ORIGINAL ARTICLE

Time-Restricted Feeding And Brisk Walking in Overweight and Obese Adults

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ABSTRACT

Introduction: Obesity and its associated metabolic consequences such as hypertension, type 2 diabetes mellitus and cardiovascular disease are a global epidemic. Conventional treatment of obesity is daily calorie restriction which many patients find challenging. Time-restricted feeding (TRF) is an emerging alternative although very limited scientific evidence is available. Alternatively, brisk walking (BW) has been shown to reduce mortality risks. The objective of this study was to examine the effects of TRF (16 hour/day of fasting) and investigate the additional effects of BW with TRF (16 hour/day of fasting) in overweight and obesity management. **Methods:** Thirty-six (n=36) overweight and obese participants were enrolled equally into three different groups according to their preferences in this 16-week prospective experimental study; Group A (TRF combined with BW), Group B (TRF alone) and Group C (control group maintaining their lifestyle). Data collection was conducted at the beginning and end of the study for statistical analysis. **Results:** All Group A and Group B participants showed significant reductions in body mass index, waist circumference, hip circumference, waist-to-hip ratio, body fat percentage, visceral fat level, whole body subcutaneous fat percentage, trunk subcutaneous percentage, legs subcutaneous percentage and arms subcutaneous fat percentage as compared to their control counterparts (Group C) (all $p<0.05$). However, no significant differences were observed in all anthropometric measurements of Group A participants compared to Group B counterparts. **Conclusion:** TRF (16 hour/day fasting) can be adopted in weight reduction management of overweight and obese patients. BW for 16 weeks combined with TRF renders no additional effects in overweight and obesity management.

Keywords: Time-restricted feeding (TRF), Obesity, Brisk walking, Overweight

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INTRODUCTION

Obesity and its associated metabolic consequences such as hypertension, type 2 diabetes mellitus and cardiovascular disease are a global epidemic (1-4). Obesity is caused by excessive calorie consumption beyond body energy expenditure (5). Conventional treatment of obesity is daily calorie restriction (CR) but non-compliance to the regime usually becomes an issue to patients (6,7). Intermittent fasting (IF) is an emerging alternative such as alternate-day fasting (ADF) (8-11) and modified fasting (MF) (6, 12-15) but they are not adherable in long term (6,9,11). Another emerging form of intermittent fasting is time-restricted feeding (TRF) of various protocols (16-22) shown to not only improve insulin sensitivity in prediabetic men (18) but reduces body weight in both normal-weight (22) and overweight (17) adults. However, despite of the promising weight-loss effect shown from TRF (17,20-22), very limited scientific evidence is available on TRF (16) and no known study primarily focuses on examining or optimizing TRF (16 hour of fasting per day) as a potential non-pharmacological tool in overweight and obesity management for a duration of at least 16 weeks in overweight and obese adults. To date, this is the first TRF study with the purpose of optimizing TRF and examining its potential as a non-pharmacological therapeutic tool in overweight and obesity management. Brisk walking is a form of exercise that has already been shown to reduce mortality risks in brisk-walkers (23). Although brisk walking is convenient, requires minimal space and no special equipment (24), no known study focuses on the benefits of brisk walking combined with time-restricted feeding in overweight and obesity management in overweight and obese adults. Therefore, this is also the first study with the aim to investigate the possible additional effects 16 weeks of brisk walking combined with 16 weeks of time-restricted feeding in overweight and obesity management of overweight and obese adults as a combination of appropriate physical activity and dieting is conventionally deemed the best approach to maintaining healthy body weight and composition (5).

MATERIALS AND METHODS

Participants

Sample Recruitment

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the International Islamic University of Malaysia (IIUM) Ethics Committee (IREC 2019-171). Written informed consent was obtained from all participants. The participants were recruited through online messaging (mass Whatsapp) or approached by the researcher in public settings such as shopping malls, restaurants and coffee shops in Kuantan, Pahang, Malaysia. All interested participants were screened prior to the study to ensure they met the study criteria given below.

Inclusion and Exclusion Criteria

Participants must be within 20 to 50 years old, Malaysian citizens of Malay ethnicity and body mass index (BMI) of at least 25.0kg/m2 and at most 43.0kg/m2. Participants were excluded if they were involved in another study, non-adherent to the regimen of this study, have medical contraindications for exercise or fasting, renal dysfunction or malignancy or undergoing chemotherapy, pregnant or breastfeeding or undergoing pharmacological or surgical contraceptive regimen.

Sample Size Calculation

In a study conducted examining the effect of brisk walking in young Asian adults (25), the response within each subject group was normally distributed with standard deviation 4. The difference in the experimental and control means is 8. Therefore, after using Power and Sample Size Program, with the alpha level set at 0.05 and power at 90%, this study needs 6 experimental subjects and 6 control subjects to provide a statistical significance. Therefore, each group would be made of 6 male and 6 female participants (25). The subjects were matched according to race, gender, age and body mass index (BMI).

Prospects of Participants Throughout the Study

The 76 participants were initially enrolled into three different groups according to their preferences to ensure their maximal adherence to the regimens in this prospective experimental study; Group A (time-restricted feeding combined with brisk walking), Group B (time-restricted feeding alone) and Group C (control group, maintaining their lifestyle particularly diet and physical activity). Although the participants were non-randomly allocated into their groups being the limitation of the study, adherence of the participants to their regimens is vital to the completion of the study. Participants were most likely to quit or not adhere to regimens assigned to them without their own preferences. Therefore, even though randomization of participants allocated to the groups would be of the ideal scenario from a researcher's perspective, such practice would result in high non-adherence or withdrawal rate among the participants as they were assigned to regimens not of their interest thus this study would not be completed. Hence, a researcher must also consider and acknowledge the personal interest of the participants in order to gain their full cooperation and ensure the completion of the study (26). Seven participants were excluded from the study when they stop adhering to the regime, 28 had no controls to be matched and 5 subjects defaulted visit appointment for some reason. Ultimately, only 36 participants (6 males and 6 females per group) who finished their regiments were called for post-intervention data collection for statistical analysis whereas the remaining participants who were non-adherent, had no control to be matched or defaulted visit appointments were excluded from the statistical analysis.

Protocols

After the participants were screened in accordance to the inclusion and exclusion criteria for the study, they were briefed on the nature of the study and its purpose. A written informed consent was then obtained from the participants who agreed to participate. Participants were then given individually scheduled appointments for data collection. They were requested to fast overnight (minimum 8 hours) before the day of data collection. Height, body weight, body composition, waist and hip circumference were measured and recorded. After a light breakfast, a talk on healthy diet was given by a certified dietitian. Throughout the study (which lasted for 16 weeks), each participant was followed-up fortnightly to monitor and ensure adherence to the protocol. At the end of the study, the participants again fasted overnight and had their height, body weight, anthropometric measurements, waist and hip circumferences measured.

Regimens

Time-restricted Feeding

Time-restricted feeding regimen of 16-hour fasting (encouraged from 6 pm and ends at 10 am the next day) with an 8-hour ad libitum eating window for 5 days per week and ad libitum eating pattern for the remaining 2 days of the week was employed for Group A and Group B only in this study. No calorie intake is allowed in the 16-hour fasting window and only plain water consumption is permissible. Unsweetened coffee or tea is allowed. The participants were technically allowed to eat and drink to their heart's content in the 8-hour eating window.

Brisk walking

One hour of continuous brisk walking for 5 days a week was employed for Group A in this study.

Control condition (Group C)

Control (Group C) subjects in the study maintained their pre-study lifestyle particularly their diet and physical activities throughout the whole study.

Measurements

Height was measured using a stadiometer (Charder). Body mass index (BMI) (18.5-25.0kg/m2) (3), body fat percentage (BFP) (8-19.9% for male, 21-32.9% for female), visceral fat level (0-9), whole body subcutaneous fat percentage (WB.SFP), trunk subcutaneous percentage, legs subcutaneous percentage, arms subcutaneous percentage, relative whole body skeletal muscle percentage (WB.SMP) (33.3-39.3% for male, 24.3-30.3% for female), trunk skeletal muscle percentage, legs skeletal muscle percentage and arms skeletal muscle percentage were measured at the beginning and the end of the study with the participants barefoot and wearing light clothing using OMRON Fat Analyser Scale (OMRON HBF-514) accurate to ±0.1kg (27). Waist (83-92cm for male, 83-88cm for female) and hip circumferences were measured using stretch-resistant measuring tape that provides a constant 100g of tension through the use of a special indicator buckle to reduce differences in tightness (28).

Statistical Analyses

Data for continuous, closely symmetrical variables were analysed using standard descriptive methods to estimate means and standard deviation (SD). Comparisons between means of three groups were made by analysis of variance (One-way ANOVA) in normally distributed data, whereas the Kruskal-Wallis test was used for non-normally distributed data. The comparison between means of two groups was determined using the Independent Sample t-test. As for non-normally distributed data, the Mann-Whitney test was used. The level of statistical significance was set at $p<0.05$. All statistical analyses were performed with the statistical software package for the social sciences, SPSS (version 22, SPSS Inc, Chicago, USA).

RESULTS

Baseline data of participants

At the start of the study, no significant differences were noted among the three groups of participants in terms of baseline age, body weight and anthropometric measurements of participants as shown in Table I.

Data of Participants After 16 Weeks

After 16 weeks of study, all participants from Group A who underwent time-restricted feeding combined with brisk walking showed significant reductions in their body mass index (BMI), waist circumference (WC), hip circumference (HC), waist-to-hip ratio, body fat percentage (BFP), visceral fat level, whole body subcutaneous fat percentage (WB.SFP), trunk subcutaneous percentage, legs subcutaneous percentage and arms subcutaneous percentage compared to their control counterparts (Group C) (all $p<0.05$) (Table II). Furthermore, all Group A participants also experienced significant increases in relative whole-body skeletal muscle percentage (WB.SMP), trunk skeletal muscle percentage, legs skeletal muscle percentage and arms skeletal muscle percentage compared to Group C counterparts (all $p<0.05$) (Table II).

Similarly, all participants from Group B who underwent time-restricted feeding (TRF) alone significantly reduced

Table I: Baseline characteristics of participants

Parameters	Group			p value*
	A (TF +BW) (n=12)	B (TF only) (n=12)	C (control) (n=12)	
Age (years)	29 ± 6	28 ± 6	29 ± 7	0.919
Body mass index (BMI) (kg/m2)	30.1 (2.8)	31.0 (2.3)	30.5 (2.3)	0.684
Waist circumference (cm)	94.7 (16.9)	92.7 (11.2)	92.5 (14.3)	0.834
Hip circumference (cm)	109.7 (5.2)	105.9 (10.7)	107.1 (4.5)	0.480
Waist-to-Hip ratio	0.88 ± 0.08	0.88 ± 0.10	0.87 ± 0.09	0.961
Body fat percentage (%)	35.3 (8.5)	34.5 (11.7)	36.5 (8.6)	0.726
Visceral fat level	12 (6)	14 (6)	13 (6)	0.879
Whole-body subcutaneous fat percentage (%)	30.2 (14.3)	31 (16)	29.9 (14.3)	0.794
Trunk subcutaneous fat percentage (%)	27.6 (11.4)	28.2 (12.7)	27.5 (11.7)	0.716
Legs subcutaneous fat percentage (%)	41.5 (20.3)	43.6 (22.8)	41.8 (20.6)	0.671
Arms subcutaneous fat percentage (%)	42.4 (23.1)	44.4 (24.8)	42.8 (22.6)	0.631
Whole-body skeletal muscle percentage (%)	25.4 (6.8)	25.3 (6.6)	25.0 (6.6)	0.737
Trunk skeletal muscle percentage (%)	17.9 (4.9)	18.4 (6.2)	17.4 (4.6)	0.720
Legs skeletal muscle percentage (%)	40.9 (10.5)	41.1 (10.5)	40.9 (10.6)	0.666
Arms skeletal muscle percentage (%)	27.2 (14.5)	27.7 (15.1)	27.2 (13.9)	0.983

Normally distributed data are expressed in mean ± standard deviation. Non-normally distributed data are expressed as median (interquartile range). *p-value for comparison between the three groups. The cut-off value for statistical significance is $p<0.05$.

Table II: Comparison of net effects following 16-week-duration of time-restricted feeding combined with brisk walking to time-restricted feeding only and in-control subjects on body weight and characteristics of participants

Parameters	Group			p-value*
	A (TF +BW) (*n*=12)	**B (TF only) (*n*=12)**	**C (control) (*n*=12)**	
Body mass index (BMI) (kg/m^2)	-1.9 (1.9)[a]	-2.0 (1.4)[b]	0.5 (0.4)	0.000
Waist circumference (cm)	-7.7 (11.2)[a]	-4.2 (4.4)[b]	1.4 (2.5)	0.000
Hip circumference (cm)	-5.3 (5.3)[a]	-2.7 (3.2)[b]	0.9 (1.3)	0.000
Waist-to-Hip ratio	-0.02 (0.08)[a]	-0.02 (0.04)[b]	0.00 (0.02)	0.000
Body fat percentage (%)	-2.4 ± 1.8[a]	-1.7 ± 1.5[b]	1.0 ± 0.6	0.000
Visceral fat level	-2 (3)[a]	-2 (2)[b]	0 (1)	0.000
Whole body subcutaneous fat percentage (%)	-2.2 ± 1.7[a]	-1.8 ± 1.5[b]	0.6 ± 0.3	0.000
Trunk subcutaneous fat percentage (%)	-1.6 (3.3)[a]	-1.6 (1.7)[b]	0.4 (0.6)	0.000
Legs subcutaneous fat percentage (%)	-2.6 (5.1)[a]	-1.8 (3.4)[b]	1.0 (1.3)	0.000
Arms subcutaneous fat percentage (%)	-2.5 ± 2.1[a]	-2.1 ± 1.9[b]	1.2 ± 0.9	0.000
Whole body skeletal muscle percentage (%)	0.8 (1.2)[a]	0.6 (0.8)[b]	-0.4 (0.4)	0.000
Trunk skeletal muscle percentage (%)	1.2 ± 1.1[a]	1.0 ± 0.8[b]	-0.5 ± 0.3	0.000
Legs skeletal muscle percentage (%)	0.7 (1.2)[a]	0.6 (1.1)[b]	-0.5 (0.3)	0.000
Arms skeletal muscle percentage (%)	1.6 (1.7)[a]	0.8 (1.7)[b]	-0.3 (0.5)	0.000

The differences in the baseline and post-study parameter are used in analysis. Negative integer indicates loss whereas positive integer indicates gain. Normally distributed data are expressed in mean ± standard deviation. Not-normally distributed data are expressed as median (interquartile range). *p-value for comparison between the three groups. The cut-off value for statistical significance is p<0.05. . [a]statistical significance between Group A compared to Group C. [b]statistical significance between Group B compared to Group C

their BMI, WC, HC, waist-to-hip ratio, BFP, visceral fat level, WB.SFP, trunk subcutaneous percentage, legs subcutaneous percentage and arms subcutaneous percentage compared to their control counterparts (Group C) (all p<0.05) (Table II). Moreover, all Group B participants who underwent time-restricted feeding alone also showed significant increases in their relative WB.SMP, trunk skeletal muscle percentage, legs skeletal muscle percentage and arms skeletal muscle percentage compared to Group C counterparts (all p<0.05) (Table II).

However, no statistical difference was noted between all Group A and Group B participants when comparing the reductions in the BMI, WC, HC, waist-to-hip ratio, BFP, visceral fat level, WB.SFP, trunk subcutaneous fat percentage, legs subcutaneous fat percentage and arms subcutaneous fat percentage (Table II). Furthermore, no statistical difference was observed between all Group A and Group B participants when comparing the increases in relative WB.SMP, trunk skeletal muscle percentage, legs skeletal muscle percentage and arms skeletal muscle percentage (Table II).

DISCUSSION

One of the main purposes of this study is to investigate the effect of time-restricted feeding (TRF) on body weight in overweight and obese subjects. This study had shown that all participants who underwent TRF alone (Group B) significantly reduced all of their body weight, characteristics and body fat compositions parameters compared to their control counterparts (Group C) after 16 weeks of intervention. These findings signify the weight-reducing and the anti-obesity property of time-restricted feeding in overweight and obese adults. Significant reductions in BMI, WC, HC and waist-to-hip ratio of Group B participants showed significant reductions in their body fat compositions and mass compared to control counterparts which further suggests that the loss mass was contributed by their stored fat. Similarly, other TRF studies also suggest that TRF poses weight-reducing and anti-obesity effects by reporting lowered body weight (-0.4 ± 1.1kg) (21) (-1.4kg) (22) and body fat mass (-2.1kg) (22) in TRF subjects compared to controls (21,22). Significant decrease in body weight (-0.2 ± 0.1kg) was also reported from 4 days of TRF compared to controls which were possibly due to glycogen depletion (17). In the absence of food consumption, TRF acts by "flipping" the metabolic switch of body's preferential source of energy by promoting the utilisation of hepatic glycogen storage until they are depleted and on to lipolysis in adipose tissue to produce free fatty acids (FFAs) and glycerol (29,30). In doing so, TRF shifts the body's preference of energy source from glycogenolysis-derived glucose to FFAs and fatty acid-derived ketones (29,31), although ketone bodies concentrations were not measured in this study. This is the reason why many experts have suggested that intermittent-fasting regimens have the potential in managing obesity (29,32).

Similarly, all participants who underwent TRF combined with brisk walking (TRF + BW) (Group A) showed significant reductions in all of their body weight, characteristics and body fat compositions parameters compared to the controls. This finding substantiates the weight-losing and anti-obesity properties of TRF + BW. However, there was no statistical difference comparing the reductions in all of the body weight, characteristics and body fat compositions parameters of Group B to

Group A participants for both genders, suggesting that brisk walking has no statistical impact on body weight and body fat losses. Mixed findings were reported from other TRF studies as significant decrease in fat mass (-16.4%) (20) was observed in TRF combined with resistance training group in one study but no significant changes were observed in body weight or total body composition (body fat) of either TRF combined with resistance training group (RT-TRF) or normal diet combined with resistance training (RT-ND) group in another study (16). However, promising results were also seen from modified fasting (MF) studies as significant body weight (13,33), waist circumference (13) and fat mass (13,33) reductions were reported from group of MF combined with exercise. However, no significant difference was observed in body weight and fat mass reductions of MF combined with exercise group compared to the MF-alone group (33). Such findings further emphasized the fact that physical muscular activity only accounts to 30% of body energy expenditure whereas basal metabolism accounts for the majority 60% and assimilation of food accounts 10% in an average person (5). In order to put such statistics into context, a mere slice of bread containing 75 kcal requires a person to brisk walk (225 kcal/h) for 20 minutes to completely burn off the said 75kcal (5). Furthermore, obesity occurs as a result of consuming excessive food more than is required by the body's energy demand (5). Moreover, a wide range of error in estimation of calories during exercise and in a meal had been reported to occur among adults (34). Therefore, it is most likely that in comparison to participants who underwent intermittent fasting alone, those who underwent intermittent-fasting combined with exercise in general might have been more lenient or less disciplined in the amount of calories they consumed due to their misassumption of burning more calories during exercise. This may be the possible explanation for certain TRF study (16,33) where intermittent fasting combined with exercise did not lead to weight-losing and anti-obesity properties. This also explains why this present study found no statistical difference in the body weight and body fat parameters reductions of intermittent fasting combined with exercise group compared to intermittent fasting alone group.

Due to the significant reductions observed in the body weight, characteristics and body fat compositions parameters, all Group B participants who underwent time-restricted feeding alone also showed significant increment in all their relative skeletal muscle percentage compared to the control group. However, such finding does not indicate actual increment of skeletal muscle mass but rather resulted from body composition improvements that occur from body fat parameter reductions. Although body skeletal muscle masses were not weighed in the study, skeletal muscle mass preservation most likely occurred during the study instead of skeletal muscle loss as the "flip" of metabolic switch/shift of body energy source preference from glucose to adipose tissue lipolysis-derived FFA and ketones during intermittent fasting preserves body's muscle mass from being further catabolised to feed amino acids into body's gluconeogenesis pathways (29). Despite the limited available scientific evidence, other TRF studies (19,22) seem to suggest similar notion by reporting that no significant difference was seen in fat-free mass and between the TRF group compared to the control condition. Scientific evidence from modified fasting (MF) regimens also support such explanation as no significant change was observed in fat-free mass (FFM) (13-15), skeletal muscle mass (33) and lean mass (35) of MF participants. Nevertheless, TRF or intermittent fasting in general cannot be conclusively regarded as a skeletal muscle preserving weight-losing regimen due to the limited pool of currently available scientific evidences.

TRF combined with brisk walking may also render skeletal muscle preservation as well as all Group A participants experienced significant increment in all the relative skeletal muscle percentages compared to Group C counterparts. TRF studies seem to suggest a similar notion by reporting no significant change occurred in lean soft tissue (16) and observed fat-free mass retention (20) in TRF combined with exercise participants. Mixed findings were shown from MF studies as retention of fat-free mass (FFM) (13) was reported from one MF study but significant skeletal muscle reduction (-0.5 ± 0.3kg) (33) was reported in another MF study in MF combined with exercise group participants. Therefore, TRF combined with brisk walking or intermittent fasting combined with exercise in general cannot be conclusively regarded as a skeletal muscle preserving weight-losing regimen due to the limited pool of available scientific evidences and contrasting findings.

Furthermore, no significant increment is seen in all of the relative skeletal muscle percentages of all Group B and Group A participants. This finding may indicate that 16 weeks of brisk walking may not be enough to statistically change skeletal muscle mass in participants although skeletal muscle mass was not directly measured in the study. Similar findings are shown from MF studies as no significant difference was observed in fat free mass (FFM) (13) and skeletal muscle mass (33) of MF combined with exercise group compared to the MF alone group. However, recent evidence has suggested that long-term aerobic exercise preserves skeletal muscle mass and function with increasing age (36).

To date, this is the first TRF study conducted on overweight and obese adults in examining the potential therapeutic weight-losing and anti-obesity nature of TRF in overweight and obesity management. This study thus further adds to the limited body of scientific evidence on TRF (16).

The strengths of this study includes that this is the first TRF study that was conducted in a Southeast Asian population specifically the Malay demographic which will be benefitial for future consideration of any TRF prescription in overweight and obesity management in Malaysian clinical settings. Furthermore, this is the longest conducted TRF study in human by far which is 16 weeks as most previous studies conducted within at most 8 weeks (16,20). Meanwhile, limitations of this study include the relatively small sample size although it was adequate for statistical purposes. Nevertheless, larger sample size is required for future studies before any clinical prescription of TRF can be considered in overweight and obese management in Malaysian clinical settings. Moreover, the lack of documentation on the food consumed by the participants throughout the study is also a limitation that should be considered and addressed in future studies as well.

CONCLUSION

Time-restricted feeding of 16-hour fasting per day can be utilised as a non-pharmacological therapeutic tool in overweight and obesity management in adults due to its weight-losing and anti-obesity effects. Additionally, 16 weeks of brisk walking combined with time-restricted feeding renders no additional weight-losing or anti-obesity effects. Future studies are recommended to explore the effect of continuous brisk walking combined with time-restricted feeding for a longer duration.

ACKNOWLEDGEMENTS

We would like to thank dieticians from International Islamic University Malaysia (IIUM) for assisting this study.

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