Original Article

Effects of 12 Weeks of Interval Training on Body Composition in Overweight and Obese Dental Students

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ABSTRACT

Background

The prevalence of overweight and obesity is increasing due to sedentary lifestyles, with dental students particularly at risk due to prolonged sitting during study and clinical practice. This study examined the effects of interval training on body composition in overweight and obese dental students at Universiti Sains Malaysia (USM).

Methodology

Thirty-three participants classified as overweight (BMI 23.0–27.5 kg/m²) or obese (BMI >27.5 kg/m²) were randomly assigned to either the control (n=17) or exercise (n=16) group. Body composition was assessed pre- and post-intervention, with baseline calorie intake recorded through a 24 h diet recall. The 12-week interval training programme was conducted three times per week, progressively increasing in duration every four weeks. Data were analysed to compare changes between and within groups.

Results

No significant differences were observed between the control and exercise groups in BMI (p=0.267), body fat percentage (BFP, p=0.957), lean mass (LM, p=0.746), resting metabolic rate (RMR, p=0.589), or waist-hip ratio (WHR, p=0.631) post-intervention. Similarly, within the exercise group, BMI (p=0.590), BFP (p=0.833), LM (p=0.944), RMR (p=0.584), and WHR (p=0.384) remained unchanged.

Conclusion

The 12-week interval training did not significantly impact body composition parameters, likely due to the moderate exercise intensity, short duration, and lack of dietary control. Future studies should integrate structured dietary monitoring to enhance weight management outcomes.

Keywords

Body composition; overweight; obese; moderate-intensity exercise; tabata exercise.

INTRODUCTION

Overweight and obesity, characterised by excessive fat accumulation that poses significant health risks, have become a global public health concern [1]. According to the World Health Organization (WHO), approximately 1.9 billion adults worldwide are overweight, with 609 million classified as obese [2]. In Malaysia, the situation is particularly alarming, as 30.4 % of adults are categorised as overweight and 19.7 % as obese, collectively affecting nearly half of the adult population [3].

The rising prevalence of obesity places a substantial burden on healthcare systems, contributing to increased medical costs and work absenteeism [1]. Dental professionals are particularly vulnerable due to the sedentary nature of their work, which involves prolonged sitting and low energy expenditure [4]. Additionally, chronic occupational stress particularly in dentistry has been linked to elevated cortisol levels, which may contribute to increased fat accumulation, in the abdominal region, further complicating weight management [5,6].

Obesity is also associated with ectopic fat deposition, which refers to excessive lipid

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accumulation in non-adipose tissues such as the liver, pancreas, and skeletal muscle. This occurs when adipose tissue reaches its storage capacity. Ectopic fat contributes to insulin resistance and significantly increases the risk of developing metabolic syndrome [7–9]. Although metabolic syndrome varies in its definitions, abdominal obesity is a consistent diagnostic criterion [10]. Importantly, adipose tissue distribution (particularly visceral adiposity) plays a more critical role in metabolic health than total body fat. Individuals with comparable body mass index (BMI) may show substantially different cardiometabolic risks depending on their adipose tissue distribution [11,12]. Excessive visceral adipose tissue accumulation has been associated with impaired cardiorespiratory fitness and an increased risk of coronary artery disease [13–15].

While dietary interventions remain fundamental in obesity management, physical activity is essential for reducing body fat and improving metabolic health. Exercise training induces a caloric deficit and enhances mitochondrial function in skeletal muscle, promoting fat loss from ectopic sites such as the liver, heart, and pancreas [16]. However, limited research has compared the long-term effects of combining exercise with dietary interventions versus dietary modifications alone in reducing ectopic fat [17–19].

Among various exercise modalities, interval training has emerged as a highly effective approach to counteract sedentary behaviour and improve body composition [20]. Studies have demonstrated that structured exercise programmes, including resistance training and aerobic exercise, significantly reduce body weight, body mass index (BMI), and fat mass [21–29]. These improvements are often accompanied by enhanced basal metabolic rate, reduced blood pressure, and improved lipid profiles [21–27]. Furthermore, 12-week exercise interventions have been shown to enhance cardiovascular fitness, flexibility, muscular strength, agility, and balance [22,25–27]. The feasibility and adherence rates of both supervised and home-based exercise programmes, such as high-intensity interval training (HIIT) and aerobic-resistance exercise combinations, have also been well-documented [29,30].

Given the sedentary lifestyle challenges faced by dental students, this study aims to assess the impact of a 12-week interval training programme on body composition parameters among overweight and obese dental students at Universiti Sains Malaysia. By evaluating the role of structured exercise interventions in reducing fat mass, particularly ectopic fat, this study seeks to contribute to a more comprehensive approach to obesity management in this population. The overall summary of this study is illustrated in Fig. 1.

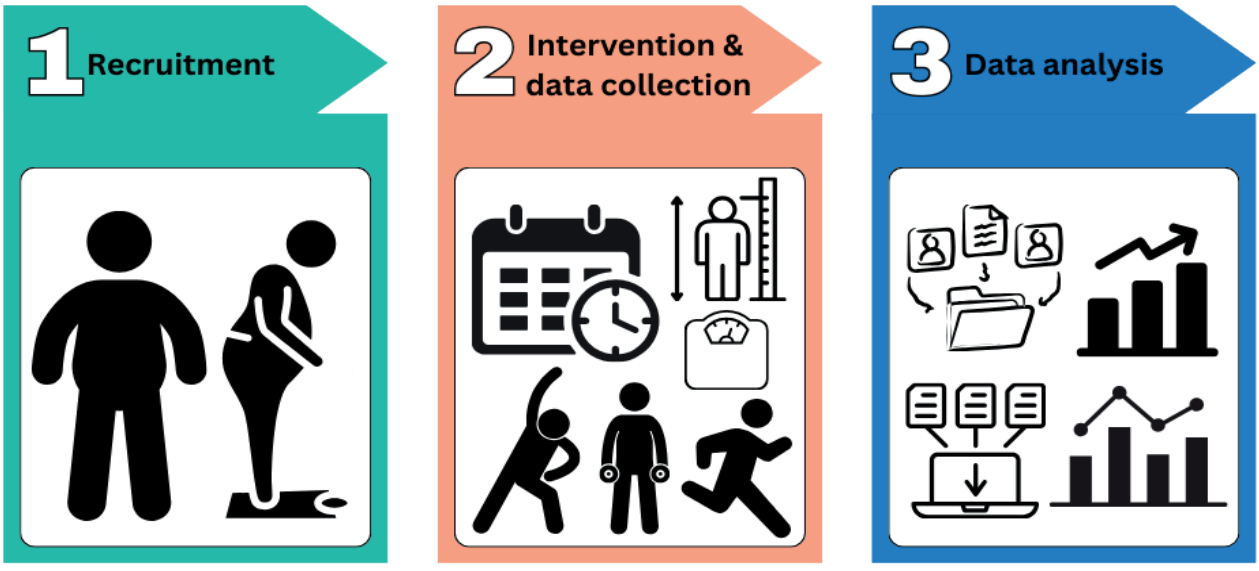

Fig. 1. The overall summary of this study (created using canva.com)

MATERIALS AND METHODS

This study was an interventional, randomised controlled trial with a pre-test and post-test design. The sample size was estimated using G-Power 3.1.9.7, with fat percentage as the dependent variable based on previous study [31].

A total of 36 participants were recruited using an opportunistic sampling approach based on eligibility criteria. Eligibility criteria included being overweight (BMI 23–27.5 kg/m²) or obese (>27.5 kg/m²) based on the Asian Pacific BMI cut-off and having a sedentary lifestyle. Individuals with injuries in the past six months or a recent fever within two weeks were excluded. Participants were randomly assigned to either a control group (C) or an exercise group (E) through block randomisation using a computer-generated randomisation tool (www.randomization.com). The control and exercise groups were matched for age and body weight. Only 33 overweight and obese participants aged 18–30 years completed this study.

The 12-week intervention aimed to evaluate the effects of exercise program on body composition parameters, including body mass index (BMI), body fat percentage (BFP), visceral fat (VF), lean mass (LM), and others, among overweight and obese dental students at Universiti Sains Malaysia. The exercise program progressively increased in duration every four weeks to enhance adaptation and minimise dropout risk while maintaining adherence. This progression aligns with established exercise guidelines for overweight and obese populations, which recommend gradual increases in intensity and duration to optimise fat loss and improve metabolic health while reducing the risk of injury and overexertion. The structured increments were designed to promote continuous physiological adaptation and improve overall exercise tolerance throughout the intervention period [2].

Anthropometric and Body Composition Measurement

Anthropometric and body composition measurements were collected to evaluate changes resulting from the 12-week exercise intervention. These included height, body weight (BW), body mass index (BMI), body fat percentage (BFP), visceral fat (VF), lean mass (LM), and resting metabolic rate (RMR). Measurements were taken using a SECA Measuring Height Scale, Cescorf Anthropometric Body Tape, and a Karada Scan Body Composition Monitor Weighing Scale HBF-214.

Exercise Program

The 12-week exercise program was designed with a gradual increase in duration to accommodate overweight and obese participants unfamiliar with structured training. Conducted three times per week, the program followed the principle of progression [32]. to enhance stamina while minimizing excessive strain. Session durations were systematically extended, reaching 20 minutes by the 8th week (Table 1).

Table 1. 20 min of an interval training session.

Segments	Types of Exercises			
1	Knee drive	Step Back Jacks	Hip Swirls	Lunges
2	Oblique Twist Squat	Windmill	Floor Taps	Reach Through
3	Lateral Taps	Butt Kicks	Squat	Russian Twist
4	Jumping Jacks	Body Rotation	Mountain Climber	Plank

During the first three weeks, participants completed 10-min sessions (segments 1 and 2) to ease them into regular physical activity, reducing the risk of overexertion and injury, particularly for those previously sedentary. From weeks 4 to 7, session duration increased by 5 minutes each week, reaching 15 minutes with the addition of segment 3, allowing for a gradual adaptation to the growing physical demands [33–35]. By weeks 8 to 12, sessions extended to 20 minutes, incorporating all segments to sustain engagement while progressively enhancing fitness levels. This structured approach ensured a steady and manageable progression, helping participants build confidence, improve physical capacity, and foster long-term adherence to exercise [19,22-24]. Each segment included twice the number of exercise repetitions, with participants completing as many repetitions as possible within 20 seconds, followed by a 10-second rest. A one-minute recovery period was provided between segments before starting the next round [25].

The interval training was designed to maintain participants within 60% to 70% of their heart rate reserve (HRR), ensuring suitability for sedentary, overweight, and obese individuals. Exercises progressed from lower to upper body movements to gradually build endurance without excessive strain. The target heart rate zone was determined using the Karvonen formula based on Eq. 1 [36]:

$$THR\ zone = [(MHR - RHR) \times intensity\ (\%)] + RHR$$

Eq.1

THR zone: Target heart rate zone

MHR: Maximum heart rate

RHR: Resting heart rate

Each participant received a heart rate tracker to monitor their heart rate throughout the session. The tracker emitted a beep if their heart rate exceeded or dropped below the target range, ensuring they remained within the intended intensity level.

24-Hour Diet Recall

A single 24-hour diet recall was administered one day prior to the start of the exercise program to determine baseline energy intake. Participants provided information on meal venue, timing, food items, preparation methods, and portion sizes using standard household measures. Dietary data were analysed with Nutritionist Pro software to calculate total calorie intake. The 24-hour diet recall method has shown acceptable convergent validity compared to interviewer-administered protocols [37].

Data analysis

Data was analysed using SPSS version 27.0. Normality was assessed with the Shapiro-Wilk test. Normally distributed data were reported as mean ± standard deviation, while non-normal data were expressed as median ± interquartile range (IQR). Independent and paired t-tests were used for normal data, whereas Mann-Whitney U and Wilcoxon Signed-Rank tests were applied for non-normal data.

Ethical Clearance

This study was reviewed and approved by the Human Research Ethics Committee of USM (JEPeM USM code: USM/JEPeM/19060363). Informed consent was obtained from all participants prior to the 12-week exercise program.

RESULTS

The participants' sociodemographic characteristics, BMI, and total calories intake are presented in Table 2. The study included 33 individuals (8 males, 25 females) with a mean age of 22 ± 1 years. Participants were classified as overweight (BMI: 23.0-27.5 kg/m²) or obese (BMI > 27.5 kg/m²). The overweight group had eight participants in both the control and exercise groups, while the obese group included nine in the control and eight in the exercise group. All participants led sedentary lifestyles, exercising no more than twice weekly.

Table 2. Sociodemographic characteristics and total calorie intake of the participants

Variables	Control group	Exercise group
Age (years old)	22.1 ± 1.2[a]	22.4 ± 1.2[a]
Gender	Male: n=3 (18%), Female: n=14 (82%)	Male: n=5 (31%), Female: n=11 (69%)
BMI classification	Overweight: n=8 (47%), Obese: n=9 (53%)	Overweight: n=8 (50%), Obese: n=8 (50%)
Total Calories Intake	2006.2 ± 935.2 kcal/day	2376.9 ± 669.9 kcal/day

[a]Mean ± SD, BMI=Body Mass Index

The comparison of anthropometric parameters, including WHR and body composition (BW, BMI, BFP, VF, LM, RMR), between control and exercise groups are presented in Table 3. Independent t-tests were used for normally distributed variables (BW, BMI), and Mann-Whitney U tests for non-normally distributed variables (BFP, VF). Changes were assessed over 12 weeks, but no significant differences were found between groups. However, a slight BFP reduction was observed in the exercise group.

Table 3: Comparison of BW, BMI, WHR, BFP, VF, LM and RMR between control group and exercise group among overweight and obese dental students during 12 weeks of intervention

Variables [b]	Control	Exercise	*t*-statistics(df)	*p*-value
	Mean ± SD			
BW (kg)	0.78 ± 1.51	0.23 ± 1.64	-1.006(31)	0.322
BMI (kg/m²)	0.31 ± 0.55	0.81 ± 0.62	-1.130(31)	0.267
WHR	0.01 ± 0.04	0.02 ± 0.08	0.485(31)	0.631
	Median ± IQR		*z*-statistics(df)	*p*-value
BFP (%)	0.1 ± 7.35	-0.1 ± 2.08	-0.054(31)	0.957
VF (kg)	0.0 ± 1.50	0.0 ± 1.00	-0.304(31)	0.761
LM (kg)	-0.1 ± 2.10	0.0 ± 0.88	-0.324(31)	0.746
RMR (kcal)	20.0 ± 40.50	3.5 ± 24.75	-0.541(31)	0.589

[b] The calculation for each variable for control and

exercise groups is based on the difference before and after the 12-week intervention. Significant values are set at $p < 0.05$.

BW=body weight, BMI=body mass index, WHR=waist-and-hip ratio, BFP=body fat percentage, VF=visceral fats, LM=lean mass, RMR=resting metabolic rate

The comparisons for the exercise group using paired t-tests and Wilcoxon signed-rank tests within group are presented in Table 4. No significant changes were found in BMI (p=0.590), BFP (p=0.833), LM (p=0.944), RMR (p=0.584), or WHR (p=0.384) post-intervention. The lack of significant changes suggests that the MIIT program may not have been of sufficient intensity or duration. Studies indicate that greater exercise volume, higher intensity, or resistance training components may be needed for noticeable improvements. Participant adherence and baseline fitness levels may also have influenced results, as untrained individuals often require longer adaptation periods.

Table 4. Comparison of BW, BMI, WHR, BFP, VF, LM and RMR between pre and post intervention within exercise group among overweight and obese dental students during 12 weeks of intervention

Variables	Pre	Post	*t*-statistics(df)	*p*-value
	Mean ± SD			
BW (kg)	73.28 ± 13.11	73.51 ± 12.45	-0.550(15)	0.590
BMI (kg/m^2)	27.76 ± 3.91	27.84 ± 3.53	-0.525(15)	0.607
WHR	0.79 ± 0.09	0.81 ± 0.07	-0.897(15)	0.384
BFP (%)	31.93 ± 6.03	32.06 ± 5.19	-0.215(15)	0.833
RMR (kcal)	1519.88 ± 245.33	1524.06 ± 240.96	0.559(15)	0.584
	Median ± IQR		*z*-statistics(df)	*p*-value
VF (kg)	10.00 ± 6.75	10.00 ± 5.75	-1.387(15)	0.166
LM (kg)	25.80 ± 6.10	25.75 ± 7.68	-0.070(15)	0.944

Significant values are set at $p < 0.05$.

BW=body weight, BMI=body mass index, WHR=waist-and-hip ratio, BFP=body fat percentage, RMR=resting metabolic rate, VF=visceral fats, LM=lean mass, Pre=before intervention, Post=after 12 weeks of intervention

The study's small sample size (n=33) may have limited its ability to detect significant differences. While the power calculation was based on prior research, individual variability in response to exercise may have impacted the results. Future studies should consider larger samples and controlled dietary intake to better evaluate MIIT's effects on body composition.

DISCUSSION

This study examined the impact of a 12-week interval training program on body composition among overweight and obese dental students at USM. While a slight increase in resting metabolic rate (RMR) was observed in the exercise group, no significant changes were found in body composition parameters compared to the control group. This limited effect may be attributed to factors such as the moderate exercise intensity, relatively short intervention duration, and the lack of dietary control.

The relationship between exercise intensity and body composition has been extensively studied, particularly in its ability to enhance lean body mass, reduce fat mass, and decrease body weight. Research has shown that both moderate- and high-intensity exercise can effectively lower body fat and visceral adipose tissue in young, untrained adults, with minimal differences between the two intensities [38,39]. Similarly, studies on obese children and adolescents have demonstrated that exercise, regardless of intensity, significantly improves body composition and reduces fat mass[40]. Additionally, a multidisciplinary approach combining exercise, medical consultation, and nutrition counselling has shown greater reductions in body fat percentage and increases in lean mass. Notably, supplementation with inulin-propionate ester alongside moderate-intensity exercise has also been found to enhance fat oxidation and further reduce body fat [41,42].

Despite evidence supporting the benefits of moderate-intensity exercise, this study did not observe significant improvements in body composition parameters within the exercise group. This suggests that moderate-intensity exercise alone may not be sufficient to induce notable changes in lean mass, body fat, or BMI within 12 weeks [38]. While moderate-intensity training is frequently recommended for overweight and obese individuals, its effectiveness can vary based on exercise duration, intensity, and participant adherence. Furthermore, research indicates that both moderate-intensity

continuous training (MICT) and high-intensity interval training (HIIT) can reduce body fat, though HIIT may yield greater reductions in absolute fat mass and improve cardiorespiratory fitness more effectively [43–51].

The duration and intensity of the exercise intervention may have also influenced the lack of significant findings. The 20-minute interval training, which progressively increased by 5 minutes per week, may not have been sufficient to elicit substantial changes in body composition. Previous studies suggest that sustained moderate-intensity training over at least 12 weeks is necessary to observe meaningful alterations in body composition, particularly in overweight and obese populations [52–54]. Some research has reported that both HIIT and MICT over 12 weeks produced comparable reductions in body fat and weight in obese individuals. However, HIIT is often associated with more significant improvements in VO2 peak and overall cardiorespiratory fitness [43–45].

Participant fitness levels may also influence the intervention's effectiveness. While overweight and obese individuals are encouraged to follow standard exercise guidelines, their adherence and physiological responses may differ due to factors such as orthopaedic issues, pulmonary conditions, and cardiovascular risks[55–57]. Nonetheless, engaging in exercise programs remains crucial in managing obesity and reducing the risk of metabolic diseases, cardiovascular conditions, and inflammation-related disorders [58–60].

The increase in RMR observed in the exercise group suggests potential metabolic benefits of interval training. RMR reflects the energy expenditure at rest, which is essential for maintaining basic physiological functions. This improvement may be linked to resistance exercises incorporated in the training program, such as planks, squats, and floor taps, which utilize body weight as resistance. Previous studies indicate that resistance training over ten weeks can lead to fat mass reduction around 1.8 kg, lean mass gains, and an increase in RMR around 1.4 kg and 7 % respectively [61,62].

Encouraging overweight and obese individuals to adhere to exercise regimens remains a challenge, often due to weight-related stigma and self-exclusion [63]. Low-intensity training may enhance adherence by improving participant satisfaction, yet moderate- to high-intensity exercise is still recommended for achieving weight loss [64]. Future interventions should consider strategies to improve adherence, such as individualized exercise plans and behavioural support programs.

Dietary intake is another critical factor that may have influenced the study outcomes. The 24-hour diet recall method used to estimate caloric intake may not fully reflect participants' usual dietary habits, as it relies on self-reported data from a single day. More accurate assessments require multiple non-consecutive recalls, though this approach demands significant time and resources. Additionally, since diet was not strictly controlled during the study, variations in participants' eating habits could have introduced confounding factors, potentially masking the effects of the exercise intervention.

A limitation of this study is the smaller final sample size resulting from participant dropout. Although the sample size was calculated at 18 participants per group (including an allowance for a 20% dropout rate), three participants withdrew during the study, leaving a total of 33 participants. While the initial calculation ensured adequate power to detect large effects, the reduced sample may have limited the ability to detect smaller or more subtle differences between groups. Future research with larger and more diverse samples should be considered to enhance statistical power and generalisability.

In conclusion, while the 12-week interval training program did not significantly alter body composition parameters, a small increase in RMR suggests potential metabolic benefits. The findings highlight the need for higher-intensity or longer-duration interventions, dietary control, and larger sample sizes in future research to better understand the impact of moderate-intensity exercise on body composition in overweight and obese individuals.

CONCLUSION

Moderate-intensity interval training is a feasible introductory exercise for sedentary overweight and obese individuals, but it may not significantly impact weight loss. Effective weight management requires a comprehensive approach, integrating diet, exercise, and behavioural strategies. Future research should refine exercise protocols and incorporate dietary interventions to enhance outcomes in this population.

Conflict of interest

The authors declare no competing interest.

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Authors contribution

Concept/idea/research design: Nurulezah Hasbullah, Nur Karyatee Kassim, Nur Syamsina Ahmad. Acquisition of data: Nursharlina Sharan, Pui Yee Lee, Nuranis Nabilah Shaperi. Analysis and interpretation of data: Nursharlina Sharan, Nuranis Nabilah Shaperi, Pui Yee Lee. Writing the draft of the manuscript: Nursharlina Sharan. Review/editing of manuscript: Nurulezah Hasbullah, Norhafizah Saari. All the authors approved the final version of the manuscript.

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