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# Restraint eating in bariatric surgery patients: longitudinal patterns and associations with eating disorders

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**Resumo**

Este estudo longitudinal avaliou a evolução dos comportamentos alimentares restritivos em doentes submetidos a cirurgia bariátrica metabólica e a sua associação com o peso e os comportamentos alimentares problemáticos. Os doentes foram avaliados antes da cirurgia e 6, 12, 18, 24 e 36 meses após a cirurgia. A avaliação incluiu o questionário EDE para identificar episódios de perda de controlo alimentar (LOCE) e um conjunto de medidas de autoavaliação que avaliavam variáveis sociodemográficas e antropométricas, bem como comportamentos alimentares problemáticos, incluindo comportamentos restritivos, alimentação descontrolada (UE) e preocupações com a comida, o peso e a forma física (EDE-Q; TFEQ-R21). A restrição alimentar no EDE-Q foi mais elevada no pré-operatório, diminuiu durante os primeiros 24 meses após a cirurgia e aumentou novamente aos 36 meses. Em contraste, a Restrição Cognitiva no TFEQ-R21 foi mais baixa no início do estudo e aumentou aos 6, 12 e 18 meses. À semelhança do EDE-Q, a restrição diminuiu significativamente aos 24 meses em comparação com os 6 meses, aumentando novamente aos 36 meses. Apesar destas diferenças, ambas as medidas indicaram uma redução da restrição cerca de 24 meses após a cirurgia. Enquanto a subescala de Restrição Cognitiva do TFEQ-R21 se associou positivamente ao LOCE e negativamente ao UE, a restrição do EDE-Q apresentou o padrão inverso. Apenas a subescala de restrição do EDE-Q se associou positivamente às preocupações com a comida, o peso e a forma física. Não foram encontradas associações significativas entre qualquer uma das medidas de restrição e os resultados de perda de peso. Em geral, os resultados sugerem que o EDE-Q e o TFEQ-R21 avaliam dimensões distintas de restrição. Embora a restrição não estivesse diretamente associada aos resultados de peso, estava associada a comportamentos alimentares problemáticos que têm sido relacionados com a recuperação de peso a longo prazo.

**Palavras-chave:** Cirurgia Bariátrica; Restrição Alimentar; Instrumentos de avaliação de restrição; Comportamento Alimentar; Resultados de Peso.

**Abstract**

This longitudinal study examined the trajectory of restrictive eating behaviors in patients receiving metabolic bariatric surgery (MBS), and its association with weight and problematic eating. Patients were assessed pre-surgery, and at 6, 12, 18, 24, and 36 months post-surgery. Assessment included and interviewed (EDE) for identifying loss of control eating (LOCE) episodes and a set of self-report measures assessing sociodemographic and anthropometric variables, and problematic eating including restrictive behaviors, uncontrolled eating (UE) and concerns about eating, weight, and shape (EDE-Q; TFEQ-R21). EDE-Q restraint eating was highest preoperatively, decreased during the first 24 months after surgery, and increased again at 36 months. In contrast, TFEQ-R21 Cognitive Restraint was lowest at baseline, and increased at 6, 12, 18 months. Similarly to EDE-Q, restraint decreased significantly at 24 months compared to 6 months, increasing again at 36 months. Despite these differences, both measures indicated a reduction in restraint around 24 months post-surgery. While TFEQ-R21 Cognitive Restraint subscale was positively associated with LOCE and negatively associated with UE, the EDE-Q restraint showed the reverse pattern. Only EDE-Q restraint subscale was positively associated with concerns about eating, weight, and shape. No significant associations were found between either measure of restraint and weight loss outcomes. Overall, the findings suggest that the EDE-Q and TFEQ-R21 assess distinct dimensions of restraint. Although restraint was not directly associated with weight outcomes, it was associated with problematic eating behaviors that have been linked to long-term weight regain.

**Keywords:** Metabolic bariatric surgery; Restraint eating; Restraint Measures; Eating Behaviour; Weight Outcomes

***Index***

## Lista de Abreviaturas

MBS – Metabolic Bariatric  Surgery

ED/EDs – Eating Disorder (s)

PEB/PEBs – Problematic Eating Behaviour (s)

RE – Restraint Eating

UE – Uncontrolled Eating

LOCE – Loss of Control Eating

BMI – Body Mass Index

%TWL – Percentage of Total Weight Loss

GEE – Generalized Estimating Equations

TFEQ-R21 – Three Factor Eating Questionnaire-R21

TFEQ-R21_CR – Three Factor Eating Questionnaire-R21 Cognitive Restraint Subscale

TFEQ-R21_UE – Three Factor Eating Questionnaire-R21 Uncontrolled Eating Subscale

EDE-Q – Eating Disorder Examination Questionnaire

EDE-Q_RS – Eating Disorder Examination Questionnaire Restraint Subscale

EDE – Eating Disorder Examination

# I – Introduction

The World Health Organization reported in 2022 that one in eight people worldwide was living with obesity (Holt, 2005; Monteforte & Turkelson, 2000; Song & Fernstrom, 2008), and since 1990, this prevalence has more than doubled (Holt, 2005; WHO, 2025). In Portugal, in the same year, more than half of the population aged 18 or older was overweight (37.3%) or obese (15.9%) (INE, 2025).

Metabolic bariatric surgery (MBS) has been considered the most effective method for the treatment of severe obesity (BMI > 40 kg/m2), when compared to non-surgical approaches, such as behavioural modification, and pharmacologic therapy. In general, MBS promotes weight loss by reducing food intake through gastric restriction and, in some procedures, decreasing nutrient absorption. According to recent data, sleeve gastrectomy and Roux-en-Y gastric bypass (RYGB) are the most commonly performed bariatric procedures in Portugal. Sleeve gastrectomy involves the surgical removal of most of the stomach fundus and body, resulting in a permanent reduction in gastric capacity. In contrast, RYGB is a combined restrictive and malabsorptive procedure in which a small gastric pouch is created to limit food intake, while the duodenum and proximal jejunum are bypassed, leading to reduced nutrient and caloric absorption (Durão et al., 2020; NHMRC, 2013; ULSSJ, 2024).

This intervention offers benefits in maintaining weight loss over time, improving associated comorbidities (such as Type 2 Diabetes Mellitus, hypertension, and sleep apnoea), and yielding positive psychological outcomes, including improved quality of life, reduced anxiety and depression, enhanced self-esteem, and improved social relationships (Monteforte & Turkelson, 2000; NHMRC, 2013; Sjöström et al., 2004; Song & Fernstrom, 2008).

However, not all patients achieve the expected results regarding weight and psychosocial outcomes, and there is a subgroup of patients that following MBS reported weight regain, Eating Disorders (EDs), and Problematic Eating Behaviours (PEBs). Evidence indicates that weight regain commonly occurs between two and five years after surgery (Bocchieri et al., 2002; Monteforte & Turkelson, 2000), while PEBs tend to emerge beyond the second postoperative year (Conceição et al., 2018). Together, these findings highlight the importance of understanding this problematic in long-term MBS outcomes.

The use of Restraint eating (RE) is common among bariatric surgery patients, consisting in the cognitive effort to reduce food intake with the goal of controlling weight and body shape, regardless of whether it is successful. Although often used interchangeably, in definitions and assessments instruments, the concepts of restraint, and dietary restriction, represent distinct constructs, with the last one implying an actual reduction in caloric intake (Schaumberg et al.,

2016; Trolio et al., 2026). This distinction is particularly important in obesity research, as individuals with obesity more frequently express an intention to reduce caloric intake and maintain a healthier diet, but they do not always manage to achieve these goals, which leads to higher levels of cognitive restraint (Sweerts et al., 2019).

RE has been associated with more severe disorder eating symptoms and poorer psychological well-being (Hindle et al., 2020; Lydecker et al., 2019; Parker et al., 2015). Also, some studies have demonstrated that cognitive restraint is associated with poorer weight loss outcomes. Namely, a three-year follow up study, in a representative Dutch sample, has presented that dietary restraint was significantly associated with an increase in BMI at follow-up (van Strien et al., 2014). Some factors have been pointed out in literature in order to explain this outcome such as perceived deprivation, dysregulation of internal perception of hunger and satiety, disinhibition and emotional dysregulation (Hindle et al., 2020; Markowitz et al., 2008; Sweerts et al., 2016; Timmerman & Gregg, 2003).

Outside the bariatric context, several theories explained the role that RE plays as a maintenance factor for EDs, and PEBs. The Restraint Theory proposes that individuals who regulate eating through cognitive control rather than internal hunger and satiety cues become more vulnerable to violating self-imposed dietary rules, leading to loss of control over eating, increased dietary disinhibition, and a higher risk of binge eating and overeating (Herman & Polivy, 1984; Polivy & Herman, 1985; Lowe et al., 2001; Markowitz et al., 2008). Similarly, the Dual-Pathway Model suggests that bulimic behaviours arise from the interaction between restrictive dieting and negative affect associated with body dissatisfaction, which is reinforced by family, social, cultural, and media pressures (Stice, 2001). According to this model, unsuccessful attempts to control weight through dieting intensify negative emotions and increase vulnerability to compulsive eating behaviours. Finally, the Cognitive-Behavioural Theory of Eating Disorders posits that dietary restraint stems from the overvaluation of eating, weight, shape, and self-control in self-evaluation. In this framework, disinhibited eating emerge following the violation of rigid dietary rules and function as a maladaptive coping strategy for negative emotions, thereby perpetuating concerns about weight and shape and maintaining this vicious cycle (Fairburn et al., 1986; Fairburn et al., 2003).

However since not all individuals who restrain develop disorder eating, some evidence suggest that this only happens in the presence of some risk factors such as: a history of repeated weight loss attempts, stigma, body image dissatisfaction, social pressure for thinness, anxiety, and depression (Haines & Neumark-Sztainer, 2006; Isomaa et al., 2010; Schaumberg et al., 2016; Stewart et al., 2022; Stice et al., 2011). Taking this findings into the context of MBS,

these patients might be at increased risk of developing ED symptoms and PEBs given that they report a long history of unsuccessful weight loss attempts, cycles of weight loss and regain, negative experiences of social, occupational, educational, and clinical stigma, as well as internalization of stigma (Bennett et al., 2022; Gibbons et al., 2006; Lillis et al., 2010; Sarwer et al., 2008a), thereby making them particularly vulnerable to concerns about eating, weight, shape. Therefore, depressive symptomatology is highly prevalent among patients undergoing MBS. Considering that some patients already undergo surgery with these preoccupations in mind, it is natural that, after surgery this concerns are exacerbated by the strict control over dieting that is prescribed, the constant warnings of weight risk, and also, particularly related to body concerns, the excessive skin that most patients present after the significant weight loss (Ramalho et al., 2015; Steffen et al., 2012; Watson et al., 2020). Ultimately, these exacerbated concerns may foster further efforts to restrict, resulting in more PEBs (Conceição et al., 2015; Conceição et al., 2018; Marino et al., 2012; Watson et al., 2020).

Among postoperative PEBs, Loss Of Control Eating (LOCE) has been receiving considerable attention in the bariatric literature due to its association with more postsurgical complications, such as greater psychopathology, reduced health-related quality of life, poorer weight outcomes, and increased risk for Picking, Nibbling and Grazing (Brode & Mitchell, 2019; de Zwaan et al., 2010). Indeed, a Portuguese sample study demonstrates that LOCE was present in 26.7% of patients pre-operative, 16.9% in long-term patients, and in 11.8% of the short-term patients (Conceição et al., 2014b).

In contrast with these findings, other studies argued that this association between restraint and PEBs may not occur in all contexts. On the contrary, they indicate that RE within a structured weight loss programme may reduce the presence of LOCE (da Luz et al., 2015; Goodrick et al., 1998; House et al., 2021; Schaumber et al., 2016).

Given these contradictory findings, it is important to clarify the role that RE portrays in the development of this disorder behaviours in the bariatric context. Moreover, studies within the bariatric field are still very limited, and this may be partially related to the similarity between post-surgical dietary prescriptions and PEBs and symptoms of EDs, that makes it difficult to distinguish whether these behaviours result from excessive concerns about weight and body shape or whether they represent an effort to comply with treatment recommendation (Conceição et al., 2015; Conceição et al., 2018; Marino et al., 2012; Sockalingam et al., 2017).

Even though the reasons for the onset of EDs and PEBs may not be yet very clear, a large number of studies have suggested that its presence before and after surgery may affect weight loss outcomes (Conceição et al., 2015; Williams-Kerver et al., 2019). Specifically, Conceição et al. (2017) showed that about 65% of patients with weight regain reported PEB´s. Also, in a recent literature review, Williams-Kerver et al. (2019), report that being diagnosed with an ED following surgery was associated with less weight loss two and three years post-surgery. With this in mind, if RE may contribute to EDs and PEBS, and if these are predictors of poor weight outcomes post surgery, therefore one can presumably assume that the first is a possible predictor of the last.

However, evidence regarding the relationship between restraint and weight trajectory remains controversial. A recent meta-analysis studying the correlates of RE with weight loss post surgery revealed inconsistent results: 46% of the studies indicated that restraint was associated with poorer weight outcomes, whereas 54% suggested that restraint was linked to greater weight loss (Hindle, 2026). In fact, some studies suggest that there is no association between restraint and weight outcomes (Custers et al., 2023; Roehrig et al., 2009; Schaumberg & Anderson; 2016), and suggest that this variability can be partially explained by diet quality, eating patterns, and the degree of flexibility of restraint.

These findings are in accordance with Westenhoefer et al. (1999) theory of restraint, which establish that different outcomes can result depending on the type of restraint adopted. A more rigid pattern is characterised by inflexible dietary rules and an “all-or-nothing” approach to eating, often accompanied by elevated concerns about eating, weight and shape. Because this form of restraint requires substantial cognitive effort, it may be difficult to maintain and can contribute to cycles of restriction and overeating. In contrast, flexible restraint reflects a more moderate and sustainable approach to eating regulation, promoting a less rigid relationship with food, which predictably leads to a more sustainable eating style over time (Bryant et al., 2019; Schaumberg et al., 2016; Stewart et al., 2022; Westenhoefer et al., 2004; Westenhoefer et al., 2013).

Based on these results, a better understanding of the longitudinal trajectory of RE after MBS is essential to clarify how this construct may relate to weight and psychosocial outcomes over time. Although previous evidence suggests that weight regain and disordered eating behaviours tend to emerge approximately two years after surgery (de Zwaan et al., 2010), to the best of our knowledge, only few studies have specifically examined how cognitive restraint evolves throughout the postoperative follow-up (Hindle, 2026). This lack of longitudinal

characterization limits the understanding of whether changes in restraint may contribute to, precede, or result from these poorer outcomes.

Overall, despite the growing recognition of PEBs and EDs as important determinants of long-term MBS outcomes, the role of RE remains poorly understood. Existing findings are scarce and inconsistent, with studies suggesting that restraint may function either as a risk factor for disordered eating and poorer weight outcomes or as a protective strategy that supports weight management. Given the increasing number of bariatric procedures performed worldwide and the limited longitudinal evidence available, a better understanding of the trajectory of RE and its relationship with eating-related psychopathology and weight outcomes following MBS is needed. Such knowledge may contribute to the development of more comprehensive and integrated approaches to obesity treatment that address both weight-related and psychological outcomes.

## II – Objectives

The present study aimed to examine the longitudinal trajectory of Restraint Eating following MBS, as assessed by two distinct measures: the Cognitive Restraint subscale of the Three-Factor Eating Questionnaire–Revised 21 (TFEQ-R21) and the Restraint subscale of the Eating Disorder Examination Questionnaire (EDE-Q). Additionally, this study sought to investigate the association between restraint and weight-related outcomes, as well as PEB´s and eating related cognition outcomes (e.g., LOCE, Uncontrolled Eating, and concerns about eating, weight, and shape) from the pre-operative period through post surgical follow-up.

To address these aims, the following research questions were developed:

Q1 - How does restraint eating change over the course of follow-up after bariatric surgery?

Q2 - Is restraint eating associated with the development of problematic eating behaviours following bariatric surgery?

Q3 - Is restraint eating associated with weight loss following bariatric surgery?

To answer this questions, the following hypothesis were, respectively, formulated:

H1 - Restraint Eating follows distinct patterns of change across the postoperative follow-up period.

H2 - Higher levels of Restraint Eating are associated with a greater likelihood of problematic eating behaviours following bariatric surgery.

H3 - Higher levels of Restraint Eating are associated with lower weight loss after bariatric surgery.

## III – Methods

### Procedure

These study is part of a larger longitudinal study conducted at a central hospital in the north of Portugal (Pinto-Bastos et al., 2019). All patients admitted to MBS between April 2014 and April 2017 were considered eligible for the study. Participants were assessed preoperatively and at 6, 12, 18, 24, and 36 months postoperatively. Baseline assessments were conducted during the month before surgery, and follow-up assessments took place after routine postoperative medical appointments.

Exclusion criteria included pregnancy after surgery, severe cognitive impairment that limited patients´ autonomy, severe psychiatric conditions with severe impairment of global functioning, major active psychiatric disorder other than an eating disorder as primary diagnosis, inability to understand Portuguese, and undergoing a ketogenic or liquid diets before surgery.

The study received approval from the University Ethics Committee and the Hospital Institutional Review Boards, and all participants provided written informed consent, after being informed of the aims and voluntary nature of the participation.

### Participants

The final sample used to the purpose of these study comprised 373 adults at baseline. However, due to the exclusion criteria, no-shows to appointments with the multidisciplinary team, refusal to participate, transferences to different hospital, and delays in previous medical appointments resulting in conflicting schedules with the research interviews, some patients were lost during the follow-up.

### Sociodemographic and Anthropometric Variables

Sociodemographic information was collected through a face-to-face semi-structured clinical interview. Variables assessed included gender, age, educational level, employment status, and type of surgery.

Regarding anthropometric variables, height, preoperative weight, and postoperative weights at each follow-up assessment were collected from participants' medical charts. These measures were used to compute weight-related outcomes such as BMI pre to post surgery, and Percentage of Total Weight Loss at each assessment period.

The different weight-related variables were computed as follows: BMI pre surgery: weight_presurg / (height * height); BMI post surgery: weight_post / (height * height); Percentage of total weight loss (%TWL): ((weight_presurg - weight_post)/weight_presurg)*100.

**Measures**

Restraint Eating was assessed using two self-report measures: the Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Beglin, 1994) and the Three-Factor Eating Questionnaire–Revised 21 (TFEQ-R21; Cappelleri et al., 2009; Duarte et al., 2020). These instruments were also used to assess other disordered eating behaviours and eating disorder psychopathology, namely Eating, Weight, Shape related Concerns, and Uncontrolled Eating. Lastly, the presence of Loss of Control Eating was assessed using other measures, as described below.

***Eating Disorder Examination Questionnaire (EDE–Q)***

The Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Beglin, 1994) is a 28-item self-report measure assessing eating disorder psychopathology. It yields four subscale scores (Restraint, Eating Concern, Shape Concern, and Weight Concern), as well as a global score. Items are rated on a 7-point scale (0–6) according to the frequency of behaviours, attitudes, and emotions experienced during the previous 28 days, with higher scores indicating greater psychopathology.

The Restraint subscale assesses attempts to restrict food intake in order to influence body shape or weight and comprises five items (Items 1, 2, 3, 4, and 5; e.g., "Have you been deliberately trying to limit the amount of food you eat to influence your shape or weight?") . The other subscales of the EDE-Q are used to measure the degree of concern about eating (Items 7, 9, 19, 20, and 21; e.g., "Has thinking about food, eating or calories made it very difficult to concentrate on things you are interested in (for example, working, following a conversation, or reading)?"), weight (Items 8, 12, 22, 24, and 25; e.g., "Have you had a strong desire to lose weight?"), and body shape ( Items 6, 8, 10, 11, 23, 26, 27, and 28; e.g., "Has your

shape influenced how you think about (judge yourself as a person?"). To the purpose of these study, a composite score of eating , weight, and shape related concerns was computed, based on previous evidence indicating substantial overlap between these EDE-Q subscales among bariatric surgery candidates (Grilo et al., 2013).

In the present study, the composite score comprising Eating, Weight and Shape Concern demonstrated good internal consistency with values ranging from α = .86–.89. The Restraint subscale showed moderate to acceptable internal consistency (α = .64–.73).

***Three-Factor Eating Questionnaire–Revised 21 (TFEQ-R21)***

The Three-Factor Eating Questionnaire–Revised 21 (TFEQ-R21; Cappelleri et al., 2009; Duarte et al., 2018) is a 21-item self-report measure assessing three dimensions of eating behaviour: Cognitive Restraint, Uncontrolled Eating, and Emotional Eating. Items are rated using a 4-point Likert scale, with the exception of Item 21, which is rated on an 8-point scale.

The Cognitive Restraint subscale evaluates conscious and constant efforts to restrict food intake to achieve a desirable weight and comprises six items (Items 1, 5, 11, 17, 18, and 21; e.g., "I deliberately choose small helpings to control my weight"). On the other hand, Uncontrolled Eating reflects the tendency to overeat due to loss of control over eating behaviour and subjective feelings of hunger. The subscale comprises nine items (Items 3, 6, 8, 9, 12, 13, 15, 19, and 20; e.g., "Sometimes when I start eating, I just can't seem to stop").

The TFEQ-R21 demonstrated good internal consistency for the Uncontrolled Eating subscale at all assessment time points (α = .84–.88). The Cognitive Restraint subscale showed lower and more variable levels of internal consistency throughout the follow-up period (α = .53–.73).

***Eating Disorder Examination interview (EDE)***

The diagnostic items of the 17th edition of the Eating Disorder Examination (Fairburn et al., 2008) interview were used to assess different PEBs and to identify EDs according to the DSM-5. This interview allows the identification of binge eating episodes (when eating is accompanied with loss of control - a sense that one cannot avoid eating or stop eating once started), which can be objective (when an extremely large amount of food is eaten), or subjective (when the amount of food is not extremely large, but is experience as excessive by the respondent). The diagnostic items to identify binge eating episodes (objective and subjective) were used in this study to determined the presence and absence of LOCE. The

presence of LOCE is defined by endorsing at least one episode of binge eating per week over the last three months.

**Statistical analysis**

Statistical analyses of the data were conducted using IBM Statistical Package for the Social Sciences (SPSS), Version 30.0.

Descriptive statistics and frequency analyses were calculated for the main study variables, including restraint eating, weight-related outcomes, and PEBs. Means and Bonferroni-corrected pairwise comparisons, were performed to examine longitudinal changes across the follow-up period. Differences in LOCE over time were examined using Cochran's Q test and McNemar tests with Bonferroni correction.

Normality was assessed using the Kolmogorov–Smirnov test with Lilliefors correction, given the sample size (n = 373), complemented by histograms and evaluation of skewness and kurtosis values. Results indicated that only %TWL met the assumptions of normality, with all the remaining variables significantly deviated from normality ($p < .001$).

Given the non-normal distribution of several variables, the presence of missing data across follow-up assessments, and the longitudinal nature of the data, Generalized Estimating Equations (GEE) were used to test the study hypotheses. GEE models are robust to deviations from normality, particularly in large samples, and allow the inclusion of participants with incomplete repeated measures data (Lu et al., 2009; Wang et al., 2016).

To examine longitudinal changes in restraint eating (Hypothesis 1), two separate GEE models were conducted: one for EDE-Q_RS scores using a normal distribution and one for TFEQ-R21_CR scores using a Gamma distribution. Normal models with identity link functions were used for approximately normally distributed variables, whereas Gamma models with logarithmic link functions were applied to positively skewed continuous variables.

To test the associations between restraint eating, PEBs, and weight outcomes (Hypotheses 2 and 3), additional GEE models were performed. Binomial, Gamma, and normal distributions were used to examine LOCE, UE, and the EDE-Q concern subscales, respectively. A normal distribution GEE model was used to assess the association between restraint eating and %TWL. An exchangeable working correlation matrix was specified for all analyses in this study.

## IV – Results

### Sample Characterization

The sample consisted of 373 participants undergoing MBS, the majority of whom were female (90.6%), with a mean age of 45 years old. Regarding clinical data, the most common surgical procedure performed among the participants was Gastric Bypass surgery, with most of them undergoing a primary surgery. Sociodemographic and clinical characteristics at baseline are presented in Table 1.

**Table 1**

*Sociodemographic Characteristics of Participants at Baseline*

| ***Sociodemographic* characteristic** | ***n/M*** | ***%/SD*** |
|---|---|---|
| **Gender** | | |
| Female | 338 | 90.6 |
| Male | 35 | 9.4 |
| **Age** | | |
| | 373/44.8 | 10.42 |
| **Educational level** | | |
| Without | 4 | 1.1 |
| Until 4th grade | 92 | 24.7 |
| Until 6th grade | 66 | 17.7 |
| Until 9th grade | 75 | 20.1 |
| Until 12th grade | 62 | 16.6 |
| Frequency in High Education | 17 | 4.6 |
| Graduate Level | 41 | 11.0 |
| Post Graduate Level | 16 | 4.3 |
| **Employment Situation** | | |
| Employed | 198 | 53.1 |
| Unemployed | 111 | 29.8 |
| Retired | 58 | 15.5 |
| Student | 6 | 1.6 |
| **Surgery Status** | | |
| Primary | 216 | 57.9 |
| Revisional | 157 | 42.1 |
| **Type of Surgery** | | |
| Gastric Bypass | 247 | 66.2 |
| Gastric Sleeve | 126 | 33.8 |

Table 2 presents the descriptive values and differences for the clinical variables (anthropometric and psycho-behavioural) across the different assessment times. Participants' BMI ranged from 29.35 kg/m² at 18 months, to 43.40 kg/m², at baseline. Overall, BMI

progressively decreased from baseline to 24 months post-surgery, followed by an increase at 36 months.

**Table 2**

*Descriptives and Frequencies Statistics of Variables of Interest*

| | Pré | | 6m | | 12m | | 18m | | 24m | | 36m | | Statistical Diferences |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***M(n)*** | ***SD*** | ***M(n)*** | ***SD*** | ***M(n)*** | ***SD*** | ***M(n)*** | ***SD*** | ***M(n)*** | ***SD*** | ***M(n)*** | ***SD*** | |
| **Weight Variables** | | | | | | | | | | | | | |
| **BMI** | 43.40 (373) | .30 | 32.63 (358) | .26 | 29.75 (338) | .26 | 29.35 (286) | .26 | 29.59 (246) | .28 | 30.11 (167) | .32 | Pre > all time points; 6m > 12,m, 18m, 24m, 36m; 12m > 18m; 36 > 18m, 24m |
| **Percentage of Total Weight Loss** | | | 24.96 (358) | 0.47 | 31.69 (338) | 0.51 | 32.27 (286) | 0.52 | 31.88 (246) | 0.56 | 30.00 (167) | 0.67 | 6m < 12m, 18m, 24m, 36m; 36m < 12m, 18m, 24m |
| **Psychosocial Variables** | | | | | | | | | | | | | |
| **TFEQ-R21 Cognitive Restraint Subscale** | 2.56 (110) | .06 | 2.94 (122) | .048 | 2.89 (177) | .04 | 2.91 (211) | .04 | 2.76 (236) | .05 | 2.83 (182) | .05 | Pre < 6m, 12m, 18m, 36m; 6m> 24 m |
| **EDE-Q Restraint Subscale** | 1.52 (344) | .07 | 1.17 (255) | .08 | 1.12 (277) | .07 | 1.27 (296) | .07 | 1.14 (293) | .07 | 1.46 (183) | 0.10 | Pre > 6m, 12m, 24m; 36m > 12m, 24m |
| **TFEQ-R21 Uncontrolled Eating Subscale** | 2.22 (110) | .06 | 1.37 (123) | .04 | 1.49 (177) | .04 | 1.52 (211) | .04 | 1.46 (237) | .03 | 1.55 (187) | .04 | Pre > all time points; 6m < 12m, 18m, 36m |
| **EDE-Q Mean Concerns *** | 2.50 (347) | 0.10 | 1,47 (256) | .07 | 1.45 (282) | .07 | 1.43 (297) | .06 | 1.37 (294) | .06 | 1.55 (183) | .07 | Pre > all time points |
| | ***n*** (373) | **%** | ***n*** (270) | **%** | ***n*** (295) | **%** | ***n*** (313) | **%** | ***n*** (254) | **%** | ***n*** (171) | **%** | |
| **Presence of Loss of Control Eating** | 101 | 27.1 | 8 | 3.0 | 32 | 10.8 | 29 | 9.3 | 28 | 11.0 | 25 | 14.6 | Pre > 6m, 12m, 18m, 24m; 6m < 12m |

*Note.* ***** Mean computed based on the EDE-Q subscales related to eating, weight and shape concerns.

**Longitudinal trajectory of Restraint Eating following MBS**

The results regarding the longitudinal changes in restraint eating following bariatric surgery, are presented in Table 2.

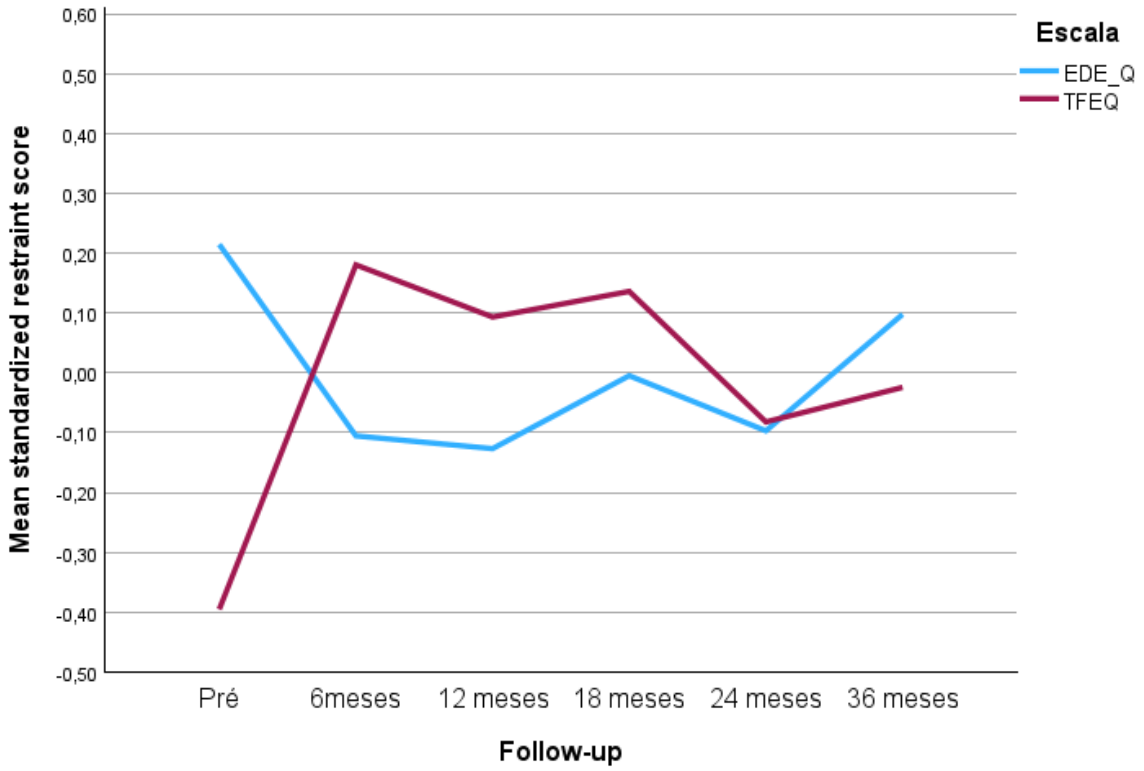
The first GEE model, examining EDE-Q_RS scores, revealed a significant effect of time (*Wald* $\chi^2(5) = 31.56$, $p < .001$). Pairwise comparisons with Bonferroni correction indicated that RE, as measured by the EDE-Q_RS, was significantly higher at the preoperative assessment ($M = 1.52$), and lowest at 12 months ($M = 1.12$). An initial postoperative reduction in restraint can be observed, followed by a significantly raising over the course of follow-up, reaching, at 36 months ($M = 1.46$) values similar, yet lower, that preoperative. However, at 24 months a significant decreased can be observed ($M = 1.14$), with values being similar to 6 and 12 months.

The second GEE model, examining TFEQ-R21_CR scores, also revealed a significant effect of time (*Wald* $\chi^2(5) = 35.55$, $p < .001$). In contrast to the EDE-Q_RS findings, Cognitive Restraint scores were significantly lower at baseline ($M = 2.56$), reaching the highest values immediately after surgery, at 6 months ($M = 2.94$). Despite the observed raising over the course of follow-up, similarly to the pattern observed EDE-Q_RS, there was a significant decrease at 24 months ($M = 2.76$)

This longitudinal changes can be visualized in Figure 1, supporting the results presented in Table 2.

**Figure 1**

*Longitudinal evolution of standardized Restraint measured by the EDE– Q and TFEQ-R21 across the follow-up*




*Note.* Changes in standardized levels of Restraint as measured by the EDE-Q_RS (blue line) and TFEQ-R21_CR (pink line) during the post-bariatric surgery follow-up period (pre-operative to 36 months)

## Associations between Restraint and Problematic Eating Behaviours following MBS

### *Loss of Control Eating (LOCE)*

The results of the GEE model indicated that both restraint measures (TFEQ-R21_CR and EDE-Q_RS) were significantly associated with the presence of LOCE, although in opposite directions. Specifically, higher levels of Cognitive Restraint measured by the TFEQ-R21_CR were associated with a greater likelihood of LOCE ($\beta$ = .61, *SE* = 0.18; *Wald* $\chi^2(1) = 11.05$, $p <$ .001). In contrast, higher EDE-Q_RS scores were associated with a lower probability of LOCE ($\beta$ = -.20, *SE* = .09; *Wald* $\chi^2(1) = 4.92$, $p$ = .026).

### *Uncontrolled Eating (UE)*

Regarding UE, the GEE analysis demonstrated significant associations for both restraint measures. Higher TFEQ-R21_CR scores were associated with lower UE levels ($\beta$ = -.05, SE =

.02; *Wald* $\chi^2(1) = 6.47$, $p = .011$), whereas higher EDE-Q_RS scores were associated with higher UE levels ($\beta = .04$, $SE = .01$; *Wald* $\chi^2(1) = 23.89$, $p < .001$).

***Mean of Eating, Weight and Shape Concerns***

Results showed that only EDE-Q_RS was significantly associated with these concerns ($\beta = .32$, SE = .03; *Wald* $\chi^2(1) = 145.52$, $p < .001$), indicating that higher levels of restraint were associated with greater concerns regarding eating, weight, and shape. TFEQ-R21_CR was not significantly associated with these concerns ($\beta = -.01$, $SE = .05$; *Wald* $\chi^2(1) = 0.05$, $p = .82$).

**Associations between Restraint and weight loss following MBS**

The results indicate that when both restraint measures were simultaneously included in the model, neither EDE-Q_RS nor TFEQ-R21_CR showed a statistically significant association with %TWL ($p > .05$).

## V – Discussion

**Longitudinal trajectory of Restraint Eating following MBS**

The primary aim of this study was to examine the trajectory of restraint before and after surgery and its correlation with MBS outcomes and disordered eating.

The findings support the first hypothesis, demonstrating that Restraint changes significantly over time, although the observed pattern are dependent on the measure used to assess this construct. Regarding restraint assessed using the EDE-Q_RS, levels were highest in the preoperative period and decreased significantly during the first 24 months following surgery, reaching their lowest point at 12 months. Subsequently, a significant increase was observed at 36 months compared to 12 and 24 months. These pattern may reflect the progressive difficulty patients experience in maintaining deliberate dietary control over time, resulting in reduced adherence to dietary recommendations and a gradual increase in food intake (Miskowiak et al., 1985; Sarwer et al., 2008b).

In contrast, restraint measured using the TFEQ-R21_CR followed a different trajectory. The lowest levels were observed preoperatively, followed by a significant increase during the postoperative period. However restraint levels decreased significantly at 24 months relative to the 6 month assessment, approaching baseline values. These reduction may likewise reflect difficulties in maintaining eating control behaviours over time. Notably, this reduction observed

at 24 months coincides with the period in which weight regain commonly begins to emerge following MBS, usually between 18 and 24 months postoperatively (Mechanick et al., 2009; Noria et al., 2023; Sjöström et al., 2004). Therefore, reduced cognitive restraint during this period may contribute to less favourable weight-related outcomes.

One of the most relevant findings of this study, which was not initially anticipated in the objectives of this study, was the contrasting baseline levels and longitudinal trajectories observed across the two measures. Although both instruments are commonly conceptualised as measures of restraint eating, the present findings suggest that they may assess different dimensions of this construct. This hypothesis was supported in previous research studying individuals with bulimia nervosa, reporting that restraint measured by the EDE-Q decreased during treatment, whereas restraint assessed by the TFEQ increased (Safer et al., 2004). The authors suggested that the EDE-Q Restraint subscale is more sensitive to rigid and extreme forms of restraint associated with eating psychopathology, while the TFEQ Cognitive Restraint subscale reflects more normative attempts to regulate food intake and prevent weight gain. Similarly, Parker et al. (2015) reported that restraint measured by the TFEQ was a less robust indicator of clinical severity than restraint assessed by the EDE-Q in bariatric surgery patients.

**Associations between Restraint and Problematic Eating Behaviours following MBS**

Restraint was associated with the development and maintenance of PEBs following MBS. Both restraint measures were significantly associated with LOCE and UE. However, the direction of these associations differed between instruments, reinforcing the hypothesis that the EDE-Q Restraint subscale and the TFEQ-R21 Cognitive Restraint subscale assess distinct dimensions of restraint.

Regarding UE, higher levels of restraint measured by the TFEQ-R21_CR were associated with lower levels of UE, whereas higher levels of restraint measured by the EDE-Q_RS were associated with higher levels of UE. These contrasting findings are consistent with the interpretation proposed above, namely that the two instruments capture different aspects of restraint. Individuals reporting higher levels of cognitive restraint on the TFEQ-R21 may engage more successfully in postoperative dietary self-regulation, resulting in lower levels of UE (Bryant et al., 2019). Conversely, the positive association between EDE-Q restraint and UE suggests that the form of restraint captured by this measure may be linked to greater vulnerability to eating related difficulties, as previously suggested by Safer et al. (2004).

The findings concerning LOCE also revealed divergent associations between the two restraint measures. Higher levels of restraint measured by the TFEQ-R21_CR were associated

with an increased likelihood of LOCE. This result can be interpreted in light of classical models of eating pathology, which propose that the continuous cognitive effort to control food intake may increase vulnerability to subjective experiences of loss of control (Herman & Polivy, 1984; Lowe et al., 2001; Markowitz et al., 2008; Polivy & Herman, 1985). This interpretation may be particularly relevant after MBS, where objective binge-eating episodes are physiologically constrained by reduced gastric capacity (Hilbert et al., 2022; Meany et al., 2014). As a result, loss of control may occur predominantly in subjective forms, whereby individuals perceive a loss of control despite consuming relatively small amounts of food. Higher levels of cognitive restraint may therefore increase both dietary monitoring and sensitivity to perceived loss of control.

Conversely, higher levels of restraint measured by the EDE-Q were associated with a lower likelihood of LOCE. This finding may reflect that individuals reporting high levels of restraint on this measure may engage in particularly strict forms of dietary control characterised by persistent food avoidance and strong efforts to regulate intake. Although anorexia nervosa and atypical anorexia nervosa are uncommon following MBS, case reports have documented clinical presentations characterised by excessive restriction, rapid weight loss, fear of weight regain, body dissatisfaction and compensatory behaviours (Atchison et al., 1998; Bonne et al., 1996; Conceição et al., 2013; Guisado et al., 2002). Such presentations involve sustained efforts to maintain control over eating behaviour, which may reduce the likelihood of experiencing subjective loss of control.

Finally, higher levels of restraint were associated with greater concerns about eating, weight and shape, only when restraint was measured using the EDE-Q_RS. This pattern is consistent with the broader set of findings observed for this measure and further supports the interpretation that the EDE-Q captures restraint more closely linked to eating psychopathology. According to the transdiagnostic model of eating disorders, dietary restraint arises from the overvaluation of weight, shape and eating control (Fairburn et al., 1986; Fairburn et al., 2003), which are features usually presented by bariatric patients. Therefore , the observed associations likely reflect the conceptual proximity between restraint and these concerns. Although some methodological overlap between these constructs cannot be excluded, the absence of similar associations for the TFEQ-R21 measure suggests that the EDE-Q captures dimensions of restraint that extend beyond the mere intention to control food intake and are more strongly related to eating disorder psychopathology.

**Associations between Restraint and weight loss following MBS**

The results did not support our hypothesis that higher levels of restraint would be associated with poorer weight outcomes throughout follow-up. None of the measures of dietary restraint showed significant associations with percentage of total weight loss. Although contrary to initial expectations, these findings are consistent with previous studies that have failed to identify a relationship between restraint and postoperative weight trajectory after MBS (Custers et al., 2023; Roehrig et al., 2009; Schaumberg & Anderson; 2016).

One possible explanation lies in the multidimensional nature of restraint eating. As discussed previously, the two restraint measures used in this study appear to capture distinct aspects of restraint. Consequently, potentially beneficial and detrimental effects of restraint may coexist within the sample, resulting in an overall null association with weight related outcomes. This interpretation is consistent with research suggesting that interventions promoting sustainable eating habits, body acceptance and flexible self-regulation can simultaneously improve weight outcomes and reduce eating disorder symptoms (Stewart et al., 2022). From this perspective, successful postoperative weight management may depend less on the presence of restraint itself and more on the underlying function, and behavioural expression.

Another factor that may explain these findings relates to the clinical context in which participants were followed. All participants received regular follow-up within a specialised bariatric programme, including multidisciplinary monitoring and nutritional support. The presence of structured dietary guidance and continuous clinical supervision may have promoted more adaptive eating behaviours and reduced the impact of individual differences in restraint on weight outcomes. As a result, the influence of restraint on postoperative weight trajectory may be less evident in patients receiving consistent professional support.

Overall, the findings suggest that restraint may not be directly associated with weight outcomes following MBS. Rather, its clinical relevance may lie primarily in its associations with psychological and behavioural outcomes. Across the present study, restraint was consistently associated with indicators of eating psychopathology, particularly LOCE, a clinically relevant phenomenon that has been associated with postsurgical eating disorder psychopathology, reduced health related quality of life, and poorer long-term outcomes following MBS.

These findings reinforce the importance of conceptualising restraint eating as a multidimensional construct and highlight the need to move beyond an exclusively weight centred perspective when evaluating postoperative outcomes. Instead, they support a more integrated model of bariatric care, in which eating behaviour and psychological adjustment are

considered alongside weight outcomes as key indicators of treatment success (Dalle Grave, 2025; Haines & Neumark-Sztaine, 2006; Stewart et al., 2022). From a clinical standpoint, assessing restraint throughout the bariatric journey may help identify patients at increased risk of developing PEBs and eating disorder psychopathology, even in the absence of poorer weight outcomes. Such information may facilitate the development of more individualised interventions tailored to patients' specific behavioural and psychological profiles. Ultimately, this approach may contribute not only to improved eating regulation and long term weight management, but also to the prevention of eating disorder psychopathology and the promotion of psychological well being following surgery.

**Limitations**

Despite the contributions of this study to the understanding of food restraint following MBS, the results should be interpreted in light of certain methodological limitations.

A first limitation relates to the instruments used to assess restraint. Although internal consistency was generally acceptable, at certain points in the assessment the values proved to be only moderately acceptable. The EDE-Q and the TFEQ-R21 are widely used measures in research on eating behaviour, however, evidence regarding their specific validity and sensitivity for the population undergoing MBS remains relatively limited. This issue is particularly relevant in light of the results obtained in the present study, which suggest that both measures may assess distinct dimensions of restraint. Consequently, it is difficult to determine to what extent the observed results reflect actual differences in the construct being assessed or limitations inherent to the instruments used.

A second limitation relates to the predominant use of self-report measures, which are subject to various sources of bias, including social desirability, recall difficulties, and subjective interpretations of the items. These factors may have influenced the accuracy of the responses provided by participants, particularly regarding variables related to eating behaviours considered socially undesirable or potentially stigmatising.

Another important limitation of this study was the lack of data at all assessment time points, despite several attempts to reschedule appointments or to collect data by telephone.

Furthermore, the study was conducted at a single hospital in northern Portugal, which may limit the generalisability of the results to different national and international bariatric samples.

**Study Implications**

Despite these limitations, this study has several strengths that reinforce its scientific and clinical relevance. Notably, the large sample size, longitudinal design, and extended follow-up period allowed for the examination of restraint across different stages of the post-surgical journey. These methodological characteristics constitute an important added value, as they allow for a more comprehensive understanding of the processes of dietary adaptation following MBS.

This thesis contribute to the conceptualisation of restraint eating as a complex phenomenon, and as a risk factor for both obesity and eating disorders. In particular, this findings reinforce the importance of a more integrative clinical approach, moving beyond a sole focus on weight outcomes and highlighting the need to simultaneously consider the behavioural and psychological aspects associated with eating behaviour following surgery.

They also contribute to understanding the heterogeneity of postoperative outcomes. Although most patients achieve substantial improvements in weight and physical health, some develop or maintain PEBs. The present results contributes to other literature that suggest that the nature and function of restraint may help explain these individual differences.

One of the main contributions of this study is the comparison of two widely used measures of restraint eating in the literature on eating behaviour and bariatric surgery. The findings suggest that the EDE-Q_RS and the TFEQ-R21_CR assess conceptually related but functionally distinct dimensions of restraint. This has important clinical and research relevance, as indicates that the choice of assessment tool should depend on the assessment objective. When the aim is to identify PEBs or indicators of eating psychopathology, the Restraint subscale of the EDE-Q appears to be a more sensitive measure. On the other hand, when the aim is to monitor food control strategies and behavioural adaptation following MBS, the Cognitive Restraint subscale of the TFEQ-R21 may provide more relevant information.

Overall, this thesis reinforce the importance of an integrated approach to bariatric follow-up. In addition to monitoring weight outcomes, the systematic assessment of dietary restraint and its various manifestations may contribute to a more comprehensive understanding of the post-surgical adaptation process, enabling the identification of patients at greater risk of behavioural and psychological difficulties. In this regard, the integration of eating behaviour assessment into routine follow-up may constitute an important complement to the monitoring of clinical outcomes traditionally valued following bariatric surgery.

**Directions for Future Research**

The results of the present study contribute to the emerging literature on the role of restraint eating following MBS. However, whilst confirming some hypotheses previously suggested by research, the findings raise new questions that merit exploration in future studies.

Firstly, the results reinforce the need for further studies to assess the validity of the different measures of restraint eating used in bariatric context, in order to understand more precisely which specific aspects of the construct are captured by each measure and how these relate to outcomes following surgery. A better understanding of these differences could contribute to the earlier identification of patients at risk of developing PEBs, facilitating the implementation of more appropriate and individualised intervention strategies.

Secondly, the results obtained reinforce the importance of distinguishing between different forms of restraint eating, particularly with regard to their degree of flexibility. Future research should seek to assess these different dimensions of restraint more specifically, allowing for a better understanding of which profiles are associated with more adaptive trajectories and which may constitute vulnerability factors for the development of behavioural and psychological difficulties following surgery.

## VI – Conclusion

Given that the literature on the role of restraint following bariatric surgery remains limited and often presents inconsistent results, this study contributes to a better understanding of the trajectory of restraint throughout the post-surgical follow-up period, as well as its relationship with weight outcomes and indicators of EDs.

The findings demonstrate that restraint is a dynamic phenomenon after MBS, showing different patterns of change over time. Moreover, the results suggest that the relationship between restraint and post-surgical outcomes depends, to a large extent, on how the construct is conceptualised and assessed. In particular, the discrepancy observed between the EDE-Q_RS and the TFEQ-R21_CR, constitutes one of the most significant contributions of this research, suggesting that both measures may capture distinct dimensions of dietary restraint, with different clinical and psychological implications.

These findings are especially relevant given that restraint is a feature common to both obesity and EDs. This conceptual overlap suggests that the eating behaviour of bariatric patients should not be understood exclusively from a weight management perspective, but also in light of the psychological factors that influence the individual's relationship with eating, weight and body image. Ignoring this interaction may limit our understanding of the outcomes following surgery and compromise the early identification of patients at greater risk of psychological and behavioural difficulties.

Consequently, the present study reinforces the importance of an integrated approach to bariatric follow-up, which simultaneously considers weight management, but also the psychological factors underlying eating behaviour. By focusing on a shared risk factor, this research aims to contribute to a more comprehensive understanding of the post-surgical journey and to the development of more individualised clinical interventions, capable of promoting not only weight loss but also psychological well-being and the sustainability of the results achieved over time.

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