



Mindful eating as a supportive intervention for breast cancer survivors: a pilot randomized controlled trial

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Abstract

Background Breast cancer (BC) survivors often face weight management and disordered eating challenges that may impair quality of life. This pilot randomized controlled trial evaluated the effects of a six-session mindful eating intervention on eating behaviors and body composition in BC survivors.

Methods Breast cancer survivors were enrolled in a pilot randomized clinical trial and randomly assigned to mindful eating intervention plus treatment-as-usual (TAU+MEI, $n=13$) or treatment-as-usual alone (TAU, $n=15$). Intuitive and mindful eating were assessed using the Intuitive Eating Scale-2 (IES-2) and the Mindful Eating Questionnaire-30 (MEQ-30). Anthropometric measures were assessed monthly over six months. Longitudinal changes were analyzed using repeated-measures ANOVA and generalized estimating equations (GEE).

Results Reliance on hunger and satiety cues increased significantly over time in both groups (TAU: $p=0.004$; TAU+MEI: $p=0.007$). Significant improvements were observed in selected mindful eating dimensions, including disinhibition, emotional eating, eating control, and eating with attention and intention (all $p<0.05$). MEQ-30 total scores increased significantly in both groups (TAU: $p<0.001$; TAU+MEI: $p=0.010$). Waist circumference decreased significantly in the TAU group ($p=0.002$), while hip circumference decreased in the TAU+MEI group ($p=0.009$). GEE analysis showed that participation in the TAU+MEI group was independently associated with lower BMI over time ($p=0.013$), whereas HR(+)/HER2(-) sub-type and chronic disease were associated with higher BMI (all $p<0.05$).

Conclusions Both TAU and TAU+MEI were associated with improvements in selected eating-behavior and anthropometric outcomes over time, including indicators of central adiposity, with no clear overall superiority of TAU+MEI across the outcomes assessed. These exploratory findings support further investigation of incorporating mindful eating into standard nutritional care for breast cancer survivors.

Trial registration The study was retrospectively registered at ClinicalTrials.gov (Identifier: NCT07007104; registration date: 28 May 2025).

Keywords Behavioral intervention · Breast cancer survivors · Eating behavior · Intuitive eating · Mindful eating · Weight management

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Introduction

Breast cancer (BC) is the most diagnosed cancer among women worldwide, with survival rates improving due to advances in early detection and treatment. Globally, four women are diagnosed with BC every minute, and one woman dies from the disease [1]. According to GLOBOCAN data, among females, BC was the most or second most frequently diagnosed cancer in 183 out of 185 countries and ranked among the top two leading causes of cancer-related mortality in 169 countries. By 2050, the number of new BC cases is projected to rise by 38%, while mortality is

expected to increase by 68%, with a disproportionate impact on countries [2]. The elevated incidence rates observed in highly developed countries are attributed to a higher prevalence of well-established risk factors, including null parity or lower parity, advanced maternal age at first birth, reduced duration of breastfeeding, early menarche, excessive body weight, physical inactivity, increased alcohol consumption, hormonal contraceptive use, and the historical administration of hormone replacement therapy for menopause [1, 2]. Evidence derived primarily from high-income countries indicates that approximately 25% of BC cases may be preventable through modifications in lifestyle and hormonal exposure. Specifically, reductions in alcohol consumption (4–16%), obesity (8–28%), physical inactivity (2–10%), and exogenous hormone use (3%), alongside increased breastfeeding (4%), have been associated with a lower risk of BC [2–4].

A significant association exists between obesity and BC risk, with its impact varying based on menopausal status [3–5]. Obesity and dysfunction of visceral adipose tissue contribute to insulin resistance and chronic inflammation, which can promote the development and progression of BC. In addition to estrogen levels, factors like inflammation, insulin resistance, and dyslipidemia could contribute to poor outcomes for obese patients with BC. Therefore, lifestyle changes such as diet and exercise, in addition to endocrine therapy, may improve prognosis [6, 7]. A retrospective research [8] stated that being overweight or obese was associated with a negative impact on disease-free survival in triple-negative BC patients in 31 months follow-up. Researchers highlighted the importance of managing weight as part of cancer care because progression was significantly correlated with overweight or obese patients [9]. While premenopausal obesity is associated with a reduced risk, postmenopausal obesity markedly increases the risk due to adipose tissue serving as the primary site for estrogen biosynthesis after menopause [10]. Elevated serum estrogen levels, coupled with increased peripheral estrogen production, are considered key factors contributing to BC development in overweight postmenopausal women. Given the role of obesity as a significant risk factor for BC in postmenopausal women, preventing weight gain and obesity onset is a crucial strategy for delaying or preventing certain types of BC [11]. According to a meta-analysis conducted by Liu et al. [12] there is a weak positive association between body mass index (BMI) and BC risk, with a 5 kg/m² increase in BMI corresponding to approximately a 2% increase in BC risk. However, in premenopausal women, a higher BMI appears to have a protective effect against BC. A meta-analysis by Amadou et al. [13] examined nine case-control and three cohort studies, revealing a significant dose-response increase in relative risk for premenopausal BC (RR 1.08;

95% CI 1.01–1.16) per 0.1-unit increase in waist-hip-ratio. These findings suggest that while general adiposity may reduce risk, central obesity is linked to an elevated risk of premenopausal BC. In another meta-analysis of 20 prospective cohort studies found that for every 5 kg/m² increase in BMI, the relative risk of developing premenopausal BC significantly decreased (RR 0.92; 95% CI 0.88–0.97) [14]. Although the underlying mechanisms remain unclear, one hypothesis is that obesity induces ovarian suppression, leading to lower circulating estradiol levels. On the other hand, weight loss has been shown to reduce circulating estrogen levels. Given that hormone-positive breast tumors in postmenopausal women are influenced by estrogen, weight reduction and the corresponding decline in estrogen levels are expected to lower the risk of BC development [7]. Physiological differences between premenopausal and postmenopausal women appear to modify the relationship between BMI and BC risk. Numerous studies and meta-analyses have reported an inverse association between BMI and BC risk in younger women, contrasting with the well-established positive correlation observed in postmenopausal women [10, 11, 15]. Although higher BMI appears to have a protective effect in premenopausal women, the degree of risk reduction is notably smaller than the increased risk of BC associated with obesity in postmenopausal women [15, 16]. Excess adiposity is linked to a proinflammatory state that can contribute to cancer progression, recurrence, and overall poorer health outcomes [17]. Given these risks, interventions targeting sustainable weight management and healthier dietary behaviors are critical for improving long-term survivorship outcomes.

Weight management through increased physical activity and reduced energy intake, particularly by limiting high sugar consumption is a key for preventing cancer [10, 18]. Individuals with obesity should strive to transition away from a sedentary lifestyle. In a meta-analysis [6], obesity was strongly linked to higher risks of all-cause mortality, BC-specific mortality, recurrence, and distant recurrence in BC patients. Also, the impact of obesity was associated with poorer outcomes, including an increased risk of recurrence, and 11.6% of patients in the cohort experienced recurrence [19]. Maintaining a healthy body weight may help reduce the risk of mortality and recurrence among BC patients, although more studies are needed to explore the biological mediators and their mechanisms across different BC subtypes [20]. Weight management and adhering to a healthy lifestyle, including a healthy diet, affect both the risk of developing BC and post-diagnosis outcomes [21]. Traditional weight management strategies for BC survivors often focus on calorie restriction and structured diet plans, which may not be sustainable or effective for long-term behavioral change. An alternative approach that has gained increasing

attention in recent years is mindful eating, a practice that encourages individuals to develop awareness of their hunger and satiety cues, reduce emotional eating, and cultivate a nonjudgmental attitude toward food [22]. Unlike conventional diet approaches that emphasize external food rules, mindful eating promotes self-regulation and autonomy in food choices, which may be particularly beneficial for BC survivors seeking sustainable lifestyle modifications [22, 23]. However, despite the growing interest in mindful eating, there is limited research exploring its effectiveness in improving eating behaviors and anthropometric outcomes in BC survivors.

As breast cancer survival rates continue to improve, there is growing emphasis on survivorship care, particularly strategies that enhance quality of life, support emotional and behavioral health, and reduce the risk of recurrence or treatment-related complications. Interventions aimed at fostering sustainable lifestyle habits—such as mindful eating—have shown promise in addressing weight management, emotional regulation, and overall well-being among breast cancer survivors. This study aimed to address this gap by evaluating the effects of a structured Mindful Eating Intervention (MEI) on eating behaviors and weight management among BC survivors. Understanding the impact of mindful eating in this population is essential for developing holistic, patient-centered nutritional approaches that integrate both physical and psychological well-being. We hypothesized that participants receiving the MEI would demonstrate greater improvements in intuitive and mindful eating behaviors, as well as more favorable anthropometric changes, compared to those receiving treatment as usual (TAU).

Materials and methods

Clinical context and standard oncological management

Early and locally advanced breast cancer includes a wide clinical spectrum, from small node-negative tumors to larger or node-positive, non-metastatic disease. Treatment is guided by tumor subtype (HR+, HER2+, or triple-negative), disease stage, and risk stratification. Surgical resection is essential but rarely used in isolation. In early-stage hormone receptor-positive (HR+) disease with low to intermediate risk, upfront surgery followed by adjuvant therapy is common. However, in HER2-positive and triple-negative breast cancers, even when the tumor is technically operable, current guidelines recommend initiating treatment with neoadjuvant systemic therapy to assess chemosensitivity and guide the intensity of adjuvant therapy based on

the pathological response [24]. Achieving a pathological complete response (pCR) is associated with improved long-term outcomes, particularly in these subtypes. Residual disease after neoadjuvant therapy informs post-operative management, such as the use of adjuvant T-DM1 in HER2+ cases or capecitabine in triple-negative disease [25]. In HR+/HER2− tumors with high-risk features, neoadjuvant chemotherapy or endocrine therapy may be considered. In the adjuvant setting, systemic regimens include endocrine therapy ± CDK4/6 inhibitors for HR+ tumors, anti-HER2 agents (trastuzumab ± pertuzumab) for HER2+ disease, and chemotherapy ± immunotherapy for triple-negative cancers. Follow-up includes clinical exams every 3–6 months for the first 3 years, every 6–12 months for years 4–5, and annually thereafter. Annual mammography remains the main surveillance tool; routine imaging or tumor markers are not recommended in asymptomatic patients [26]. This tailored, biology-driven approach improves survival outcomes and allows for personalized survivorship care.

Study group

This randomized controlled study was conducted at Acibadem Altunizade Hospital, a tertiary care oncology center in Istanbul, Türkiye, where all recruitment, intervention sessions, and follow-up procedures took place. This study was designed as a pilot randomized controlled trial with a parallel-group design and an allocation ratio of 1:1. The trial had an exploratory framework, aiming to evaluate the preliminary effects of a mindful eating intervention on eating behaviors and anthropometric outcomes in breast cancer survivors. Participants included in the study met the eligibility criteria and were randomly assigned to either the mindful eating intervention group (TAU+MEI) or nutritional treatment as usual (TAU) group. The study was completed with 13 participants in TAU+MEI group and 15 participants in the TAU group. The study was carried out over a total of two years, with independent recruitment periods.

Participants were recruited between February 2022 and June 2024. All follow-up assessments were completed by May 2025.

Inclusion and exclusion criteria

Inclusion criteria were: (1) female breast cancer survivors aged 18 years or older, (2) completion of primary treatment including surgery, chemotherapy, and/or radiotherapy, (3) currently undergoing or having completed hormone therapy, and (4) a minimum of six months elapsed since completion of active treatment.

Exclusion criteria were: (1) less than six months since treatment completion, and (2) unwillingness or inability to provide informed consent or participate in the intervention.

Randomisation

Participants were randomly assigned in a 1:1 ratio to either the TAU+MEI group or the TAU group using a computerized simple randomization method. The allocation sequence was generated with Microsoft Excel's random number function by an independent researcher (SY), who was not involved in intervention delivery or outcome assessment. The list was stored in a password-protected file accessible only to this researcher. SY also enrolled eligible participants and assigned them to their respective groups sequentially based on the pre-generated list. Neither the study team nor participants were aware of the allocation sequence at any point prior to assignment. No stratification or blocking was used. Although simple randomization was applied, some baseline imbalances between groups (e.g., body weight, BMI, fat mass) were observed. This is not unusual in pilot studies with small sample sizes and is likely due to random variability rather than allocation bias.

Anthropometric measurements and body composition analysis

Anthropometric measurements were conducted by the same trained dietitian (DB) during face-to-face individual consultations. Body weight (kg) and height (cm) were measured with participants wearing light clothing and no shoes. Standing height was measured using a wall-mounted stadiometer (Seca 206) to the nearest 0.1 cm. Body weight was measured using a Tanita MC-980 Multi Frequency Segmental Body Analyzer which was used for the BIA analysis of body composition. The impedance measurement system of the device was eight-electrode segmental multifrequency BIA, and the measurement frequencies were 1/5/50/250/500/1000 kHz. The device measures up to 300 kg, with an accuracy of 0.1 kg. Body Mass Index (BMI) was calculated as weight in kilograms divided by the square of height in meters (kg/m^2).

Body composition, including fat mass (kg), was assessed using a multi-frequency segmental Bioelectrical Impedance Analysis (BIA) device (Tanita MC-980), following the manufacturer's guidelines. Participants were instructed to avoid food, fluid intake, and strenuous activity for at least 2 h prior to measurement to improve accuracy. Before measuring body composition with the device, the individuals' heights were measured. Age, sex, and height measurements of each participant were recorded with standard mode in the Tanita computer program. Participants were asked to stand on the device such that their bare feet were in contact

with the foot electrode pads. During the measurement, the electrode arms were held with both hands in a way that would allow the palms to grasp the arms, and participants were asked to move their arms away from their body at an angle of approximately 30°. After the patients were in the appropriate position, the measurement took 30 s. Body weight was measured by the system built into the device. Using a multifrequency impedance plethysmograph body composition analyzer, the device detected intracellular and extracellular water content separately. Data from the device included body composition measurements such as fat free mass (FFM), fat mass (FM), body fat percentage (%BF), and lean soft tissue mass (LSTM).

Waist circumference (cm) was measured using a non-stretchable measuring tape placed midway between the lower margin of the last palpable rib and the top of the iliac crest, with the participant standing upright and breathing out gently. Each measurement was taken twice, and the average value was recorded.

Intervention protocol

Participants assigned to both the TAU and MEI arms were evaluated by the same experienced oncology dietitian (DB) following enrollment in the study. The intervention consisted of six structured MEI sessions led by a researcher (GA) formally trained in mindful eating practices as mindful eating teacher and accompanied by tailored nutritional education provided by a registered dietitian (DB) specialized in oncology nutrition with clinical experience in cancer survivorship care. This dual approach targeted both psychological and physiological aspects of eating behaviors to facilitate participants' ability to make more conscious and balanced food choices.

Treatment as usual (TAU)

During the first visit, questionnaire items were administered to participants using a face-to-face interview technique, and all anthropometric measurements were performed by the same experienced oncology dietitian (DB). Subsequently, the nutritional status of all participants was assessed by the same dietitian, and based on the obtained data, an individualized nutrition plan was developed and nutrition education was provided to each participant. Participants in all study arms attended 30-minute follow-up sessions once per month with the same experienced oncology dietitian for anthropometric measurements and evaluation of the nutrition plan.

During these sessions, the nutrition plan was updated and nutrition education was repeated when deemed necessary. At the seventh visit, in addition to anthropometric measurements, intuitive eating scales were readministered. In

addition to these procedures, participants in the MEI arm were followed by a trained Mindful Eating specialist dietitian according to the intervention plan described below. The following sections outline the structure of the MEI sessions and their integration with individualized nutrition support.

Mindful eating intervention (MEI)

The Mindful Eating Intervention (MEI) was consisted of six structured sessions, each lasting approximately 60 to 90 min. The six MEI sessions are as follows:

Intervention protocol: structured mindful eating intervention for cancer survivors MEI Session 1- Introduction to Mindful Eating: The concept of mindful eating was introduced and its relevance to oncology patients was discussed. The importance of self-awareness in managing eating behaviors, particularly during cancer treatment, was emphasized. Mindful eating was defined as the practice of paying full attention to the present moment while eating, without judgment. The impact of cancer treatment on appetite and eating behaviors was reviewed, and the potential benefits of mindful eating were highlighted, including reduced emotional eating, improved digestion, and better management of food intake.

MEI Session 2- Hunger and Satiety Cues with Hunger-Satiety Scale: Participants were assisted in identifying and responding to their internal hunger and satiety cues, with the aim of promoting a healthier relationship with food. The Hunger-Satiety Scale (HSS) was introduced, and participants were taught how to recognize different levels of hunger and satiety, ranging from “extremely hungry” to “uncomfortably full.” The ways in which cancer treatments may alter hunger and fullness cues were discussed, and strategies to regain balance were provided. Mindful strategies were taught to help participants listen to their body’s natural cues and make decisions regarding when and how much to eat.

MEI Session 3- Savoring Every Taste: Participants were encouraged to develop a deeper appreciation for food by engaging all of their senses during meals, thus enhancing the eating experience. The importance of slowing down and savoring food to enhance the sensory experience of eating was discussed. Techniques for engaging all five senses (sight, smell, touch, taste, and hearing) were provided, with the intention of increasing mindfulness while eating. The potential for mindful tasting to improve food satisfaction and reduce overeating was also explored.

MEI Session 4- Slowing Down with Every Food: The focus of this session was on helping participants slow down their eating habits to improve digestion, satiety, and overall

enjoyment of food. The impact of fast eating on digestion and the mind-body connection during meals was discussed. Strategies to slow down eating were provided, including placing utensils down between bites, chewing thoroughly, and engaging in mindful breathing during meals. It was emphasized that slowing down could help participants feel more in control of their eating and reduce the likelihood of overeating.

MEI Session 5- Dealing with Emotional Eating: This session addressed emotional eating habits and provided tools for managing stress and emotions during meals. The connection between emotions and eating behaviors, particularly during times of stress or anxiety associated with cancer treatment, was discussed. Participants were taught how to recognize emotional triggers for eating and how to differentiate between physical hunger and emotional hunger. Strategies for managing emotional eating, such as mindful breathing, and journaling were provided.

MEI Session 6- Integration and Follow-Up: The final session focused on reinforcing and integrating the skills learned throughout the intervention to ensure their long-term application in daily life. Key concepts learned in previous sessions, including the Hunger-Satiety Scale, mindful tasting, slowing down, and emotional eating strategies, were reviewed. Challenges and barriers participants might face in applying mindful eating practices were discussed, and individualized solutions were provided. Participants were encouraged to develop a personal plan for incorporating mindful eating practices into their daily routine after the intervention.

No adverse events or harms related to the intervention were reported by participants during or after the intervention period. Participants were systematically asked about any physical, emotional, or behavioral difficulties at each session, and no issues were noted by the facilitators. Due to the low-risk, non-invasive nature of the intervention, no formal adverse event monitoring form was used. All sessions were delivered according to a standardized protocol to ensure intervention fidelity, and no major deviations from the planned content or schedule were observed. Further details describing the structure and content of the intervention sessions are available from the authors upon reasonable request.

Sample size

As this was an exploratory pilot randomized controlled trial, a formal sample size calculation was not performed. The sample size was pragmatically determined based on the number of eligible participants accessible during the recruitment period at the study site over two years. The primary aim was to assess feasibility, acceptability, and preliminary

effects of the intervention to inform the design of future trials.

No interim analyses were conducted, and no formal stopping guidelines were established due to the exploratory nature and low-risk profile of the pilot intervention.

The trial was completed as planned. No early stopping criteria were applied.

Blinding

Due to the behavioral nature of the intervention, neither participants nor care providers were blinded to group assignment. However, outcome data were entered and analyzed by an independent researcher who was not involved in the intervention delivery or participant interaction.

Data collection tools

Participants completed a series of surveys and questionnaires administered by the researcher during their oncology dietitian interview by DB. The data collection tools included a socio-demographic and health history survey to gather information on age, medical history, and nutritional habits, anthropometric measurements of body weight, height, and body mass index (BMI), and a physical activity assessment to evaluate general physical activity status.

Data collection was conducted through structured surveys administered by the researcher face-to-face during the participants' initial consultation. The survey encompassed multiple domains, including socio-demographic characteristics, medical history of diagnosed diseases, anthropometric measurements, general dietary habits, physical activity levels and Intuitive Eating Scale-2 (IES-2), Mindful Eating Questionnaire-30 (MEQ-30).

Dietary habits were evaluated through self-reported information on meal patterns, frequency of consumption of food groups, and adherence to specific dietary practices (e.g., vegetarianism, Mediterranean diet, or other dietary regimens). Additionally, physical activity levels were assessed using self-reported data on the frequency, duration, and intensity of exercise and daily movement patterns. The collected data served as a foundational assessment for the development of personalized nutritional interventions.

Intuitive eating scale-2 (IES-2)

The IES-2 is a 23-item 5-point Likert-type scale instrument that evaluates the four major components of intuitive eating (IE). These components are unconditional permission to eat (UPE) (6 items), eating for physical

rather than emotional reasons (EPR) (8 items), reliance on hunger and satiety cues (RHSC) (6 items), and body–food choice congruence (B–FCC) (3 items). Bas et al. [27] adapted the scale to Turkish in 2017. Responses on this scale range from 1 (strongly disagree) to 5 (strongly agree). Higher scores correspond to increased intuitive eating levels.

Mindful eating questionnaire-30 (MEQ-30)

The MEQ is a 30-item scale developed by Framson et al. [28] and adapted to Turkish by Köse et al. [29] for use in Türkiye. The following seven subscales related to mindful eating (ME) are rated on a 5 Likert-type scale, with responses ranging from “never” to “always”: disinhibition (DH), emotional eating (EE), eating control (EC), eating discipline (ED), mindfulness (MF), conscious nutrition (CN), and interference (INT). Higher total and subscale scores indicate increased mindful eating.

Outcomes

The primary outcomes were changes in mindful and intuitive eating behaviors, assessed using the Mindful Eating Questionnaire-30 (MEQ-30) and the Intuitive Eating Scale-2 (IES-2), respectively. Total and subscale scores were analyzed using mean $\pm$ standard deviation, comparing pre and post-intervention values.

Secondary outcomes included changes in anthropometric variables: body weight (kg), body mass index (BMI, kg/m²), waist circumference (cm), and fat mass (kg). These were measured monthly over the six-month intervention period using a bioelectrical impedance analysis device (Tanita MC980). Data were analyzed as mean $\pm$ standard deviation, and longitudinal change was evaluated.

Statistical analysis

All statistical analyses were performed using SPSS Statistics, version 27.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as mean $\pm$ standard deviation (SD) for continuous variables and as number and percentage (n, %) for categorical variables. Baseline demographic and clinical characteristics between groups were compared using the Independent Samples t-test for continuous variables and Fisher's Exact Test for categorical variables.

Within-group changes between two time points (T_0 and T_1) were evaluated using the Paired Samples t-test. Longitudinal changes in body weight, body mass index (BMI), fat mass, and trunk fat mass across multiple time points (T_1 – T_7) were analyzed using repeated-measures

analysis of variance (Repeated Measures ANOVA). The main effects of time, group, and the time $\times$ group interaction were examined. When significant ANOVA results were observed, Bonferroni-adjusted post hoc comparisons were conducted using T₁ as the reference time point.

To examine factors associated with long-term changes in BMI and to account for the correlation structure of repeated measurements over time, Generalized Estimating Equations (GEE) were applied. The GEE models included group assignment, age, education status, occupational status, molecular subtype, presence of chronic disease, and regular physical activity as covariates. The GEE approach was selected because it appropriately adjusts for within-subject correlations arising from repeated measurements and allows for the simultaneous inclusion of both continuous and categorical covariates within the same model. Covariates included in the GEE model were selected a priori based on their clinical relevance and previously reported associations with body weight and BMI in breast cancer survivors.

A p -value of <0.05 was considered statistically significant for all analyses.

Ethical considerations

The study protocol was approved by the Ethics Committee of Acibadem University named ATADEK (protocol number: ATADEK 2022-02/05; approval date: 28 January 2022) following the Declaration of Helsinki. Due to the recruitment taking longer than expected, another ethical approval was obtained from the same committee (protocol number: ATADEK 2024-13/552; approval date: 5 September 2024). Informed consent was obtained from all individual participants included in the study. This study has also been registered at ClinicalTrials.gov (Identifier: NCT07007104; registration date: 28 May 2025; URL: <http://clinicaltrials.gov/study/NCT07007104>).

Additionally, breast cancer survivors participating in this study were not involved in the design, conduct, or reporting stages. All content and procedures were developed solely by the research team following ethical standards.

No important changes to the trial methods, outcomes, or statistical analyses were made after the trial commenced. All procedures and outcome assessments were conducted as initially planned and approved by the ethics committee.

Throughout the study, no additional behavioral, psychological, or nutritional interventions were provided outside of the assigned protocols. All participants continued their usual medical care and follow-up appointments as scheduled by their oncology teams. Concomitant care during the study period did not differ between the intervention and control groups.

Results

Participant flow

A total of 29 participants were randomized to either the TAU+MEI group ($n=14$) or the TAU-only group ($n=15$). All participants received their assigned intervention. One participant in the TAU+MEI group did not complete the final outcome assessment because of breast cancer recurrence and subsequent initiation of treatment; therefore, this participant was excluded from the primary outcome analysis (Fig. 1).

All participants included in the final analysis had complete data for the primary outcomes, namely MEQ-30 and IES-2 scores at baseline and post-intervention. Therefore, no participants were lost to follow-up for the primary outcome. Missing data occurred only for the secondary longitudinal anthropometric outcomes. In the TAU group, 15 participants had baseline anthropometric data; however, the number of participants with available anthropometric measurements decreased over subsequent follow-up visits. The number of participants with available data was 1 after Visit 7, 8 after Visit 8, and 6 after Visit 9. These missing data were related only to secondary outcomes and did not affect the primary outcome analysis.

Characteristics of participants at baseline

The study included participants with a mean age of 53.25 ± 7.32 years. In terms of education, 46.4% had a university degree, 25.0% completed high school, and 28.6% had an elementary school education. Nearly three-quarters of the participants (71.4%) were retired, while 28.6% were workers (Table 1).

Also in Table 1, marital status data showed that 85.7% of the participants were married, while 14.3% were single. Regarding molecular subtype, 75.0% had hormone receptor-positive/HER2-negative tumors, 14.3% had HR (+/-)/HER2-positive tumors, and 10.7% had triple-negative breast cancer. Menopause status varied, with 89.3% being postmenopausal and 10.7% premenopausal. Surgical treatments included modified radical mastectomy (67.9%) and mastectomy (32.1%). Regarding treatment history, 85.7% of participants received chemotherapy, 85.7% received radiotherapy, and 78.6% received hormonotherapy. Finally, 78.6% of participants had no lymphedema, while 21.4% experienced lymphedema.

Group comparisons of baseline characteristics revealed a statistically significant difference between the intervention and control groups in terms of age ($p=0.040$), with slightly higher age values observed in the control group. No statistically significant differences were observed for the other

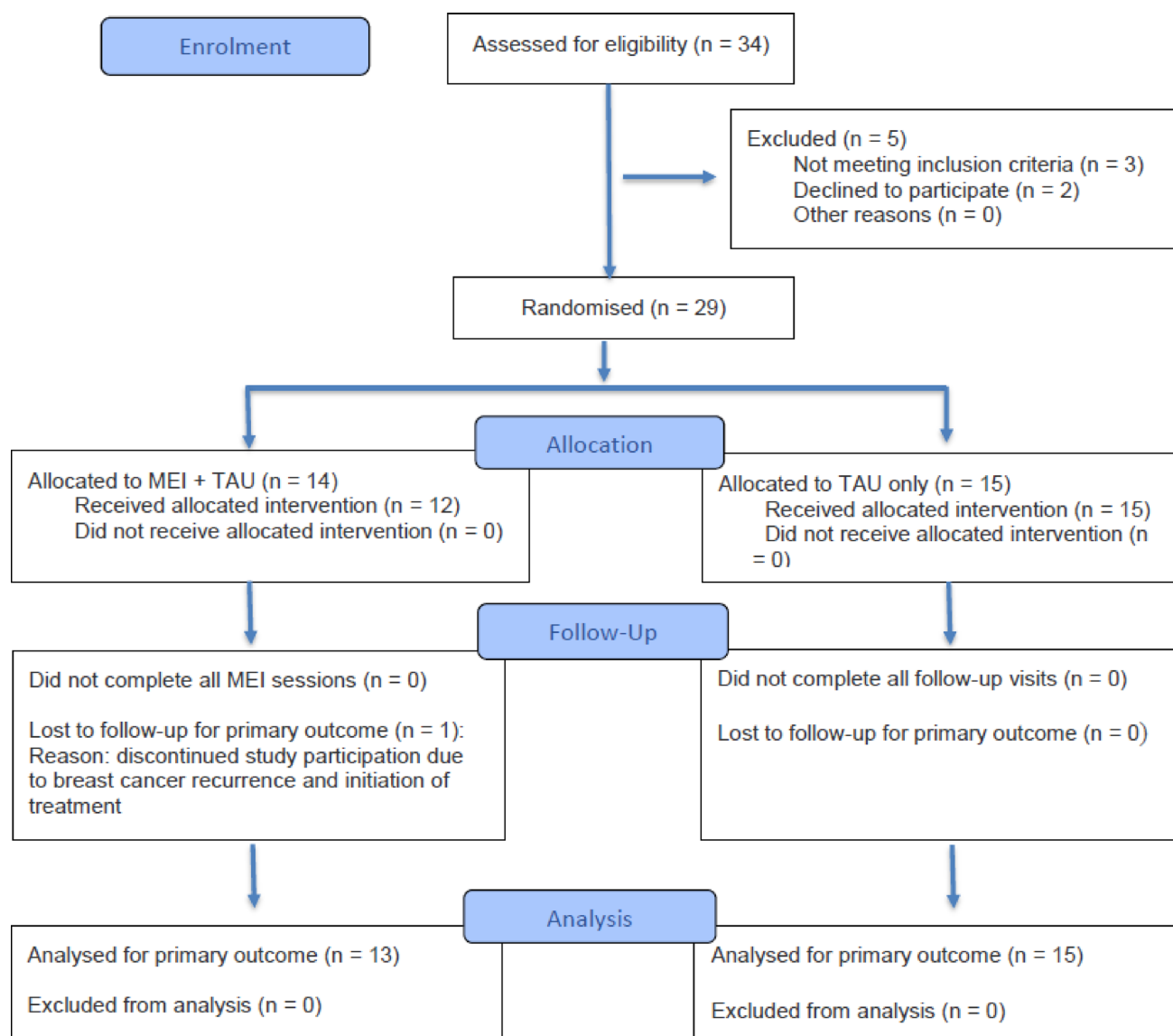


Fig. 1 CONSORT 2025 flow diagram

baseline variables (Table 1). These minor baseline imbalances are not unexpected in small sample pilot trials and were addressed in the Discussion section.

For all primary outcomes, the number of participants included in the analysis was 28 (TAU+MEI: $n=13$; TAU: $n=15$) as results are presented as mean $\pm$ SD for each group in Table 2. All participants had complete outcome data at baseline and at follow-up. At baseline, there were no statistically significant differences between the TAU and TAU+MEI groups in any of the IES-2 or MEQ-30 subscale scores (all $p>0.05$). Between-group comparisons of change scores showed no statistically significant differences between the TAU and TAU+MEI groups across any of the intuitive eating or mindful eating subscales (all $p>0.05$),

although the increase in ED approached significance in favor of the TAU group ($p=0.048$).

In the TAU group, significant within-group improvements from T0 to T1 were observed in RHSC ($p=0.004$), DIS ($p=0.008$), EE ($p=0.007$), ED ($p=0.006$), INT ($p=0.019$), and the MEQ-30 total score ($p<0.001$). No significant changes were detected in UPE, EPR, B-FCC, EC, MN, CN, or IES-2 total score (all $p>0.05$). In the TAU+MEI group, significant improvements were observed in RHSC ($p=0.007$), EC ($p=0.010$), and MEQ-30 total score ($p=0.010$). Changes in other subscales, including UPE, EPR, B-FCC, DIS, EE, MN, ED, CN, INT, and IES-2 total score, were not statistically significant (all $p>0.05$) (Table 2).

Table 1 Baseline demographic and clinical characteristics of participants by group ($n=28$)

Variables	TAU ($n=15$)	TAU+MEI ($n=13$)	Total ($n=28$)	<i>P</i> -value
Age (year), $\bar{X}\pm SD$	55.87 $\pm$ 6.78	50.23 $\pm$ 6.97	53.25 $\pm$ 7.32	0.040 ^a
Marital status, n (%)				> 0.999 ^b
Single	2 (13.3)	2 (15.4)	4 (14.3)	
Married	13 (86.7)	11 (84.6)	24 (85.7)	
Menopausal status, n (%)				0.087 ^b
Premenopausal	0 (0)	3 (23.1)	3 (10.7)	
Postmenopausal	15 (100)	10 (76.9)	25 (89.3)	
Education, n (%)				0.888 ^b
Elementary school	5 (33.3)	3 (23.1)	8 (28.6)	
High school	4 (26.7)	3 (23.1)	7 (25)	
University	6 (40)	7 (53.8)	13 (46.4)	
Occupational status, n (%)				0.410 ^b
Worker	3 (20)	5 (38.5)	8 (28.6)	
Retired	12 (80)	8 (61.5)	20 (71.4)	
Chronic disease (CD) Presence, n (%)				0.128 ^b
None	5 (33.3)	9 (69.2)	14 (50)	
Present CD	10 (66.7)	4 (30.8)	14 (50)	
Surgical therapy, n (%)				0.689 ^b
BCS	11 (73.3)	8 (61.5)	19 (67.9)	
Mastectomy	4 (26.7)	5 (38.5)	9 (32.1)	
Molecular subtype, n (%)				0.369 ^b
HR (+)/HER2 (-)	13 (86.7)	8 (61.5)	21 (75)	
HR (+/-)/HER2 (+)	1 (6.7)	3 (23.1)	4 (14.3)	
Triple negative	1 (6.7)	2 (15.4)	3 (10.7)	
Systemical therapy, n (%)				
Chemotherapy	14 (93.3)	10 (76.9)	24 (85.7)	0.311 ^b
Radiotherapy	12 (80)	12 (92.3)	24 (85.7)	0.600 ^b
Hormonotherapy	14 (93.3)	8 (61.5)	22 (78.6)	0.069 ^b
Physical activity, n (%)				0.705 ^b
None	6 (40)	4 (30.8)	10 (35.7)	
Regular	9 (60)	9 (69.2)	18 (64.3)	
Presence of lymphedema, n (%)				> 0.999 ^b
No lymphedema	12 (80)	10 (76.9)	22 (78.6)	
Presence of lymphedema	3 (20)	3 (23.1)	6 (21.4)	

HR: Hormone Receptor-Positive, HER2: Human Epidermal Growth Factor Receptor 2-Positive, BCS (Breast-Conserving Surgery)

Secondary outcomes – anthropometric measures

As shown in Table 3, waist circumference decreased significantly over time in the TAU group ($p=0.002$). In addition, hip circumference showed a significant reduction over time in the TAU+MEI group ($p=0.009$). The waist-to-hip ratio also decreased significantly in the TAU group ($p=0.024$). At baseline, significant between-group differences were observed for waist circumference ($p=0.018$) and waist-to-hip ratio ($p=0.002$).

As shown in Table 4, repeated-measures ANOVA revealed a significant main effect of time on BMI ($F=20.632$, $p<0.001$, $\eta^2=0.442$), indicating a significant change in BMI over the study period in both groups. Within-group analyses demonstrated significant reductions in BMI from baseline (T1) at multiple follow-up time points in the TAU

group (T1 vs. T2: $p=0.026$; T1 vs. T3: $p=0.002$; T1 vs. T4: $p<0.001$; T1 vs. T5: $p<0.001$; T1 vs. T6: $p=0.006$; T1 vs. T7: $p=0.022$). In the TAU+MEI group, significant reductions in BMI from baseline were observed at T3 ($p=0.007$), T4 ($p=0.048$), T5 ($p=0.007$), and T6 ($p=0.018$).

Repeated-measures ANOVA revealed a significant main effect of time on body weight ($F=23.113$, $p<0.001$, $\eta^2=0.471$), indicating a significant change in body weight over the study period in both groups. Within-group analyses demonstrated significant reductions in body weight from baseline (T1) at multiple follow-up time points in the TAU group (T1 vs. T2: $p=0.008$; T1 vs. T3: $p=0.001$; T1 vs. T4: $p<0.001$; T1 vs. T5: $p<0.001$; T1 vs. T6: $p=0.002$; T1 vs. T7: $p=0.009$). Similarly, in the TAU+MEI group, significant reductions in body weight from baseline were

Table 2 Effects of the mindful eating intervention on intuitive and mindful eating scores

	Time	TAU (<i>n</i> =15) $\bar{X} \pm SD$	TAU+MEI (<i>n</i> =13) $\bar{X} \pm SD$	<i>P</i> -value ^a
UPE	T ₀	3.60±0.47	3.47±0.32	0.420
	T ₁	3.40±0.47	3.30±0.44	0.552
	Difference	-0.20±0.77	-0.18±0.37	0.928
	<i>P</i> -value ^b	0.334	0.105	
EPR	T ₀	3.39±0.45	3.18±0.33	0.176
	T ₁	3.15±0.53	3.28±0.35	0.466
	Difference	-0.24±0.56	0.10±0.54	0.116
	<i>P</i> -value ^b	0.114	0.533	
RHSC	T ₀	3.12±0.81	3.21±0.65	0.770
	T ₁	3.89±0.67	3.77±0.60	0.625
	Difference	0.77±0.87	0.56±0.63	0.492
	<i>P</i> -value ^b	0.004**	0.007**	
B-FCC	T ₀	3.58±0.60	3.82±0.55	0.278
	T ₁	3.82±0.70	3.87±1.09	0.886
	Difference	0.24±0.71	0.05±0.83	0.511
	<i>P</i> -value ^b	0.202	0.827	
IES-2-Total	T ₀	3.40±0.32	3.35±0.31	0.666
	T ₁	3.50±0.36	3.49±0.34	0.956
	Difference	0.10±0.46	0.14±0.33	0.767
DIS	T ₀	3.35±0.83	3.43±0.73	0.779
	T ₁	3.91±0.55	3.63±0.67	0.243
	Difference	0.56±0.70	0.20±0.55	0.147
	<i>P</i> ^b -value	0.008**	0.217	
EE	T ₀	3.51±1.05	3.77±0.97	0.499
	T ₁	4.04±0.76	4.15±0.77	0.698
	Difference	0.53±0.65	0.39±0.70	0.563
	<i>P</i> ^b -value	0.007**	0.069	
EC	T ₀	3.28±1.15	3.37±1.18	0.854
	T ₁	3.53±1.17	4.04±0.96	0.227
	Difference	0.25±0.57	0.67±0.79	0.115
	<i>P</i> ^b -value	0.114	0.010***	
MN	T ₀	3.48±0.52	3.45±0.44	0.856
	T ₁	3.48±0.39	3.29±0.41	0.224
	Difference	0.00±0.48	-0.15±0.48	0.403
	<i>P</i> ^b -value	> 0.999	0.268	
ED	T ₀	2.85±0.78	3.40±0.69	0.059
	T ₁	3.50±0.65	3.52±0.83	0.946
	Difference	0.65±0.77	0.12±0.56	0.048*
	<i>P</i> ^b -value	0.006**	0.468	
CN	T ₀	3.27±0.72	3.29±0.60	0.920
	T ₁	3.55±0.58	3.55±0.38	0.970
	Difference	0.28±0.68	0.26±0.48	0.935
	<i>P</i> ^b -value	0.133	0.072	
INT	T ₀	3.73±0.84	3.73±0.86	0.994
	T ₁	4.23±0.53	4.04±0.78	0.440
	Difference	0.50±0.73	0.31±0.60	0.457
	<i>P</i> ^b -value	0.019***	0.088	
MEQ-30-Total	T ₀	3.33±0.55	3.47±0.52	0.493
	T ₁	3.72±0.39	3.72±0.47	0.999

Table 2 (continued)

Time	TAU (<i>n</i> =15) $\bar{X} \pm SD$	TAU+MEI (<i>n</i> =13) $\bar{X} \pm SD$	<i>P</i> -value ^a
Difference	0.38±0.30	0.24±0.29	0.216
<i>P</i> ^b -value	< 0.001*	0.010***	

p*<0.001; *p*<0.01; ****p*<0.05; TAU+MEI=Treatment as Usual+Mindful Eating Intervention; TAU=Treatment as Usual; UPE: Unconditional Permission to Eat, EPR: Eating for Physical Rather than Emotional Reasons, RHSC: Reliance on Hunger and Satiety Cues, B-FCC: Body-Food Choice Congruence, DIS: Disinhibition, EE: Emotional Eating, EC: Eating Control, MN: Mindfulness, ED: Eating Discipline, CN: Conscious Nutrition, INT: Interference, MEQ-30: Mindful Eating Questionnaire 30 (Turkish)

observed at T2 (*p*=0.044), T3 (*p*=0.004), T4 (*p*=0.034), T5 (*p*=0.006), and T6 (*p*=0.015).

For fat mass, repeated-measures ANOVA demonstrated a significant main effect of time (*F*=17.283, *p*<0.001, η^2 = 0.399), indicating a significant change in fat mass over the study period in both groups. Within-group analyses revealed significant reductions in fat mass from baseline (T1) in the TAU group at T2 (*p*=0.014), T3 (*p*=0.035), T4 (*p*<0.001), T5 (*p*=0.001), and T6 (*p*=0.002). In the TAU+MEI group, significant reductions in fat mass from baseline were observed at T5 (*p*=0.026), T6 (*p*=0.022), and T7 (*p*=0.042).

For trunk fat mass, repeated-measures ANOVA revealed a significant main effect of time (*F*=9.768, *p*<0.001, η^2 = 0.273), indicating a significant change over the study period. Within-group analyses showed a significant reduction in trunk fat mass in the TAU group at T4 (*p*=0.043) and T5 (*p*=0.026) compared with baseline (T1). In the TAU+MEI group, a significant reduction from baseline was observed at T6 (*p*=0.043) (Table 4).

The generalized estimating equations (GEE) analysis demonstrated that group assignment was a significant predictor of BMI over time, with participants in the TAU+MEI group showing significantly lower BMI values compared with the TAU group (*B*=−2.176, 95% CI: −3.890 to −0.462, *p*=0.013). Age was also negatively associated with BMI (*B*=−0.159, 95% CI: −0.292 to −0.026, *p*=0.019). In addition, higher education status (*B*=−0.951, 95% CI: −1.561 to −0.341, *p*=0.002) and being occupationally active (*B*=−2.567, 95% CI: −4.601 to −0.534, *p*=0.013) were associated with lower BMI over time (Table 5). Regarding clinical characteristics, molecular subtype (*B*=1.304, 95% CI: 0.299 to 2.309, *p*=0.011) and the presence of chronic disease (*B*=2.666, 95% CI: 0.893 to 4.440, *p*=0.003) were significantly associated with higher BMI values. Regular physical activity was not a significant predictor of BMI in the GEE model (*p*=0.141) (Table 5).

Table 3 Changes in waist and hip circumference before and after the intervention

Variables	Time	TAU (<i>n</i> = 15) $\bar{X} \pm SD$	TAU+MEI (<i>n</i> = 13) $\bar{X} \pm SD$	<i>P</i> ^a - value
Waist circumference	T ₀	106.53 ± 12.52	96.62 ± 7.10	0.018*
	T ₁	101.33 ± 15.16	92.69 ± 7.19	0.072
	Difference	-5.20 ± 5.40	-3.92 ± 7.27	0.599
	<i>P</i> ^b -value	0.002*	0.076	
Hip circumference	T ₀	116.13 ± 11.28	116.08 ± 5.95	0.987
	T ₁	113.87 ± 11.80	111.77 ± 6.95	0.579
	Difference	-2.27 ± 5.11	-4.31 ± 4.99	0.296
	<i>P</i> ^b -value	0.108	0.009*	
Waist/hip ratio	T ₀	0.92 ± 0.07	0.83 ± 0.06	0.002*
	T ₁	0.88 ± 0.08	0.83 ± 0.07	0.055
	Difference	-0.03 ± 0.05	0.00 ± 0.06	0.131
	<i>P</i> ^b -value	0.024*	> 0.999	

p* < 0.01; *p* < 0.05; TAU+MEI = Treatment as Usual + Mindful Eating Intervention; TAU = Treatment as Usual

Discussion

This pilot randomized controlled trial examined the effects of a structured mindful eating intervention (MEI) on eating behaviors and anthropometric outcomes in breast cancer survivors receiving standard care. The findings of this study contribute to the growing body of survivorship research highlighting the importance of behavioral and psychosocial approaches in addressing weight management and eating-related challenges following cancer treatment. The present study provides preliminary data regarding the addition of mindful eating practices to standard nutritional care; however, it does not establish an additional benefit of MEI over TAU. Even if weight loss was not the primary focus in this present study, it was aimed weight management with alterations in eating behaviors. Weight management was crucial due to the BMI of the participants. Central obesity is linked to an elevated risk of premenopausal breast cancer [13]. Obese postmenopausal women face an elevated risk of developing hormone-sensitive breast tumors due to high serum estrogen levels and increased peripheral estrogen production [11]. Excessive fat mass is a risk for breast cancer development in overweight postmenopausal women. Preventing weight gain, having a healthy body weight and fat can be a crucial strategy for recurrence of breast cancer [15]. In this study, participants were mostly (*n* = 25) postmenopausal. Researchers highlighted the importance of managing weight as part of cancer care because progression was significantly correlated with overweight or obese patients [9]. Elevated serum estrogen levels, coupled with increased

peripheral estrogen production, are considered key factors contributing to BC development in overweight postmenopausal women [11]. Over the six-month follow-up period, significant reductions were observed in body weight, BMI, fat mass, waist circumference (WC), and waist-to-hip ratio in both the TAU + MEI and TAU groups, although the magnitude and timing of these changes varied between groups. Overall, both groups demonstrated improvements in anthropometric outcomes over time. According to World Health Organization (WHO) [30], the primary objective of weight loss therapy should be an initial reduction of approximately 10% from the starting weight. Both the TAU + MEI and TAU groups demonstrated significant reductions in BMI over the intervention period. Decreases in fat mass were also observed in both groups, with a more pronounced early reduction in the TAU group, whereas reductions in the TAU + MEI group emerged more gradually over time. Similar changes as reduction in body weight and BMI resulted in cancer intervention studies [23, 31, 32]. In a mindful eating intervention study in African American women following breast cancer treatment aimed to increase mindful eating behaviors, with a focus on weight loss, it was suggested that mindful eating interventions can help women with breast cancer reduce weight, particularly when combined with individual counseling and group support [32].

These findings indicate improvements in body composition and central adiposity over time. However, because similar improvements were observed in both groups, these changes cannot be attributed specifically to the mindful eating intervention. The validity of BIA in breast cancer survivors has been supported by a study which demonstrated strong correlations between BIA and dual-energy X-ray absorptiometry despite systematic differences in fat mass and fat-free mass estimates [33]. In a similar pilot study by Sattler et al. [34] examined the effect of a mindful eating (ME) intervention on clinical obesity markers and cardiovascular disease risk in postmenopausal breast cancer survivors with a mean age of 64.4 ± 6.0 years and mean BMI was 33.7 ± 7.6 kg/m². Also, an 8-week mindful eating intervention was associated with a modest but significant reduction in BMI, alongside decreases in waist circumference. In the present study, reductions in waist circumference were also observed over time, with significant within-group changes detected, although changes in the waist-to-hip ratio were more limited. Waist circumference decreased over time, particularly in the TAU group; however, the absence of a significant between-group difference does not support attributing this change specifically to MEI. Mindful eating is rooted in the broader framework of mindfulness-based interventions and has been associated with improvements in psychological well-being, reduced binge eating, and greater adherence to healthy dietary patterns [22]. Mindfulness

Table 4 Longitudinal changes in body weight, bmi and fat mass following the intervention

Variables	Time	TAU	TAU+MEI	Repeated measures ANOVA			
		$\bar{X} \pm SD$	$\bar{X} \pm SD$	Effects	F	P-value	η^2
BMI	T ₁	33.90±5.48	30.64±2.64	Group	3.422	0.076	0.116
	T ₂	33.05±5.77	30.02±2.52	Time	20.632	<0.001	0.442
	T ₃	32.59±5.66	29.61±2.32	Time*Group	0.924	0.411	0.034
	T ₄	32.41±5.75	29.57±2.51				
	T ₅	32.25±5.92	29.02±2.35				
	T ₆	32.31±5.81	29.05±2.65				
	T ₇	32.39±5.93	28.75±3.06				
Change from baseline within the group							
		MD	P-value	MD	P-value		
T ₁ vs T ₂		-0.85	0.026	-0.62	0.069		
T ₁ vs T ₃		-1.31	0.002	-1.03	0.007		
T ₁ vs T ₄		-1.49	<0.001	-1.07	0.048		
T ₁ vs T ₅		-1.65	<0.001	-1.62	0.007		
T ₁ vs T ₆		-1.59	0.006	-1.59	0.018		
T ₁ vs T ₇		-1.51	0.022	-1.89	0.114		
Variables	Time	TAU	TAU+MEI	Repeated Measures ANOVA			
		$\bar{X} \pm SD$	$\bar{X} \pm SD$	Effects	F	P-value	η^2
Body weight	T ₁	86.57±13.38	81.04±5.31	Group	1.486	0.234	0.054
	T ₂	84.05±13.95	79.39±5.48	Time	23.113	<0.001	0.471
	T ₃	83.01±14.04	78.38±5.76	Time*Group	1.160	0.324	0.043
	T ₄	82.39±14.17	78.22±5.65				
	T ₅	82.09±14.67	76.86±6.18				
	T ₆	82.29±14.60	76.92±6.41				
	T ₇	82.47±14.68	76.12±7.73				
Change from baseline within the group							
		MD	P-value	MD	P-value		
T ₁ vs T ₂		-2.52	0.008	-1.65	0.044		
T ₁ vs T ₃		-3.57	0.001	-2.66	0.004		
T ₁ vs T ₄		-4.19	<0.001	-2.82	0.034		
T ₁ vs T ₅		-4.49	<0.001	-4.18	0.006		
T ₁ vs T ₆		-4.29	0.002	-4.12	0.015		
T ₁ vs T ₇		-4.10	0.009	-4.92	0.084		
Variables	Time	TAU	TAU+MEI	Repeated measures ANOVA			
		$\bar{X} \pm SD$	$\bar{X} \pm SD$	Effects	F	P-value	η^2
Fat mass	T ₁	34.83±9.05	30.71±3.94	Group	1.575	0.221	0.057
	T ₂	33.09±9.20	30.15±4.17	Time	17.283	<0.001	0.399
	T ₃	32.07±9.89	29.41±3.61	Time*Group	2.163	0.092	0.077
	T ₄	32.09±9.86	29.19±3.82				
	T ₅	31.65±9.90	28.05±4.30				
	T ₆	31.77±10.00	27.62±4.43				
	T ₇	32.40±9.87	27.67±4.77				
Change from baseline within the group							
		MD	P-value	MD	P-value		
T ₁ vs T ₂		-1.74	0.014	-0.56	>0.999		
T ₁ vs T ₃		-2.76	0.035	-1.30	0.170		
T ₁ vs T ₄		-2.73	<0.001	-1.52	0.222		
T ₁ vs T ₅		-3.18	0.001	-2.66	0.026		
T ₁ vs T ₆		-3.06	0.002	-3.09	0.022		
T ₁ vs T ₇		-2.43	0.069	-3.04	0.042		
Variables	Time	TAU	TAU+MEI	Repeated measures ANOVA			
		$\bar{X} \pm SD$	$\bar{X} \pm SD$	Effects	F	P-value	η^2
Trunk fat mass	T ₁	15.51±4.28	14.45±2.26	Group	0.338	0.566	0.013
	T ₂	14.62±4.15	14.35±2.50	Time	9.768	<0.001	0.273

Table 4 (continued)

Variables	Time	TAU	TAU + MEI	Repeated measures ANOVA			
		$\bar{X} \pm SD$	$\bar{X} \pm SD$	Effects	F	P-value	η^2
	T ₃	14.40 ± 4.11	14.02 ± 2.14	Time*Group	1.620	0.145	0.059
	T ₄	14.39 ± 4.69	13.89 ± 2.39				
	T ₅	14.01 ± 4.61	13.26 ± 2.56				
	T ₆	14.07 ± 4.65	12.89 ± 2.55				
	T ₇	14.49 ± 4.69	13.13 ± 2.40				
Change from baseline within the group							
		MD	P-value	MD	P-value		
	T ₁ vs T ₂	-0.89	0.063	-0.10	> 0.999		
	T ₁ vs T ₃	-1.11	0.171	-0.43	> 0.999		
	T ₁ vs T ₄	-1.12	0.043	-0.55	> 0.999		
	T ₁ vs T ₅	-1.49	0.026	-1.19	0.107		
	T ₁ vs T ₆	-1.44	0.067	-1.55	0.043		
	T ₁ vs T ₇	-1.01	0.414	-1.32	0.081		

* $p < 0.05$; ** $p < 0.01$; a, Independent samples t-test; TAU+MEI = Treatment as Usual + Mindful Eating Intervention; TAU = Treatment as Usual

Table 5 GEE analysis of BMI changes over time after the intervention (generalized estimating equations)

Variables	B	SE	95% CI (Low- Up)		Wald χ^2	P -value
Intercept	40.583	4.320	32.116	49.050	88.249	< 0.001
Group (TAU + TAU/MEI)	-2.176	0.874	-3.890	-0.462	6.193	0.013**
Age	-0.159	0.068	-0.292	-0.026	5.515	0.019**
Education status	-0.951	0.311	-1.561	-0.341	9.337	0.002*
Occupation status (yes/no)	-2.567	1.038	-4.601	-0.534	6.123	0.013**
Molecular subtype (HR(+)-HER2(-) /other group)	1.304	0.513	0.299	2.309	6.463	0.011**
Chronic disease (yes/no)	2.666	0.905	0.893	4.440	8.688	0.003*
Regular physical activity (yes/no)	0.977	0.664	-0.325	2.280	2.164	0.141

* $p < 0.01$; ** $p < 0.05$; SE, Standard Error; CI, Confidence Interval

and mindful eating, as behavioral interventions, have been explored for their potential in improving the eating experience of cancer patients [34, 35]. Within the TAU + MEI group, significant improvements were observed in reliance on hunger and satiety cues, eating control, and the MEQ-30 total score. However, between-group comparisons of change scores did not demonstrate significant superiority of TAU + MEI over TAU across the intuitive and mindful eating outcomes. Similar to this study, in a Stage I pilot randomized controlled trial aimed to assess the feasibility of integrating exercise and nutrition counseling with Mindfulness Oriented Recovery Enhancement (MORE) to target appetitive dysregulation in overweight and obese cancer survivors. The trial involved 10-week treatment: exercise and nutrition counseling or exercise, nutrition counseling, and MORE. Restrained, emotional, and external eating showed reductions in the MORE intervention but not in the control group. MORE was also associated with significant improvements in self-reported interoceptive awareness, a mechanism that may prevent overeating in the face of ubiquitous encounters with appetitive cues in the obesogenic sociocultural environment [23]. Previous studies have suggested that mindful eating may have potential relevance for emotional well-being and eating-related experiences among

breast cancer survivors [36, 37]. Mindful eating involves focusing on the sensations of eating in a nonjudgmental way [22], which can help patients with cancer cope with their symptoms. In clinical settings, mindful eating has been found to reduce anxiety around eating, alleviate symptoms like dry mouth, and foster a positive shift in the overall eating experience [35]. The SOAR intervention was developed by Huang et al. [31] as integrating mindful eating into a teaching kitchen format for breast cancer survivors within the context of a plant-based Mediterranean diet cooking sessions with a nutrition education was provided. SOAR program was effective in enhancing mindfulness, particularly in the areas of food awareness, emotional eating, and managing external cues. Overall improvements were shown in the MEQ subscales, except for the distraction domain. Previous research has suggested that mindfulness training in eating may help individuals better manage their eating behaviors, potentially contributing to healthier dietary habits and greater adherence to general healthy eating recommendations [38, 39]. No significant changes were observed in the MN subscale, suggesting that while eating behaviors improved, broader mindfulness-related components may require additional or longer-term strategies. Sattler et al. [34] stated that an 8-week mindful eating group workshops

with no nutritional education could lead to weight loss and increased mindfulness in breast cancer survivors and added that increased mindfulness may have contributed to a better relationship with food and improved emotional regulation. Overall mindfulness might require as additional strategies to mindful eating interventions. In a recent umbrella review by Wang et al. [40], maintaining healthy BMI values was underscored as a critical factor in breast cancer etiology; consequently, the importance of metabolic control in preventing recurrences and improving prognosis necessitates the exploration of sustainable dietary approaches, such as intuitive eating.

Improvements in selected intuitive and mindful eating outcomes were observed over time in both study groups, and between-group comparisons did not demonstrate clear superiority of TAU + MEI over TAU. Within the TAU + MEI group, significant improvements were observed in reliance on hunger and satiety cues, eating control, and the MEQ-30 total score. No adverse events related to the intervention were reported during the study. These findings should be interpreted in light of several important limitations. The mindfulness subscale did not show significant improvement, indicating that changes observed in selected eating-related dimensions did not extend to the broader mindfulness construct measured in this study. Furthermore, the small sample size, single-center design, and absence of blinding limit the generalizability and introduce potential sources of bias. The lack of effect size estimates and confidence intervals also restricts the precision of between group comparisons. Because TAU included individualized nutritional counseling and regular follow-up by an experienced oncology dietitian, improvements in both groups may partly reflect the effects of standard nutritional care, thereby limiting the ability to isolate any additional contribution of MEI. Given the pilot nature of this study, the relatively small sample size, and participant attrition during follow-up, the present findings should be considered exploratory and hypothesis-generating rather than confirmatory. In addition, the multivariable GEE model should be interpreted cautiously given the pilot nature of the study and the limited sample size. Although clinically relevant covariates were selected *a priori*, larger studies are needed to provide more stable estimates of the independent associations.

Another limitation is that randomization was not stratified according to clinical characteristics such as endocrine therapy status. Because endocrine therapy may influence body weight and body composition, an imbalance between groups cannot be completely excluded. In addition, although participant flow and attrition are presented in the CONSORT diagram, the relatively high dropout observed during the six-month follow-up may have reduced statistical precision and introduced attrition bias. Future randomized controlled

trials should consider stratified randomization based on key clinical variables and incorporate retention strategies, such as flexible scheduling, regular reminders, and hybrid or online intervention components, to improve participant adherence throughout long-term follow-up.

Nevertheless, the study was conducted over a six-month period at a single center and was delivered by the same experienced oncology dietitian and a trained mindful eating teacher. All anthropometric measurements were performed by the same professional using standardized procedures, and the same measurement devices were used throughout the study, thereby minimizing interobserver variability and measurement bias. In addition, this trial provides valuable preliminary data on behavioral and anthropometric outcomes observed when mindful eating was added to standard nutritional care in breast cancer survivors.

In this pilot randomized controlled trial, improvements in selected eating-behavior and anthropometric outcomes were observed over time in both the TAU and TAU + MEI groups. For intuitive and mindful eating outcomes, between-group comparisons of change scores did not demonstrate clear superiority of TAU + MEI over TAU. In addition, exploratory GEE analysis identified an association between TAU + MEI group assignment and lower BMI over time; however, this finding should be interpreted cautiously given the small sample size and potential model instability. Older age, higher educational level, and active employment status were also associated with lower BMI values, whereas having an HR(+)/HER2(−) molecular subtype and the presence of chronic disease were related to higher BMI. These exploratory associations indicate that weight-related outcomes may vary according to multiple clinical, demographic, and care-related factors.

From a practical standpoint, this pilot study demonstrates the feasibility of delivering a structured MEI alongside standard nutritional care. As a non-invasive, low-cost, and behaviorally focused approach, MEI was designed to encourage patients to make more conscious food choices without relying on restrictive dieting. The structured format used in this study may inform the design of future adequately powered trials evaluating whether MEI provides additional benefit beyond standard nutritional care. Future large-scale, adequately powered randomized controlled trials with longer follow-up periods are needed to determine whether adding MEI to standard nutritional care provides clinically meaningful benefits beyond TAU and to explore its potential longer-term effects on metabolic health and psychological well-being.

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Data availability The data that support the findings of this study are available from Acibadem University but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of Ethics Committee of Acibadem University.

Declarations

Conflict of interest The authors declare that there are no financial, professional, or personal relationships that could be construed as potential conflicts of interest.

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