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Mindful eating for weight loss in women with obesity: a randomised controlled trial

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Abstract

Mindful eating (ME) has been linked to improvement in binge eating disorder, but this approach in obesity management has shown conflicting results. Our aim was to assess the effect of ME associated with moderate energy restriction (MER) on weight loss in women with obesity. Metabolic parameters, dietary assessment, eating behaviour, depression, anxiety and stress were also evaluated. A total of 138 women with obesity were randomly assigned to three intervention groups: ME associated with MER (ME + MER), MER and ME, and they were followed up monthly for 6 months. ME + MER joined seven monthly mindfulness-based intervention group sessions each lasting 90 min and received an individualised food plan with MER (deficit of 2092 kJ/d - 500 kcal/d). MER received an individualised food plan with MER (deficit of 2092 kJ/d - 500 kcal/d), and ME joined seven monthly mindfulness-based intervention group sessions each lasting 90 min. Seventy patients completed the intervention. Weight loss was significant, but no statistically significant difference was found between the groups. There was a greater reduction in uncontrolled eating in the ME group than in the MER group and a greater reduction in emotional eating in the ME group than in both the MER and the ME + MER groups. No statistically significant differences were found in the other variables evaluated between groups. The association between ME with energy restriction did not promote greater weight loss than ME or MER.

Key words: **Obesity: Weight loss: Diet: Mindfulness: Feeding behaviour: Depression: Anxiety: Stress: Psychological**

Obesity is a chronic disease that results from the interaction of genes, environment, behaviour, culture and socio-economic factors,[1] and it is associated with a wide range of health problems, such as CVD, diabetes and some cancers[2]. Mental health is also a concern in individuals with obesity, with studies reporting high rates of depression[3,4], stress[5] and anxiety[6] among this population. Both physical, metabolic and mental comorbidities determine the reduction in quality of life and life expectancy[2]. The multifactorial aetiology of obesity renders its treatment complex.

In the last years, anti-diet movements have emerged that advocate that obesity is not a disease and that individuals with overweight should not adhere to hypoenergetic diets[7,8], and that they should eat based on hunger, satiety, nutritional needs and pleasure[8]. In this sense, the mindfulness-based eating awareness training (MB-EAT) programme brings awareness of the physical sensations of hunger and satiety, and through practice, aims that the individual achieves hedonic pleasure with small amounts of food and remains cognizant of the triggers that lead to eating and making food-related choices, while being aware of their emotions and seeking to find healthy ways to manage these emotions[9]. MB-EAT was originally developed for the treatment of binge eating disorder[8]; however, other factors beyond the benefits for binge eating have begun being studied in recent decades such as the impact of mindful eating (ME) on reduced energy intake; reduction of automatic or emotional eating; weight loss; reduction in symptoms of depression, anxiety and stress and improvement of biochemical parameters[10–16]; yet, the designs and outcomes of studies that analyse the mindfulness-based interventions have remained quite heterogeneous to date, with some including nutritional guidance or an eating

Abbreviations: MB-EAT, mindfulness-based eating awareness training; MER, moderate energy restriction; ME, mindful eating.

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plan aimed at weight loss[11–13], while others aim at controlling binge eating without necessarily promoting weight loss[14,17–21].

The guidelines for the treatment of obesity recommend an energy-restricted diet with an energy deficit of 2092 kJ/d (500 kcal/d) or 3138 kJ/d (750 kcal/d) according to individual energy requirements to promote a negative energy balance and, consequently, weight loss[22,23]. However, appetite regulation is impaired in individuals with obesity, with hyperactivation of the reward system and a weakening in executive functions[24,25]; therefore, the perception of signs of hunger and satiety may also be altered. This population may also engage in maladaptive eating behaviours, such as binge eating[26], rigid cognitive restraint and uncontrolled and emotional eating[27,28]. Thus, simply instructing the patient with obesity to perceive their body signals may not be an appropriate strategy. Although ME has been developed to cultivate attention and food awareness, in addition to increasing the perception of the senses (sight, taste, smell, touch, hearing) and of sensations (hunger, satiety) related to the act of eating, we hypothesise that adding a more structured nutritional guidance via an energy-restricted diet to ME should improve weight loss in women with obesity. Furthermore, a MB-EAT programme with monthly visits would be more convenient to the participants, which may improve adherence to the programme.

Therefore, the aim of the study was to assess the effect of ME associated with energy restriction on weight loss in women with obesity and also on cardiometabolic parameters, food intake, eating behaviours, symptoms of depression, anxiety and stress.

Subjects and methods

Participants and procedures

This study was approved by the ethics committee of the institution (Comitê de Ética em Pesquisa – CEP; CAEE: 81114217·2·0000·0068) and was conducted according to the guidelines set forth in the Helsinki Declaration. The trial is registered with the ensaiosclinicos.gov.br/ identifier RBR-22p3nn2, UTN: U1111–1207–7666 (https://ensaiosclinicos.gov.br/rg/RBR-22p3nn2). The registration process began during the intervention and was completed after the end of the study. Informed consent was obtained from all participants for inclusion in the study. The study was performed from March, 2018, to August, 2019, at the outpatient clinic of Hospital das Clinicas, Sao Paulo University. The MB-EAT programme[9] was adapted to the conditions of the service (Sistema Único de Saúde - SUS), for which weekly monitoring would be impractical, considering the limitations of health services (availability of professionals, attendance rooms and time) and patients (availability of time, travel costs, absenteeism). Thus, the MB-EAT occurred during monthly visits. After screening, patients were enrolled and assigned randomly in a 1:1:1 ratio to three groups: ME + MER, MER and ME. Each group had a specified day of attendance that did not coincide with the other groups. This model was adopted to maintain the groups separated to avoid the exchange of intervention-related information between participants in the waiting room, which could corrupt the validity of the resultant data. To perform the sample size calculation, weight loss was considered the main outcome. One-way ANOVA was used with an effect size of 0·365, a significance level of 5 % and test power of 95 %. The effect size was estimated based on the literature related to weight loss programmes, in which the variance explained by the effect was 0·065 and the variance between groups was 0·5. Using the G × Power 3·1·97 software and the parameters listed above, the sample was calculated at thirty-two individuals per group[29]. Considering that dropout is common in this type of intervention, we recruited 40 % more individuals.

The eligibility criteria comprised women with a BMI of 30·0–39·9 kg/m^2 and aged 18–50 years. The exclusion criteria comprised pregnancy, breastfeeding, menopause, illiteracy, cognitive deficit, non-adherence to the study protocol, bariatric surgery, current participation in a weight loss programme, endocrine disease or genetic syndromes that cause obesity, cardiac, renal or hepatic failure, use of medications that may affect weight, drug addiction and active psychiatric disorder.

Study design

MER subjects were attended by a registered dietitian and received an individualised food plan with MER (deficit of 2092 kJ/d - 500 kcal/d), balanced in macro and micronutrients, according to the routine, schedules, preferences and aversions of individual participants. Total energy expenditure was calculated by multiplying the resting metabolic rate obtained through indirect calorimetry by the physical activity level[30]. Women in this group also received orientations to modify eating behaviours throughout meals, such as eating while seated at the table, removing dishes from the table, eating food slowly, resting the cutlery while eating and eating without distractions (e.g. television, computer, smartphone), which is part of standard weight loss programmes.

ME group participants joined seven mindfulness-based intervention group sessions lasting 90 min once per month, when MB-EAT[9] and exercises from the workbook *Eat, Drink and Be Mindful*[31] were applied. The original 10-week programme protocol was adapted for seven monthly sessions. The content of each group session can be found in the Supplementary Information. During the sessions, participants were trained in mindfulness and ME exercises.

ME + MER individuals took part in seven mindfulness-based intervention group sessions lasting 90 min once per month and also received an individualised hypoenergetic food plan and orientations to modify eating behaviours, identical to MER subjects.

Each ME session was conducted by the main registered dietitian (RB) and addressed topics such as awareness, being in the moment, non-judgement and acceptance along with mindfulness practice (e.g. mindfulness of the breath, ME exercises). Besides this, all patients in the ME and ME + MER groups received audio recordings of the exercises through smartphone message or email for daily at-home practice.

All groups received guidance on healthy eating via the food pyramid adapted to the Brazilian population[32], as well as healthy recipes to support changes in eating habits. The follow-up frequency was monthly, and contact was also made via smartphone message, email or telephone every 15 days to

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help maximise adherence to treatment between visits. Patients were encouraged to engage at least 150 min of physical activity per week.

Measurements

Height, weight, BMI and waist circumference were measured. Body fat percentage was measured using bioelectrical impedance analysis (InBody 720 - Biospace Co. Ltd). Resting metabolic rate was assessed through indirect calorimetry (Analyzer Assembly Vmax Encore 29 - Viasys Respiratory Care Inc.). All of these measurements were performed at baseline and at the end of the study (6 months).

Weekly physical activity energy expenditure was determined using metabolic equivalents of task using the equation: kcal = metabolic equivalents of task × weight (kg) × duration (h)[33]. Participants in the ME and ME + MER groups were asked at each visit to report the daily time spent on ME exercises.

Dietary intake was evaluated through a 3-day food registry[34], which was delivered on every visit. We compared the records of the last visit with those of the first and used the Avanutri® software version 3.0 (2019) to perform the analysis. All foods were registered in the programme, applying as reference the Brazilian Table of Food Composition; when the food was not listed, the USDA table was used.

Patients were evaluated regarding clinical and metabolic parameters at the beginning and end of the intervention.

Eating behaviour was assessed using the Binge Eating Scale[35] and the Three-Factor Eating Questionnaire-R21[32]. Depression, anxiety and stress symptoms were assessed using the Depression, Anxiety and Stress Scale[36]. Mindfulness was assessed using the Mindful Attention Awareness Scale[37,38]. Each of these questionnaires was self-administered at baseline and at the end of the study.

Statistical analysis

Categorial variables are presented in absolute and relative frequencies and the difference between groups was assessed using the Chi-square test. The comparisons between groups using ANOVA for the variables with parametric distribution, with the Bonferroni *post hoc* test. The differences between variables with non-parametric distribution were assessed using the Kruskal–Wallis test.

Comparison of weight loss between groups was performed using the intention-to-treat analysis, with missing data being dealt with using the last observation carried forward method) and per protocol analysis. This analysis was performed using two-way, non-parametric ANOVA. The software R version 3.6.0 and SPSS version 17.0 were used to perform the analyses. For all analyses, a difference of $P < 0{\cdot}05$ was considered statistically significant.

Results

Participants characteristics

Three hundred and ten women responded to the advertisement of this trial. Of those, 138 met the inclusion criteria for the study and were randomly assigned to one of three intervention groups: (MER) (n 49), (ME) (n 46) or (ME + MER) (n 43) (Fig. 1).

Baseline socio-demographic and anthropometric characteristics of the patients are shown in Table 1 and did not differ significantly, except for the weight between MER and ME groups, as well as the waist circumference between the ME and ME + MER groups (Table 1).

Anthropometric and cardiometabolic outcomes

There was significant weight loss among the three groups (ME + MER, $P = 0{\cdot}006$; ME, $P = 0{\cdot}026$; MER, $P = 0{\cdot}001$), without difference between groups (Table 2), and the intention-to-treat analysis ($P = 0{\cdot}749$) and per protocol analysis ($P = 0{\cdot}833$) also did not reveal statistically significant differences in the percentage of weight loss between groups (Fig. 2). Reduction in waist circumference, fat mass and body fat percentage were also similar between the three groups (Table 2).

At the end of study, 13 (41·9 %) MER participants, 4 (21·1 %) ME participants and 4 (20 %) ME + MER participants lost ≥ 5 % of their initial weight. Four (12·9 %) MER participants, 1 (5·2 %) ME participant and 1 (5·0 %) ME + MER participant lost ≥ 10 % of their initial weight. The weight reduction ≥ 5 % and ≥ 10 % of participants was similar between groups ($P > 0{\cdot}05$).

Clinical and laboratory analyses indicated that the mean blood pressure, heart rate, blood glucose, insulin, homeostatic model assessment for insulin resistance, total cholesterol and fractions and hepatic enzymes were within the normal range at both the beginning and end of treatment and remained similar across the three groups, except for total cholesterol, which was higher at the end of the study in ME group than in ME + MER group ($P = 0{\cdot}042$; Table 3).

Dietary intake, eating behaviour and psychosocial assessment

At the onset of the study, dietary intake was similar between the three groups, except for the consumption of polyunsaturated fats, which was higher in the ME group (7·3 % ± 2·0 %) compared to the ME + MER group (6·1 % ± 2·0 %) ($P = 0{\cdot}031$). At the end of the study, the energy and nutrient intake were similar between groups.

Screening for binge eating was positive in 61 (44·5 %) patients at the beginning of the study and in 10 patients (14·9 %) at the end of the follow-up. Reductions in the mean Binge Eating Scale are presented in Table 4.

At the beginning of the intervention, patients had a similar mean score related to uncontrolled eating, emotional eating and cognitive restraint on the Three Factor Eating Questionnaire-R21. Variations observed at the end of the study in the three groups are shown in Table 4.

The frequency of depression, anxiety and stress was high in all groups at the beginning of the intervention. At the end of the study, improvement in these variables was observed in the MER and ME groups, but these were not statistically significant between groups (Table 5).

When evaluating the mindfulness practice comparing patients in tertiles of meditation time, there was no difference regarding weight loss (ME, $P = 0{\cdot}108$; ME + MER, $P = 0{\cdot}262$),

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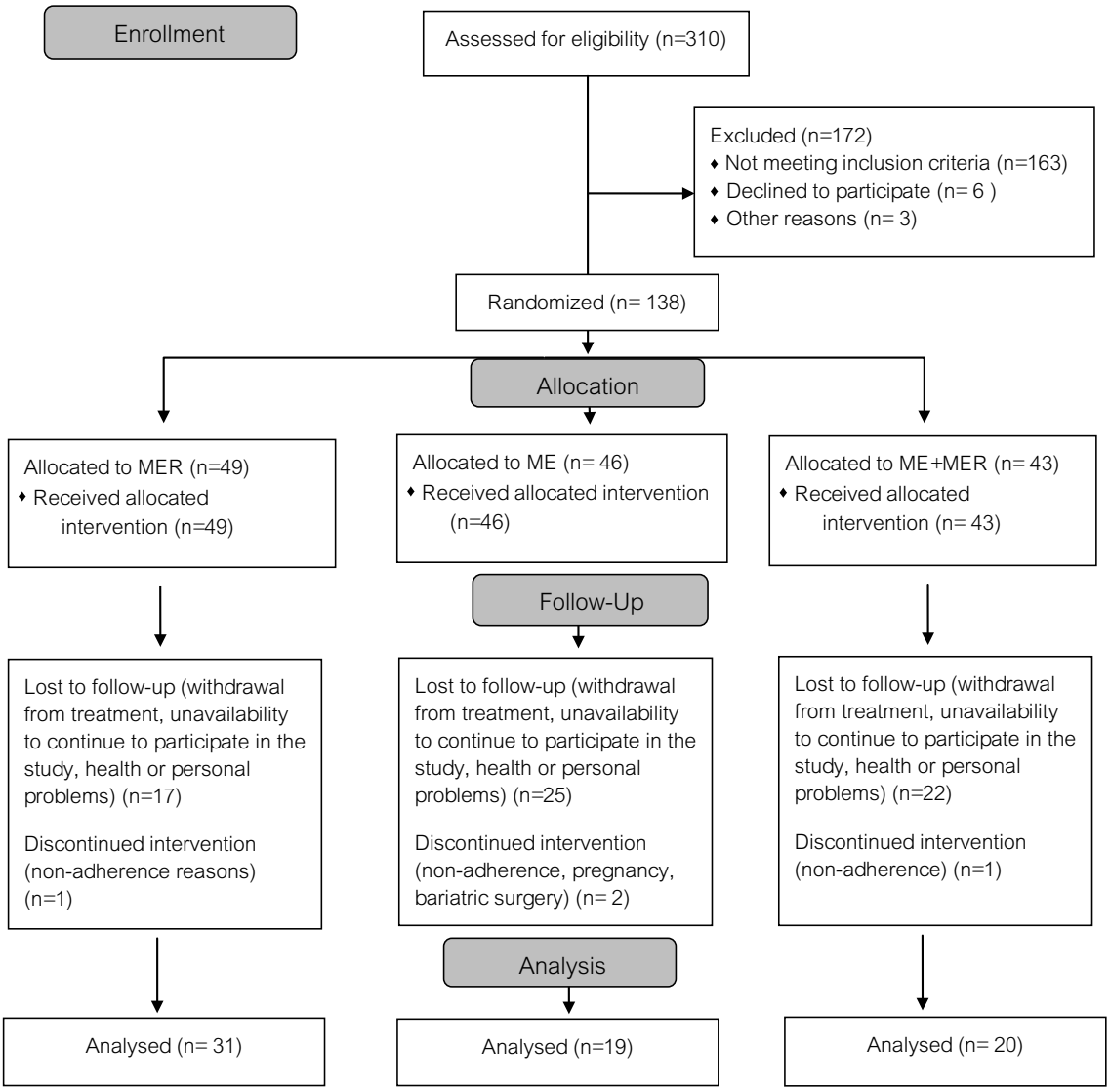

Fig. 1. Participants' disposition in the study.

uncontrolled eating (ME, $P = 0{\cdot}114$; ME + MER, $P = 0{\cdot}266$), emotional eating (ME, $P = 0{\cdot}207$; ME + MER, $P = 0{\cdot}052$) and cognitive restraint (ME, $P = 0{,}473$; ME + MER, $P = 0{\cdot}518$).

At the end of the intervention, there was an increase in the level of mindfulness in the ME group relative to baseline ($3{\cdot}3 \pm 0{\cdot}8$, $4{\cdot}1 \pm 0{\cdot}6$, $P < 0{\cdot}001$). Applied only at the end of the study in MER ($4{\cdot}2 \pm 0{\cdot}9$) and ME + MER ($4{\cdot}3 \pm 0{\cdot}8$), the mean Mindful Attention Awareness Scale score did not differ between the two groups ($P = 0{\cdot}673$).

Attrition

The attrition rate observed was higher than expected. Eighteen (36·7 %) participants in the MER group, 27 (58·7 %) in the ME group and 23 (53·5 %) in the ME + MER group dropped out of the intervention. There was a statistical difference between the MER and ME groups ($P = 0{\cdot}030$).

The reasons for dropping out of the study were withdrawal from treatment (36, 52·9 %), unavailability to continue to participate in the study (16, 23·5 %), health problems (6, 8·8 %), personal problems (5, 7·4 %), non-adherence (3, 4·4 %), opting for bariatric surgery (1, 1·5 %) and becoming pregnant during the study (1, 1·5 %).

Discussion

Unlike other studies evaluating mindfulness-based interventions *v.* standard weight loss programmes or no treatment, the present study compared three types of monthly approaches to weight loss in women with obesity: energy restriction, ME and association of ME with energy restriction in women with obesity. Patients in all groups had significant weight loss, an outcome that corroborates those of previous studies on energy restriction or ME[11,13,18,39]. Furthermore, it is possible that the ME group, simply by being more vigilant and more careful about food choices, achieved greater control in food intake, thereby accounting for the observed weight loss.

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Table 1. Baseline socio-demographic and anthropometric characteristics

Variable/Group	MER (*n* 49)				ME (*n* 46)				ME + MER (*n* 43)				*P*
	Mean	%	SD	CI(%)	Mean	%	SD	CI(%)	Mean	%	SD	CI(%)	
Age (years)	36·6		6·8	34·65, 38·58	37·0	7·2	7·2	34·88, 39·16	36·4		7·7	33·98, 38·72	0·907
Ethnic origin													0·579
Caucasian	28	57·1 %			23	50·0 %			20	46·5 %			
Non-caucasian	21	42·9 %			23	50·0 %			23	53·5 %			
Weight (kg)	87·3		9·2	84·62, 89·91	92·4		9·1	89·68, 95·08	88·6		7·3	86·38, 90·9	0·014*
Height (m)	1·61		0·07	1·59, 1·63	1·63		0·06	1·61, 1·65	1·63		0·05	1·62–1·64	0·181
BMI (kg/m^2)													
Median	32·5			32·94, 34·42	34·4			33·92, 35·56	33·4			32·73, 34·31	0·091
IQR	31·4–35·9				32·4–37·5				31·5–35·6				
WC (cm)	101·8		5·7	100·13, 103·34	104·4		8·6	101·82, 106·9	100·1		7·5	97·74, 102·37	0·022†
SMM (kg)	26·2		3·2	25·3, 21·14	27·6		3·2	26·69, 28·6	26·7		2·9	25·8, 27·58	0·081
FM (kg)	39·6		5·9	37·95, 41·34	42·4		6·9	40·44, 44·36	40·4		6·6	38·38, 42·45	0·100
BFP (%)	45·4		3·8	44·31, 46·52	45·8		4·6	44·51, 47·22	45·4		4·9	43·91, 46·96	0·888
MET (kJ/week)	7541·2		4396·6	6278·5, 8804·0	9780·1		5074·4	8273·0, 11287·2	5214·9		2590·3	4417·9, 6012·0	0·782
TEE (kJ/day)	7746·7		1264·4	7383·5, 8109·8	7752·1		1232·2	7386·0, 8118·2	7512·0		970·7	7213·2, 7810·7	0·357

IQR, interquartile range; MER, moderate energy restriction; ME, mindful eating; WC, waist circumference; SMM, skeletal muscle mass; FM, fat mass; BFP, body fat percentage; MET, metabolic equivalents of task; TEE, total energy expenditure.
* *P* = 0·014 between MER and ME.
† *P* = 0·019 between ME and ME + MER.

The average percentage of weight loss observed in the three groups was similar between groups in the two applied statistical methods (intention-to-treat and per protocol). The similar results of the two analyses validate the observed outcomes. It is well documented in the literature that no one diet suits everyone ideally[40] and, in less intensive approaches, patients show individualised responses.

Although the weight loss was significant in the three groups, the weight loss observed in our study is smaller than in other studies based on the lifestyle changes approach already reported. A meta-analysis showed that, after 6 months of follow-up with conventional diet programmes, the mean loss is 5 % of the initial weight[41].

Studies that evaluate intervention intensity between healthcare professionals and patients show that more frequent contact promotes greater weight loss[42]. A study that compared behavioural treatment with 16 (low intensity), 32 (moderate intensity) and 48 (high intensity) sessions over 2 years found that a moderate intensity intervention produced weight losses similar to the high-intensity intervention and significantly greater than the low-intensity intervention and control[43]. Therefore, it is possible that a shorter interval between visits is more important for weight loss than the approach itself.

Published findings on the effect of ME on weight loss are conflicting[16,44,45]. Systematic reviews indicate a significant weight loss with mindfulness-based interventions mainly when weight loss is the primary outcome[46], and when the mindfulness-based interventions are compared with a control group without diet intervention[47].

At the beginning and end of the present intervention, the average of the metabolic parameters was within normal limits. This fact is probably due to the relatively young sample, whose mean age is 36·7 ± 7·2 years. In fact, in other large studies, such as The Multi-Ethnic Study of Atherosclerosis[48] and The Atherosclerosis Risk in Communities[49], in addition to some meta-analyses, it was observed that individuals with obesity (either metabolically healthy or not) are at increased risk of cardiovascular events during the follow-up period[50,51]. Although no significant difference in weight loss was observed between groups, improvement in metabolic parameters was more pronounced in the control group. It is not possible to state because the analysis of food intake was similar between the three groups, but it is possible that a more structured nutritional guidance expands the patient's knowledge, allowing him or her to make healthier choices, which could explain the better metabolic evolution of the control group.

Reduction in binge eating was observed in all study groups, with no advantage being noticed with ME, nor worsening with energy restriction. In most studies that evaluated mindfulness-based interventions, a reduction in the frequency and intensity of binge eating was observed[17–19]. Improvement or remission of binges is observed with other weight loss strategies, such as intensive lifestyle changes[52], pharmacological treatment associated with lifestyle changes[53,54], as well as in individuals undergoing bariatric surgery[55].

The weight loss observed in our study may also be related to the reduction of uncontrolled eating and emotional eating, which has already been observed in other studies[10,14,17–19].

Table 2. Variation in anthropometric and energy expenditure outcomes by group

	MER			ME			ME + MER			
Variable/Group	Mean	SD	CI (%)	Mean	SD	CI (%)	Mean	SD	CI (%)	*P*
Weight (δ% kg)	−3·9	5·7	−6·03, −1·83	−3·3	5·8	−5·45, −0·27	−2·6	3·8	−4·43, −0·85	0·692
WC (δ% cm)	−4·2	5·2	−6·05, −2·41	−3·4	6·2	−5·84, −0·38	−3·6	3·6	−5·29, −1·87	0·844
SMM (δ% kg)										
Median	−1·4		−2·32, −0·35	−0·3		−3·26, 3·5	−0·2		−1·26, 4·06	0·182
IQR	−3·2–0·5			−2·9–1·7			−1·7–2·4			
FM (δ% kg)	−7·6	10·9	−11·57, −3·54	−6·2	9·3	−10·72, −1·72	−7·2	8·9	−11·32, −2·99	0·899
BFP (δ% %)	−4·1	6·3	−6·43, −1·79	−3·7	5·9	−6·05, −0·77	−4·8	6·6	− 7·27, −1·91	0·864
MET δ% (kJ/week)	−82·4	4726·7	−2078·5, 1389·0	−210·4	5331·7	−3450·1, 1689·5	401·8	4446·3	−399·8, 3762·1	0·372
TEE δ%(kJ/day)	−11·8	41·8	−64·5, −33·8	−0·7	33·5	−19·2, 13·2	−5·0	58·6	−48·3, −33·8	0·003*

IQR, interquartile range; MER, moderate energy restriction; ME, mindful eating; WC, waist circumference; SMM, skeletal muscle mass; FM, fat mass; BFP, body fat percentage; MET, metabolic equivalents of task; TEE, total energy expenditure.
* *P* = 0·003 between MER and ME.

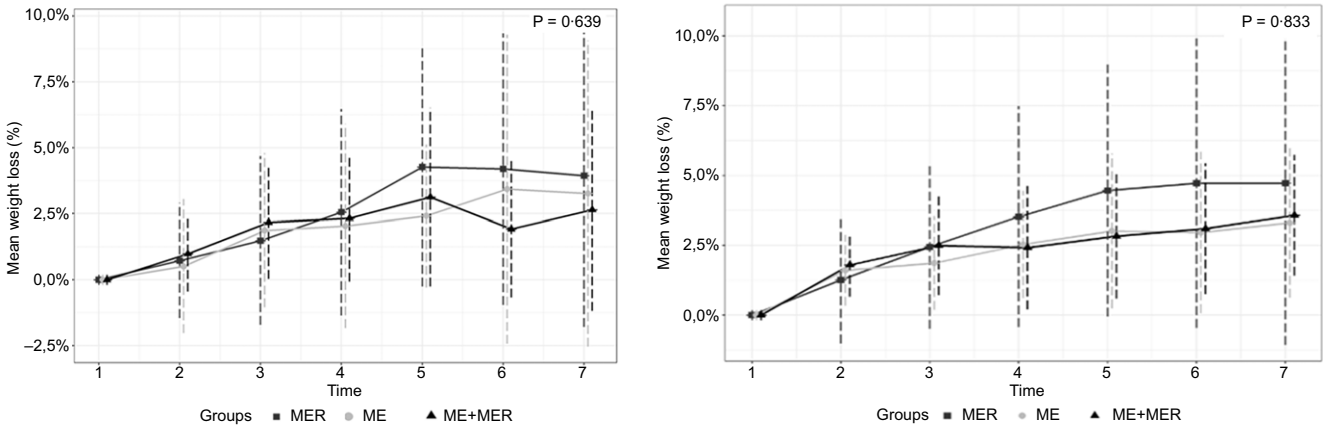

Fig. 2. Average percentage variation with standard deviation by group, ITT (left) and PP (right) analysis. ITT, intention-to-treat; PP, per protocol.

The reduction in cognitive restraint in the ME group did not appear to impact weight loss. In fact, emotional eating seems to be a better indicator of increased stress-induced food intake than cognitive restraint[27], and there was actually a reduction in the emotional eating scale for all groups. The reduction in cognitive restraint in the ME group differs from that of other studies that evaluated mindfulness-based interventions, in which an increase was observed[10,13,14,19]. Studies that evaluated the association between cognitive restraint and weight yielded conflicting results[27,56–58]. Since patients with obesity have reduced activity in the prefrontal cortex, which is responsible for decision-making and cognitive control[25], a greater cognitive restraint would be protective, facilitating weight loss. Furthermore, previous studies have already observed that a flexible restraint, which is implicated in greater knowledge related to the effects of food on energy balance, predicts greater weight loss than a rigid restraint, which is a type of restraint that comes with a dichotomous approach, emphasising food restriction and generating an emotional response and, as a consequence, compensatory behaviours such as a more rigid cognitive restraint, binging or compulsive exercising[56,57].

As well as for metabolic parameters, the positive outcomes related to eating behaviours in the control group could be explained by the structured nutritional guidance, which also informs about food choices, thereby allowing healthier habits.

Another factor that likely influenced the weight loss in our study participants may have been an increased level of awareness and attention. Although Mindful Attention Awareness Scale evaluates awareness and attention in everyday experience[37], this consciousness can also be reflected at mealtimes.

At the end of the intervention, there was a reduction in depression, anxiety and stress scores only in the ME and MER groups. It is known that there is a positive association between obesity and depression[59], and a meta-analysis of cross-sectional and cohort studies also demonstrated an association between obesity and anxiety[60]. Therefore, it is expected that weight loss will ensure a reduction in depression symptoms and anxiety, as demonstrated in studies in which lifestyle changes[61,62], pharmacotherapy associated with lifestyle changes[53] or bariatric surgery[55,63] were applied.

Chronic stress is related to worse food choices, favouring weight gain[64], via hyperactivity of the hypothalamic–pituitary–adrenal axis, which leads to increased food consumption[65]. Mindfulness-based interventions also showed improvement in depression, anxiety and stress symptoms, regardless of weight loss[10,17–19]. Despite this, modest weight

Table 3. Variation in cardiometabolic outcomes by group

	MER			ME			ME + MER			
Variable/Group	Mean	SD	CI (%)	Mean	SD	CI (%)	Mean	SD/IQR	CI (%)	*P*
SBP (δ% mm Hg)	−5·0	11·0	−8·63, −0·43	1·0	8·5	−3·56, 5·46	4·1	9·1	−0·97, 9·14	0·015*
DBP (δ% mm Hg)										
Median	−2·0		−7·86, 11·86	0·2		−3·01, 7·58	−1·1		−54·05, 114·01	0·520
IQR	−8·6–7·4			−4·9–8·1			−5·2–9·2			
HR (δ% bpm)	−0·7	10·0	−4·53, 3·07	5·3	15·6	−3·36, 13·94	16·0	27·7	−2·6, 34·56	0·020†
Glucose (δ% mg/dl)	−0·7	10·3	−4·69, 3·25	−2·1	8·9	−6·52, 2·31	5·7	12·0	0·03, 11·28	0·050
Insulin (δ% mU/L)	5·0	49·5	−15·9, 25·94	3·6	47·7	−19·67, 20·97	−14·9	36·2	−32·29, −0·08	0·327
HOMA-IR (δ%)	5·8	50·3	−14·67, 25·05	2·1	49·3	−22·13, 20·32	−6·5	49·9	−31·05, 14·15	0·728
Total cholesterol (δ% mg/dl)										
Median	−4·1		−7·6, 2·07	3·2		0·66, 13·84	0·7		−11·04, 19·89	0·075
IQR	−11·3–6·3			−0·4–14·3			−7·1–7·1			
LDL-c (δ% mg/dl)	−5·1	20·8	−13·1, 2·99	13·1	26·9	−0·7, 26·99	1·6	23·6	−9·41, 12·65	0·047‡
Non-HDL-c (δ% mg/dl)	−7·8	18·7	−15,41, −0·28	11·1	20·4	1·47, 18·91	0·1	22·1	−10·19, 10·45	0·013§
HDL-c (δ% mg/dl)	7·8	15·3	1·9, 13·75	3·1	13·1	−3·42, 9·58	4·0	16·8	−3·87, 11·85	0·525
TAG (δ% mg/dl)										
Median	−17·9		−26·07, −7·52	−2·7		−21·47, 15·75	−4·0		−32·1, 66·22	0·235
IQR	−28·1– −2·9			−29·5–9·4			−28·6–17·5			
AST (δ% U/L)	3·7	25·4	−6·21, 13·52	−1·9	28·8	−16·18, 12·43	−2·0	24·3	−13·33, 9·37	0·692
ALT (δ% U/L)	−6·2	33·9	−19·66, 4–84	−3·5	25·3	−16·1, 9·1	−14·8	23·5	−25·81, −3·85	0·439
GGT (δ% U/L)	−9·1	25·4	−19·13, 0·93	0·2	24·6	−12·06, 12·41	−13·8	22·6	−24·4, −3·21	0·208

IQR, interquartile range; MER, moderate energy restriction; ME, mindful eating; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate; HOMA-IR, homeostatic model assessment for insulin resistance; LDL-c, LDL-cholesterol; HDL-c, HDL-cholesterol; non-HDL-c, non-HDL cholesterol; AST, aspartate aminotransferase; ALT, alanine aminotransferase; GGT, gamma glutamyl transferase.
* $P = 0·018$ between MER and ME + MER.
† $P = 0·017$ between MER and ME + MER.
‡ $P = 0·041$ between MER and ME.
§ $P = 0·010$ between MER and ME.

Table 4. Changes in eating behaviour by group

	MER			ME			ME + MER			
Variable/Group	Mean	SD	CI (%)	Mean	SD	CI (%)	Mean	SD	CI (%)	*P*
UE (δ%)	−19·6	42·4	−35·71, −3·47	−54·6	33·2	−72·9, −42·33	−31·2	47·2	−54·69, −7·77	0·024*
CR (δ%)	35·1	55·4	12·24, 51·94	−63·9	18·6	−72·3, −56·76	38·8	64·7	5·25, 63·48	< 0·001†
EE (δ%)	−15·2	46·0	−32·68, 2·33	−72·4	20·1	−82·21, −64·87	−17·1	50·1	−43·77, 9·67	< 0·001‡
BES (δ%)										
Median	−37·5		−54·29, 19·05	−42·9		−62·34, −22·75	−53·6		−74·28, −38·74	0·141
IQR	−63·6–4·4			−72·9– −32·2			−85·4– −43·9			

IQR, interquartile range; MER, moderate energy restriction; ME, mindful eating; UE, uncontrolled eating; CR, cognitive restraint; EE, emotional eating; BES, binge eating scale.
* $P = 0·020$ between MER and ME + MER.
† $P < 0·001$ between MER and ME and between ME and ME + MER.
‡ $P < 0·001$ between MER and ME and between ME and ME + MER.

loss may not have been sufficient to improve mental health in all groups. Furthermore, the mindfulness component, unlike other studies, failed to bring significant improvement in depression, anxiety and stress in all groups. Moreover, the low adherence to this approach may have impacted the results.

In contrast with our results that showed little adherence from patients in the ME and ME + MER groups, it has been described that subjects who participate in mindfulness-based interventions are able to comply with the recommendation of home practice and continue to practice regularly after the end of the intervention[66]. It is possible that in the studied population, low adherence to mindfulness practice may be due to the lack of interest in the approach. Even in studies with good adherence to the mindfulness approach, the results are divergent[13,14,18].

Additionally, the dropout rate in our study was higher than expected. In the literature, dropout rates vary widely. A study comparing weight loss between seven types of treatment (diet, exercise, exercise-associated diet, meal replacements, very low-energy diet, sibutramine and orlistat) found a mean dropout rate of 29 % after 1 year of follow-up[41]. Mindfulness-based interventions show varying dropout rates (0–40 %) after 6–16 weeks of treatment[46]. It is worth mentioning that in some mindfulness-based interventions, participants received financial compensation when completing each assessment and/or at the end of the intervention[12,13,17], which may have resulted in lower attrition rates.

Limitations

The attendance and/or sessions were held monthly to facilitate adherence to treatment, considering that patients had other daily obligations and travel expenses. Thus, a monthly face-to-face

Table 5. Changes in symptoms of depression, anxiety and stress by group

Variable/Group	MER			ME			ME + MER			*P*
	Median	IQR	CI (%)	Median	IQR	CI (%)	Median	IQR	CI (%)	
Depression (δ%)	−42·0	−70·0–44·6	−43·93, 12·96	−66·7	−80·0– −40·0	−76·34, −11·67	−45·0	−100·0–21·4	−78·66, 78·54	0·514
Anxiety (δ%)	−50·0	−75·0–0·0	−92·9, 143·08	−46·7	−75·0– −15·0	−92·45, 67·24	−50·0	−66·7– −25·0	−83·58, 23·05	0·993
Stress (δ%)	−22·2	−53·3–7·7	−27·92, 40·01	−26·1	−52·2– −2·1	−44·69, 7·48	−23·6	−35·7–7·1	−39·14, 17·65	0·817

IQR, interquartile range; MER, moderate energy restriction; ME, mindful eating.

contact seemed more feasible than a weekly intervention. However, even considering telephone contact between visits, the longer period between visits may have impacted both the lower adherence to treatment and the higher attrition rate in our study.

ME associated with energy restriction is a more complex approach, demands more personnel and higher costs and has not led to better outcomes than the other two approaches. All groups presented improvements in binge eating, independent of the approach. ME exclusively led to a greater reduction in uncontrolled eating and emotional eating and, in contrast to the other groups, promoted a reduction in cognitive restraint. The attrition rate in the study was higher in the exclusively ME approach, indicating greater difficulty in adhering to this type of strategy. Further research is needed to evaluate the long-term impact of mindfulness-based interventions on obesity treatment.

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There are no conflicts of interest.

Supplementary material

For supplementary material/s referred to in this article, please visit https://doi.org/10.1017/S0007114522003932

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