventions can help reduce the synthesis of unsaturated fatty acids and accelerate their breakdown, thereby reducing body fat. Structural changes in metabolites such as lysine, arginine, and proline during HIIT can participate in polyunsaturated fatty acid metabolism, thus enhancing fat-reducing effects [54]. This aligns with the conclusion of this study that HIIT significantly improves body composition in overweight female college students compared with MICT.

Some research suggests that interventions aimed at improving college students' physical fitness should promote moderate-to-high-intensity activity levels, enhance participation in physical education (PE) classes, and focus on weight reduction [55]. PE classes are the main avenue for students to engage in exercise, yet only 40.5% of class time is used for active participation, and the intensity is often below the threshold needed for health benefits [56]. The results of this study offer a potential solution—incorporating HIIT into university PE programs for overweight students can significantly improve weight outcomes. Moreover, research has shown that overweight college students who are not regular exercisers find interval training more acceptable and enjoyable compared to other exercise forms [57].

Conclusion

In conclusion, HIIT is overall superior to MICT for overweight female college students when the goal is weight loss, especially for reducing body weight and body fat percentage. HIIT significantly impacts weight, BMI, body fat percentage, and waist circumference reduction, and improves body shape. Compared with MICT, HIIT not only increases intervention efficiency but also better enhances participants' adherence and enjoyment [58]. For overweight female college students seeking efficient and time-effective weight loss, HIIT is recommended as the preferred method—lasting 20–40 minutes per session, three times per week, for 12 weeks.

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Digital Edition: ISSN 2832-062X
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Limitations

This study has several limitations. The authenticity and reliability of results may be affected by confounding factors such as exercise modality. Only published Chinese and English literature was included, which may limit comprehensiveness. None of the referenced studies described

allocation concealment, and blinding of participants, researchers, or outcome assessors was unclear, with only a few studies addressing these issues. Differences in HIIT and MICT intervention formats, participants' body composition, and measurement methods may also introduce potential bias.

Acknowledgment

The authors would like to thank all researchers whose studies were included in this meta-analysis and the institutions that provided access to the databases used in this study.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Funding Information

This research received no external funding.

References

[1] Lulu Hunt Peters.Diet and Health: With Key to the Calories[M].Baltimore: Reilly and Lee,1918.

[2] French, S. A., Perry, C. L., Leon, G. R., & Fulkerson, J. A. Dieting behaviors and weight change history in female adolescents[J]. Health Psychology, 1995,14(6):548–555. doi:10.1037/0278-6133.14.6.548.

[3] 于芳,巫国贵.大学生 Overweight、Obese 现状及影响因素分析[J].中北大学学报(社会科学版),2005,(06):91-93.

[4] 肖涛, 甄洁, 王晨宇. 循环训练对 Obese 女大学生身体成分体适能和代谢综合征危险因素的影响[J].China 学校卫生,2020,41(02):224227.doi:10.16835/j.cnki.1000-9817.2020.02.017.

[5] Wright RR, Nelson R, Garcia S, Butler A. Health Behavior Change in the Classroom: A Means to a Healthy End?[J].The journal of primary prevention. 2020,41(5):445-472. doi:10.1007/s10935-020-00605-0.

[6] 姜卫芬,金宗强,刘文烁,刘恒源.高强度间歇训练促进青年体质健康的研究进展[J].China 学校卫生,2020,41(11):17451749.doi:10.16835/j.cnki.1000-9817.2020.11.039.

[7] 黎涌明.高强度间歇训练对不同训练人群的应用效果[J].体育科,2015,35(08):59-75+96.doi: 10.16469/j.css. 201508009.

[8] 李振, 韩永强, 王晨宇, 甄洁, 肖涛. 间歇训练改善 Overweight 大学生体脂率的网状 Meta 分析[J].China 学校卫生,2021,42(12):1798-1802+1806.doi: 10.16835/j.cnki.1000-9817.2021.12.010.

[9] 孙文新,秦曼,李丽丽,尹继林,王兴.高强度间歇训练对 OverweightObese 女大学生减脂效果的 Meta 分析[J].China 学校卫生,2021,42(10):1480-1486.doi:10.16835/j.cnki.1000-9817.2021.10.009.

[10]Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare

DOI: 10.57612/JS24.JTS.03.04

Vol.4 Iss.1 / June / 2024
Digital Edition: ISSN 2832-062X
Print Edition: ISSN 2832-0611

interventions: explanation and elaboration[J].BMJ (Clinical research ed.),2009,339:b2700. Published 2009 Jul 21. doi:10.1136/bmj.b2700.

[11] Nie J, Zhang H, Kong Z, et al. Impact of high-intensity interval training and moderate-intensity continuous training on resting and postexercise cardiac troponin T concentration[J]. Exp Physiol. 2018,103(3):370-380.doi:10.1113/EP086767.

[12] Higgins S, Fedewa MV, Hathaway ED, Schmidt MD, Evans EM. Sprint interval and moderate-intensity cycling training differentially affect adiposity and aerobic capacity in overweight young-adult women[J].Appl Physiol Nutr Metab. 2016,41(11):1177-1183.doi:10.1139/apnm-2016-0240.

[13] Racil G, Ben Ounis O, Hammouda O, Kallel A, Zouhal H, Chamari K, Amri M. Effects of high vs. moderate exercise intensity during interval training on lipids and adiponectin levels in obese young females[J]. Eur J Appl Physiol. 2013,113(10):2531-40. doi: 10.1007/s00421-013-2689-5.

[14] Racil G, Coquart JB, Elmontassar W, Haddad M, Goebel R, Chaouachi A, Amri M, Chamari K. Greater effects of high- compared with moderate-intensity interval training on cardio-metabolic variables, blood leptin concentration and ratings of perceived exertion in obese adolescent females[J]. Biol Sport. 2016,33(2):145-52. doi: 10.5604/20831862.1198633.

[15] Sun S, Zhang H, Kong Z, Shi Q, Tong TK, Nie J. Twelve weeks of low volume sprint interval training improves cardio-metabolic health outcomes in overweight females[J].J Sports Sci. 2019,37(11):1257-1264. doi: 10.1080/02640414.2018.1554615.

[16] Eimarieskandari R, Zilaeibouri S, Zilaeibouri M, et al. Comparing two modes of exercise training with different intensity on body composition in obese young girls[J]. Sci Mov Health, 2012, 12: 473-8.

[17] Hu M, Kong Z, Sun S, Zou L, Shi Q, Chow BC, Nie J. Interval training causes the same exercise enjoyment as moderate-intensity training to improve cardiorespiratory fitness and body composition in young Chinese women with elevated BMI. J Sports Sci. 2021 Aug;39(15):1677-1686. doi: 10.1080/02640414.2021.1892946. Epub 2021 Feb 26. PMID: 33634738.

[18] Evangelista AL, La Scala Teixeira C, Machado AF, Pereira PE, Rica RL, Bocalini DS. Effects of a short-term of whole-body, high-intensity, intermittent training program on morphofunctional parameters. J Bodyw Mov Ther. 2019 Jul;23(3):456-460. doi: 10.1016/j.jbmt.2019.01.013. Epub 2019 Feb 5. PMID: 31563355.

[19] Fedewa MV, Hathaway ED, Higgins S, Forehand RL, Schmidt MD, Evans EM. Moderate, but not vigorous, intensity exercise training reduces C-reactive protein. Acta Cardiol. 2018 Jun;73(3):283-290. doi: 10.1080/00015385.2017.1364832. Epub 2017 Aug28. PMID: 28847205.

[20] Mazurek K, Krawczyk K, Zmijewski P, Norkowski H, Czajkowska A. Effects of aerobic interval training versus continuous moderate exercise programme on aerobic and anaerobic capacity, somatic features and blood lipid profile in collegate females. Ann Agric Environ Med. 2014;21(4):844-9. doi: 10.5604/12321966.1129949. PMID: 25528932.

[21] Zhang H, Tong TK, Kong Z, Shi Q, Liu Y, Nie J. Exercise training-induced visceral fat loss in obese women: The role of training intensity and modality. Scand J Med Sci Sports. 2021 Jan;31(1):30-43. doi: 10.1111/sms.13803. Epub 2020 Sep 4. PMID: 32789898.

DOI: 10.57612/JS24.JTS.03.04

Vol.4 Iss.1 / June / 2024
Digital Edition: ISSN 2832-062X
Print Edition: ISSN 2832-0611

[22] Sijie T, Hainai Y, Fengying Y, et al. High intensity interval exercise training in overweight young women[J]. The Journal of sports medicine and physical fitness, 2012, 52(3): 255-262.

[23] Zhang HF, Tong TK, Qiu W, et al. Comparable Effects of High-Intensity Interval Training and Prolonged Continuous Exercise Training on Abdominal Visceral Fat Reduction in Obese Young Women[J].Journal of diabetes research, 2017,2017:5071740. doi:10.1155/2017/5071740.

[24]马喜鹏. 高强度间歇训练对 Obese 大学生减肥效果影响的实证研究[D].曲阜：曲阜师范大学,2020.

[25] 彭小红. 12 周不同运动方式对 Overweight 女大学生干预研究[D].武汉：华中师范大学,2020.

[26] 齐玉刚,黄津虹,谭思洁.HIIT 和持续性有氧运动对 Obese 女大学生减肥效果的比较研究[J].China 体育科技,2013,49(01):30-33.doi:10.16470/j.csst.2013.01.005.

[27] 陈建明,吴大政,苏美华.HIIT 与 MICT 训练对女大学生的减脂效果研究[J].长春大学学报,2021,31(08):32-37.

[28] 张淼. 抗阻训练配合下 HIIT 与有氧运动对 Obese 女大学生减肥效果研究[D].长沙：湖南师范大学,2019.

[29] 张勇,王典,叶卫兵.高强度间歇运动与最大脂肪氧化强度持续运动对普通女大学生身体成分的影响[J].China 运动医学杂志,2018,37(05):384390.doi:10.16038/j.1000-6710.2018.05.004.

[30] 李昭泉.HIIT 对女大学生身体素质影响的实验研究——以天津职业大学为例[D].天津：天津体育学院，2019..

[31] 张旭. 短时间大强度间歇训练对 Obese 青年女性腹部脂肪的影响[D].石家庄：河北师范大学,2016.

[32] 韩涵. 高强度间歇和中强度持续训练对青年 Obese 女性体脂分布的影响[D].石家庄：河北师范大学,2014.

[33]刘洪富,刘忠民,王常敏.高强度间歇训练对 Obese 青年女性减肥效果的研究[J].山东体育学院学报,2016,32(06):95-98.DOI:10.14104/j.cnki.1006-2076.2016.06.017.

[34]郑子威. 不同高强度间歇训练方案对 Obese 青年女性腹部内脏脂肪量的影响[D].石家庄：河北师范大学,2018.

[35]王玲. 高强度间歇训练对 Obese 青年女性血清 FGF21 及糖脂代谢的影响[D].石家庄：河北师范大学,2017.

[36]朱显贵. 高强度间歇训练对 Obese 青年女性血液脂解激素的影响[D].石家庄：河北师范大学,2019.

[37]王京京. 12 周高强度间歇训练对青年 Obese 女性腹部脂肪的影响[D].石家庄：河北师范大学,2013..

[38] 宋旭.高强度间歇训练对中度 Obese 大学生减脂效果的实验研究[D].曲阜：曲阜师范大学,2021.DOI:10.27267/d.cnki.gqfsu.2021.000204.

DOI: 10.57612/JS24.JTS.03.04

Vol.4 Iss.1 / June / 2024
Digital Edition: ISSN 2832-062X
Print Edition: ISSN 2832-0611

[39]曾帅. 中等强度持续和高强度间歇运动对Obese 青年女性心电QTc 及血压影响以及训练适应[D].石家庄：河北师范大学,2014.

[40]Bartlett JD, Close GL, MacLaren DP, Gregson W, Drust B, Morton JP. High-intensity interval running is perceived to be more enjoyable than moderate-intensity continuous exercise: implications for exercise adherence[J]. J Sports Sci. 2011,29(6):547-553. doi: 10.1080/02640414.2010.545427.

[41]张歆然,滕育松,张龙.对高校 Obese 学生开展高强度间隙训练的可行性研究[J].文体用品与科技,2020(10):179-181.

[42]王京京,张海峰.高强度间歇训练运动处方健身效果研究进展[J].China 运动医学杂志,2013,32(03):246254.DOI:10.16038/j.1000-6710.2013.03.007.

[43] Reindell H, Roskamm H. Ein Beitrag zu den physiologischen Grundlagen des Intervall training unter besonderer Berücksichtigung des Kreilaufes[J]. Schweiz Z Sportmed,1959,7:1-8.

[44]田麦久.运动训练学[M].北京：高等教育出版社,2012.

[45]Rentería I, García-Suárez PC, Martínez-Corona DO, Moncada-Jiménez J, Plaisance EP, JiméNez-Maldonado A. Short-term high-Intensity interval training increases systemic brain-derived neurotrophic factor (BDNF) in healthy women[J].European Journal of Sport Science,2020,20(4):516-524.doi:10.1080/17461391.2019.1650120.

[46]童国元,叶礼燕,陈新民,任榕娜,林茂英,杨湘越,薛昭卿.单纯性Obese 儿童血清脑源性神经营养因子表达的变化及意义[J].China实用儿科杂志,2006,(03):197-200.

[47]林坚,赵红勤,黄雄昂,刘晓林,章睿.高强度间歇训练对 Obese 女大学生体成分和血脂及空腹胰岛素水平的影响[J].China全科医学,2016,19(18):2139-2144.

[48]顾新,李京平,陈刚,张延,张铁梅.对 Obese 者静息代谢率的研究[J].China 康复医学杂志,2005,(03):200-202.

[49] Wewege M, van den Berg R, Ward RE, Keech A. 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[J].OBESITY REVIEWS,2017,18(6):635-646. doi:10.1111/obr.12532.

[50] 王京京,韩涵,张海峰.高强度间歇训练对青年 Obese 女性腹部脂肪含量的影响[J].China 运动医学杂,2015,34(01):15-20+30.doi:10.16038/j.1000-6710.2015.01.004.

[51] TÜRK Y, THEEL W, KASTELEYN M J, et al. High intensity training in obesity: a Meta-analysis[J].Obes Sci Pract,2017,3(3):258-271.

[52] Greer BK, Sirithienthad P, Moffatt RJ, Marcello RT, Panton LB. EPOC Comparison Between Isocaloric Bouts of Steady-State Aerobic, Intermittent Aerobic, and Resistance Training[J]. Research Quarterly for Exercise & Sport, 2015,86(2):190-195. doi:10.1080/02701367.2014.999190.

[53]Stephen H. Boutcher.High-Intensity Intermittent Exercise and Fat Loss[J].Journal of Obesity,2010,2011:1-10. doi: 10.1155/2011/868305.

DOI: 10.57612/JS24.JTS.03.04

Vol.4 Iss.1 / June / 2024
Digital Edition: ISSN 2832-062X
Print Edition: ISSN 2832-0611

[54苏利强,陈海春,温岱宗,袁恩,周立分.生命科学新技术在体育科学领域的应用——以 UPLC-QTOF 在 HIIT 减脂研究中的应用为例[J].上海体育学院学报,2020,44(10):3447.DOI:10.16099/j.sus.2020.10.005.

[55] Diogo Henrique Constantino ColedamPhilippe Fanelli FerraiolJúlio Wilson dos-SantosArli Ramos de Oliveira.Factors associated with cardiorespiratory fitness in school students[J].Rev Bras Med Esporte,2016,22(1):21-26.

[56] Jenna L Hollis 1 2, Rachel Sutherland 3 4 5, Amanda J Williams 3 4 5, Elizabeth Campbell 3 4 5, Nicole Nathan 3 4 5, Luke

Wolfenden 3 4 5, Philip J Morgan 6, David R Lubans 6, Karen Gillham 3 4, John Wiggers.A systematic review and meta-analysis of moderate-to-vigorous physical activity lev- els in secondary school physical education lessons[J]. Intern J Behav Nutr Physic Activity,2017,14(1):52. doi: 10.1186/s12966-017-0504-0.

[57] Kong Z, Hu M, Liu Y, et al. Affective and Enjoyment Responses to Short-Term High-Intensity Interval Training with Low-Carbohydrate Diet in Overweight Young Women[J]. Nutrients. 2020,12(2):442. doi:10.3390/nu12020442.

[58] Bartlett JD, Close GL, MacLaren DP, Gregson W, Drust B, Morton JP. High-intensity interval running is perceived to be more enjoyable than moderate-intensity continuous exercise: implications for exercise adherence[J].Journal of Sports Sciences, 2011,29(6):547-553. doi:10.1080/02640414.2010.545427.

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DOI: 10.57612/JS24.JTS.03.04