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ORIGINAL ARTICLE

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Association between disordered eating and clinical outcomes following a surgical or endoscopic bariatric procedure: A real-world exploratory study

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Abstract

Problem: Disordered eating, such as binge, graze, and emotional eating, has been strongly linked to weight gain. Improved understanding of disordered eating by adults who elect bariatric weight loss procedures in a real-world setting is required.

Purpose: To determine the association between the number and type of disordered eating patterns (DEPs), as described by healthcare professionals during routine care without standardized assessment, with clinical outcomes in adults who elected a bariatric weight loss procedure.

Method: An observational cohort study recruited laparoscopic sleeve gastrectomy (LSG) and endoscopic sleeve gastroplasty (ESG) patients. DEPs documented in the medical record during routine care were observed and tested for association with events (symptoms, side-effects, or adverse events), micronutrient deficiencies, weight loss, and attrition. Data were observed up to 12-month post-procedure.

Results: 215 LSG and 32 ESG patients were recruited. The mean number of DEPs was 6.4 (SD: 2.1) and 6.4 (SD: 2.1) in the LSG and ESG cohorts, respectively. Night eating was associated with a higher number of events ($p < 0.008$) in the LSG cohort, and non-hungry eating was associated with a higher number of events in the ESG cohort ($p < 0.001$). ESG patients who had a surgical or medical event by 6-months post-procedure had mean 1.78 (95%CI: 0.67, 2.89) more DEPs ($p = 0.004$). DEPs were not associated with weight loss, micronutrient deficiencies, nor attrition.

Conclusion: The treating healthcare team believed the LSG and ESG patients experienced a wide variety and high frequency of DEPs requiring multidisciplinary support. Non-hungry eating and night eating were associated with poorer outcomes following an LSG or ESG.

Trial registration: The study was prospectively registered with the Australian New Zealand Clinical Trials Registry (ACTRN12622000332729).

KEYWORDS
bariatric surgery, endoscopic sleeve gastroplasty, feeding and eating disorders, laparoscopic sleeve gastrectomy, micronutrients, weight loss

1 | INTRODUCTION

Disordered eating patterns (DEPs) such as overeating, loss of control, grazing, and emotional eating directly impact dietary intake and metabolic health such as the risk of weight gain and chronic disease.[1–3] Certain disordered dietary and eating patterns have also been identified as obesogenic, such as poor food and cooking skills and a high intake of discretionary foods.[4,5] In adults living with overweight or obesity, lifestyle weight-loss methods such as caloric restriction and increased physical activity may not be feasible, achievable, or sufficiently effective.[6,7] Bariatric-metabolic procedures (i.e., medical, endoscopic, and/or surgical weight loss procedures) may be an efficacious option for eligible individuals; however, they do not necessarily address DEPs.[8]

Outcomes following bariatric procedures remain highly variable and weight loss is not the only outcome of importance.[9] Sources of variation in an individuals' response to a procedure may be due to the surgical or endoscopic technique or device used; however, may also include patient characteristics, behavioral factors, and the type and intensity of multidisciplinary follow-up care such as dietary counseling.[9] Reflecting this, the 2013 AACE/TOS/American Society for Metabolic and Bariatric Surgery (ASMBS) Clinical Practice Guideline recommends preoperative nutritional and psychosocial-behavioral assessment; and that postprocedural care should include dietary and behavioral modification.[10] Beyond this broad recommendation, multidisciplinary teams (MDT) have little guidance as to which behaviors should be assessed and prioritized.

Disordered eating patterns have been reported to be highly prevalent in bariatric-metabolic procedure patients both pre- and post-procedure. Prevalent DEPs included grazing (26%), emotional eating (38%), sweet eating (43%), loss of control (61%), binge eating (64%), and food cravings (90%).[11–13] Many patients also suffer complications related to disordered eating, including gastrointestinal symptoms or nutrient deficiencies,[14] with prevention and treatment by the MDT hampered by high rates of attrition.[15]

However, the existing literature on disordered eating in bariatric-metabolic procedure patients is limited to the research setting, with each study focused upon select DEPs.[11–13] While improving the quality of a study via valid identification of eating disorders, standardized screening and assessment for all possible DEPs in the clinical setting is not feasible. A recent review found that few bariatric surgical clinics use standardized questionnaires or interviews to identify disordered eating.[16] Another review by Ivezaj et al. reported that feasibility limitations underpinned a lack of consistent eating disorder assessment due to the need for the clinicians to have extensive training and long interview times with each patient.[17] Such barriers cause the majority of clinics to rely on patient self-report.[17]

There is a need for pragmatic real-world research to describe and explore the full breadth of DEPs encountered in routine care without standardized assessment and how they may relate to clinical outcomes. Meeting this research gap will help to inform screening and assessment priorities as well as models of care which can realistically provide behavioral modification in line with the AACE/TOS/ASMBS Clinical Practice Guidelines.

This study aimed to meet this research gap by determining the association between the number and type of DEPs, as described by healthcare professionals during routine care without standardized assessment, with clinical outcomes in adults who elected a bariatric weight loss procedure. It is hypothesized that DEPs experienced by bariatric-metabolic procedure patients will be complex, common, and associated with the need for multidisciplinary intervention. This study was prospectively registered with the Australia New Zealand Clinical Trials Registry (ACTRN12622000332729) and was approved by the Bond University Human Research Ethics Committee (AM03556), which granted a waiver of participant consent.

2 | MATERIALS AND METHODS

An exploratory observational cohort study was implemented drawing upon both retrospective and prospective data, and reported according to the STROBE checklist.[18]

2.1 | Study population

All eligible patients were consecutively enrolled via the waiver of consent. Eligible patients were ≥18 years who elected to undergo a surgical or endoscopic bariatric procedure at the study site (private medical clinic, Gold Coast, Queensland, Australia) between 5 January 2019 to 7 January 2021. Procedures included the laparoscopic sleeve gastrectomy (LSG) and endoscopic sleeve gastroplasty (ESG). Although the gastric bypass, intragastric balloon, and medical weight loss therapy are also of interest to answer the research question and were also available at the study site, insufficient (n = 15 or less) patients elected this option to warrant data collection and analysis. There were no impacts of COVID-19 or pandemic-related restrictions on patient recruitment or data collection. No patients who met the eligibility criteria were excluded from the study or removed in any data analyses.

2.2 | Usual care conditions

Pre-procedural patients attended multiple appointments with a dietitian and nurse, which involved education about the procedure, requirements for nutrient supplementation and medication, and lifestyle changes (commencement of preprocedural very low-calorie diet, preprocedural cessation of smoking and some medications, pre- and postprocedural micronutrient repletion, recovery phase texture modification). The patient was also required to attend at least one pre-procedural appointment with the psychologist and proceduralist. All patients were required to participate in 12-month intensive multidisciplinary follow-up with pre-determined appointment schedules (Table S2) and additional support where indicated.

2.3 | Data collection

Data were extracted from the study site's electronic medical records and a patient completed pre-consultation screening and demographic questionnaire. Data collection timepoints were baseline (pre-procedure), day of procedure, 6-month post-procedure, and 12-month post-procedure. Preprocedural and day of procedure data were accessed retrospectively as all eligible patients were sampled once the procedure had been performed; however, postprocedural follow-up data were accessed prospectively as patients were followed over time. Quality checking was performed for 80% of data extracted to the case report forms and then for 50% of data entered into Excel. If multiple errors were identified in a variable, that variable was quality checked 100%.

2.4 | Outcomes

2.4.1 | Independent outcome

Disordered eating patterns were considered as any eating behavior or dietary pattern deemed as requiring intervention via education or behavioral modification by the MDT as per medical record progress notes. Identification and assessment of DEPs by the MDT were performed according to usual care representing the real-world setting; therefore, systematic screening and application of validated assessment tools to identify DEPs were not applied. Furthermore, as DEPs were observed from the medical records, definitions of DEPs were not available. This study extracted the first pre- and postprocedural identification of a DEP for each patient. Rarely documented DEPs ($n = \leq 3$ incidence) were excluded from analyses. The specific clinician who documented the DEP was noted to evaluate detection bias.

2.4.2 | Primary outcome

Expected symptoms (e.g., pain at wound site, reflux in first 2-weeks), side-effects (e.g., food intolerance, hair loss), and complications/adverse events (e.g., reaction to general anesthesia, infection at wound site) were recorded as events if the patient reported them to the MDT to request support (reassurance or treatment/intervention). Therefore, events were not necessarily adverse events; but represented a trigger for support by the MDT, whether routine or unexpected. The events were categorized according to severity: (1) mild, (2) moderate, or (3) severe; relatedness: (1) directly related to the procedure, (2) possibly related to the procedure, or (3) not related to the procedure[19]; and type: (1) surgical or medical-related, (2) nutrition-related, or (3) gastrointestinal-related. Event categorization definitions and examples are provided in Table S2. Once coded, only events categorized as directly or possibly related to the procedure were considered an event for this study.

2.4.3 | Secondary outcomes

Secondary outcomes were nutritional deficiency, weight change, and attrition. The incidence of a nutritional deficiency was recorded and defined as de novo postprocedural serum protein or micronutrient deficiency (with or without micronutrient supplementation). Insufficiency and deficiency were defined according to the ASMBS Integrated Health Nutritional Guidelines[20] or as per Bazuin et al.,[21] except for protein in which deficiency was defined according to a national pathology laboratory (Table S3).

Total body weight was extracted from the medical record and represented weight both self-reported and measured at the medical clinic. Weight change was calculated as percent total body weight loss (%TBWL).

Attrition (i.e., lost-to-follow-up (LTFU)) was defined as no contact with any member of the MDT for >8-week in the first 3-months or no contact for >4-month thereafter, despite repeated attempts of MDT to contact. Those who did not attend at least one scheduled appointment at 6- or 12-month (+/– 4-week) were also recorded.

2.5 | Statistical methods

All variables were described for each procedure using descriptive statistics through mean and standard deviations for normal continuous variables, number and percentage for categorical variables, and median and interquartile range for non-parametric continuous variables. The Shapiro Wilk test and inspection of normal Q-Q plots were used to test the normality of continuous variables. A single outlier was removed from the total number of DEPs in the LSG cohort. The difference between cohorts for the number of DEPs was assessed via ANOVA.

Inferential statistics were used for each procedure separately due to inherent differences in the cohorts. The number of DEPs was tested for correlation with the number of events and %TBWL using Pearson or Spearman's correlation (two-tailed). Disordered eating patterns that occurred in ≥20% of the patients for each cohort were compared with the number of events (total, nutritional, gastrointestinal, surgical/medical) per patient using Mann–Whitney test or independent *t*-test dependent on the normality and distribution of data, and with attrition outcomes using the chi-squared test. Independent *t*-tests or Mann–Whitney U tests were used to test the association of individual DEPs with %TBWL. Binary logistic regression was used to determine the odds of a single DEP with attrition. This study used Statistical

Package for the Social Sciences (SPSS; V.26) statistical software to analyze all the data.

3 | RESULTS

A total of 215 LSG and 32 ESG patients were recruited between January 2019 and January 2021 (Table 1). The LSG cohort had a higher baseline total body weight (115.4 vs. 94.7 kg), and at 12-months, the LSG cohort achieved mean 31.2 (SD: 7.9) %TBWL and the ESG achieved mean 12.6 (SD: 4.8) %TBWL (Table 1).

There were $n = 20$ and $n = 16$ types of DEPs observed from the medical records in the LSG and ESG cohorts, respectively, mostly identified pre-procedure (Table 2). 100% of patients in both cohorts were believed by the MDT to have one or more DEPs, and the number of DEPs per patient were mean 6.4 (SD: 2.1) in the LSG cohort and mean 6.4 (SD: 2.1) in the ESG ($p > 0.05$ between groups). Disordered eating patterns which were excluded from the analysis due to their rarity were excessive alcohol intake, addition to energy drinks, food aversion, and inadequate fluids. No detection bias by specific clinicians was found when recording specific DEPs in the medical records; however, only dietitians documented the limited cases of 'eating disorder—unspecified'.

3.1 | Event outcomes in laparoscopic sleeve gastrectomy patients

The LSG cohort had $n = 714$ events ($n = 13$ on day of surgery; $n = 615$ by 6-months, $n = 86$ between 6- and 12-months), with the median number of events per patient 0.0 (IQR: 0.0–0.0) on the day of surgery, 3.0 (IQR: 2.0–4.0) at 6-months, 0.0 (IQR: 0.0–1.0) at 12-months, and 4.0 (IQR: 2.0–5.0) at any timepoint. The most common type of event was gastrointestinal-related across all timepoints, with 84.2% of patients reporting one or more gastrointestinal-related events between the day of surgery and 6-month post-surgery (Table S4; full dataset Table S5).

Laparoscopic sleeve gastrectomy surgical- or medical-related events ($n = 148$) were mostly mild ($n = 104$; 70.3) or moderate severity ($n = 34$; 23.0%); gastrointestinal-related ($n = 477$) were mostly mild ($n = 426$; 89.3%) and moderate ($n = 42$; 8.8%), and nutrition-related events ($n = 89$) were also mostly mild ($n = 79$; 88.8%) and moderate ($n = 8$; 9.0%). The most common events noted in the medical record were constipation ($n = 125$), reflux ($n = 83$), abdominal discomfort/cramping/pain ($n = 81$), nausea and/or vomiting ($n = 68$), and diarrhea ($n = 55$) which were all gastrointestinal-related events.

In the LSG cohort, only night eating behavior was consistently associated with events including gastrointestinal at 6-months ($p < 0.001$), surgical or medical at 6-months ($p = 0.002$), and nutrition-related at 6- and 12-months ($p = 0.005$ and $p = 0.008$ respectively) (Table 3). Non-hungry eating was associated with surgical or medical

TABLE 1 Characteristics of patients who elected the laparoscopic sleeve gastrectomy (LSG) and endoscopic sleeve gastroplasty (ESG) procedures.

Patient characteristics	LSG ($n = 215$)	ESG ($n = 32$)
Age, mean (SD) (years)	41.4 (9.5)	41.9 (9.3)
Female, number (%)	167 (77.7)	31 (96.9)
Weight, median (IQR) (kg)[a]	115.4 (101.0, 134.2)	94.7 (85.6, 98.4)
BMI, median (IQR) (kg/m^2)[a]	40.9 (37.0, 45.0)	33.15 (31.8, 36.8)
Employment status, number (%)		
Working	172 (80.0)	29 (90.6)
Shift work	17 (7.9)	1 (3.1)
Unemployed	26 (12.1)	2 (6.3)
Marital status, number (%)		
Single	31 (14.4)	7 (21.9)
Divorced	22 (10.2)	2 (6.3)
Married	142 (66.1)	14 (43.8)
Widowed	2 (0.9)	0 (0.0)
De facto	18 (8.4)	9 (28.1)
Smoking status, number (%)		
Never	107 (49.8)	14 (43.8)
Ceased	78 (36.3)	16 (50.0)
Current	30 (14)	2 (6.3)
Relocated overseas, number (%)	1 (0.5)	0 (0.0)
Extended leave after surgery, number (%)	6 (2.8)	1 (3.1)
Frequent traveler, number (%)	8 (3.7)	1 (3.1)
Baseline medical status, number (%)		
Reflux	99 (46.3)	13 (41.9)
PCOS	27 (12.6)	3 (9.7)
Liver disease/Hepatitis	17 (7.9)	0 (0.0)
Gastric duodenal ulcer	6 (2.8)	1 (3.2)
Gallstones	23 (10.7)	1 (3.2)
Anxiety/depression	89 (41.6)	14 (45.2)
Back pain	152 (71.0)	22 (71.0)
Arthritis/joint pain	132 (61.7)	13 (43.3)
Asthma	60 (28.0)	3 (9.7)
Hypertension	81 (37.9)	8 (25.8)
Diabetes	23 (10.7)	2 (6.5)
OSA	73 (34.1)	4 (12.9)
High Cholesterol	102 (48.6)	11 (35.5)
Micronutrient deficiency	75 (35.5)	12 (38.7)

(Continues)

TABLE 1 (Continued)

Patient characteristics	LSG (n = 215)	ESG (n = 32)
Weight loss, mean (SD)		
6-month %TBWL	23.6 (6.7)[b]	10.7 (5.6)
12-month %TBWL	31.2 (7.9)[c]	12.6 (4.8)[d]

Abbreviations: BMI, body mass index; ESG; endoscopic sleeve gastroplasty; IQR, interquartile range; kg, kilogram; LSG, laparoscopic sleeve gastrectomy; m, meter; OSA, obstructive sleep apnea; PCOS, polycystic ovary syndrome; SD, standard deviation; TBWL, total body weight loss.

[a]Median (IQR).

[b]n = 7 LSG patients did not have 6-month weight data.

[c]n = 66 LSG patients did not have 12-month weight data.

[d]n = 16 ESG patients did not have 12-month weight data.

events at 6-months ($p = 0.005$). The total number of DEPs was associated with surgical or medical events at 6-months ($p = 0.049$); however, both groups (did and did not have an event) had a median of 6 DEPs, suggesting no clinical nor statistical relevance.

3.2 | Event outcomes in endoscopic sleeve gastroplasty patients

The total number of events in the ESG cohort was $n = 80$ ($n = 0$ on day of procedure; $n = 74$ between day of procedure and 6-months, and $n = 6$ between 6- and 12-months) (full dataset Table S5). In the ESG cohort, the mean number of events per patient at 6-months was 2.9 (SD: 1.2), the median at 12-months was 0.0 (IQR: 0.0–1.0), and the mean at any timepoint was 3.3 (SD: 1.4). Nutrition-related events occurred only between the day of procedure and 6-month post-procedure and were highly prevalent at that time (96.9%) (Table S4). Gastrointestinal-related events were the most common type of event (96.9% at 6-month, 9.4% at 12-month). All surgical- and medical-related events ($n = 20$) were mild ($n = 11$, 55.0%) or moderate ($n = 9$, 45.0%) as were nutrition-related events ($n = 6$, 100% mild). Gastrointestinal-related events ($n = 67$) were predominantly mild ($n = 61$, 91.0%) with only one severe event (feculent vomiting requiring hospitalization). Constipation was the most reported event in the ESG cohort ($n = 24$) followed by abdominal cramping/pain ($n = 18$), then reflux ($n = 8$, hunger/silent reflux ($n = 8$), and nausea ($n = 8$).

In the ESG cohort, patients who experienced non-hungry eating had a higher number of total events (mean difference 2.02 [(95%CI: 1.0, 3.1)]; Table 3). The total number of DEPs was associated with the number of surgical or medical events at 6-month, where those who had a surgical or medical event had a mean of 1.78 (95%CI: 0.67, 2.89) more DEPs.

3.3 | Nutrient deficiency outcomes

In the LSG cohort at 6-months, $n = 33$ (24.6%) had one or more nutrient deficiencies (Table S4). There were 90 incidents of nutrient deficiency in total (range 0–3 per patient), which were $n = 23$ zinc, $n = 18$ thiamin, $n = 17$ total protein, $n = 17$ folate, $n = 5$ ferritin, $n = 4$ vitamin B12, $n = 3$ retinol, and $n = 3$ vitamin D. At 12-months post-procedure, $n = 49$ (63.6%) patients had one or more nutrient deficiencies ($n = 74$ incidents of nutrient deficiency; range 0–3 per patient). De novo nutrient deficiencies in the LSG cohort at 12-months were $n = 16$ zinc, $n = 16$ vitamin D, $n = 13$ total protein, $n = 10$ ferritin, $n = 9$ folate, $n = 9$ thiamin, $n = 1$ vitamin B12, and $n = 1$ retinol. There was no association between DEPs and nutrient deficiencies in the LSG cohort (Table 3).

At 6-months, there were five ESG patients who had a single de novo nutrient deficiency ($n = 3$ total protein deficiency, $n = 1$ thiamin deficiency, $n = 1$ vitamin D deficiency) and none had multiple de novo nutrient deficiencies. At 12-months, one patient had a single de novo nutrient deficiency ($n = 1$ vitamin D), and one patient had two de novo nutrient deficiencies ($n = 1$ vitamin D, $n = 1$ zinc). Because of low postprocedural pathology attendance, association with DEPs was not tested.

3.4 | Attrition outcomes

The LTFU rates were 33.5% in the LSG cohort and 43.8% in the ESG. The rates of failure to attend a 6- and 12-month appointment with a member of the multidisciplinary team were 35.3% and 48.4% in the LSG cohort and 53.1% and 62.5% in the ESG cohort, respectively. The DEP 'large portion sizes' showed an association with failure to attend a 6-month follow-up appointment in the LSG cohort ($p = 0.025$) (Table S7). Binary logistic regression found that patients with large portion sizes had 4.81 (95%CI: 1.08, 21.53, $p = 0.040$) increased odds of failing to attend the 6-month follow-up appointment.

In the ESG cohort, 'low protein' showed an association with LTFU ($p = 0.017$) and failure to attend the 6-month appointment in the ESG cohort ($p = 0.014$; Table S7). In binary logistic regression, having low protein intake was associated with 7.50 (95%CI: 1.20–43.67, $p = 0.025$) and 7.00 (95%CI: 1.386–35.35, $p = 0.019$) increased odds of LTFU and failure to attend the 6-month follow-up appointment in the ESG cohort, respectively.

3.5 | Weight loss outcomes

The total number of DEPs per patient was not correlated with %TBWL at 6- or 12-month in the LSG cohort. Laparoscopic sleeve gastrectomy patients who had non-hungry eating had higher %TBWL (6-month %TBWL mean 24.6 [SD: 7.3] vs. mean 22.8 [SD: 6.0], $p = 0.044$) and those who had poor adherence to prescribed diets had lower %TBWL (12-month %TBWL mean 28.6 [SD: 7.9] vs. mean 31.8 [SD: 7.8], $p = 0.044$), however these differences were not clinically nor statistically compelling. In the ESG cohort, the total number of DEPs was moderately negatively correlated with %TBWL at 6-months ($r = -0.407$, $p = 0.021$) and 12-month ($r = 0.532$, $p = 0.034$).

TABLE 2 Pre- and post-procedural disordered eating patterns (DEPs) of patients identified by the multidisciplinary team.

	Laparoscopic sleeve gastrectomy (n = 215)[a]			Endoscopic sleeve gastroplasty (n = 32)[a]		
	Preprocedural	Postprocedural[b]	Any time	Preprocedural	Postprocedural[b]	Any time
Total disordered eating pattern	n = 1238	n = 216	N = 1379	n = 175	n = 73	N = 204
Binge eating	49 (22.8)	0 (0.0)	49 (22.8)	8 (25.0)	2 (6.3)	8 (25.0)
Eating disorder—unspecified[c]	5 (2.3)	2 (0.9)	7 (3.3)	0 (0.0)	0 (0.0)	0 (0.0)
Eating out	24 (11.2)	1 (0.5)	25 (1.7)	4 (12.5)	0 (0.0)	4 (12.5)
Emotional eating	133 (61.9)	7 (3.3)	135 (62.8)	17 (53.1)	5 (15.6)	17 (53.1)
Extreme non-adherence to AGHE	72 (33.5)	1 (0.5)	73 (34)	10 (31.3)	1 (3.1)	10 (31.3)
Family commitments	18 (8.4)	2 (0.9)	19 (8.8)	3 (9.4)	1 (3.1)	4 (1.6)
Grazing	74 (34.4)	14 (6.5)	81 (37.7)	13 (40.6)	5 (15.6)	18 (7.3)
Irregular meal pattern	130 (60.5)	8 (3.7)	132 (61.4)	18 (56.3)	3 (9.4)	21 (8.6)
Large portions	197 (91.6)	9 (4.2)	197 (91.6)	27 (84.4)	9 (28.1)	36 (14.7)
Low protein	47 (21.9)	73 (34.0)	120 (8.3)	8 (25.0)	14 (43.8)	22 (9.0)
Lack of satiety	41 (19.1)	1 (0.5)	42 (2.9)	6 (18.8)	5 (15.6)	11 (4.5)
Meal skipping	137 (63.7)	33 (15.3)	170 (11.7)	24 (75.0)	11 (34.4)	35 (14.3)
Night eating	106 (49.3)	3 (1.4)	107 (49.8)	10 (31.3)	1 (3.1)	11 (4.5)
Night eating syndrome	13 (6.0)	0 (0.0)	13 (6.0)	1 (3.1)	0 (0.0)	1 (3.1)
Non-hungry eating	89 (41.4)	18 (8.4)	101 (47.0)	13 (40.6)	7 (21.9)	15 (46.9)
Poor food and cooking skills	13 (6.0)	5 (2.3)	16 (7.4)	0 (0.0)	0 (0.0)	0 (0.0)
Poor adherence to prescribed diets	34 (15.8)	17 (7.9)	48 (22.3)	4 (12.5)	4 (12.5)	7 (21.9)
Traveling frequently	12 (5.6)	3 (1.4)	14 (6.5)	1 (3.1)	1 (3.1)	1 (3.1)
Use of pre-prep meals	0 (0.0)	19 (8.8)	19 (8.8)	2 (6.3)	2 (6.3)	4 (12.5)
Frequent dieting	44 (20.5)	0 (0.0)	44 (20.5)	6 (18.8)	0 (0.0)	6 (18.8)

Abbreviation: AGHE, Australian Guide to Healthy Eating.

[a]Data are presented as number (% of patients).

[b]Identified post-procedurally; however, the DEP may have also been identified in the patient pre-procedurally.

[c]Recorded in the medical notes as 'eating disorder' with no further specification or description.

4 | DISCUSSION

This observational study found that, during routine care for 247 LSG and ESG patients, up to 20 different types of DEPs were frequently identified and noted in the medical record by the MDT, with an average of 6.4 unique DEPs per patient. Given that identification of DEPs relied upon patient self-report and clinician expertise rather than standardized screening and assessment, the large number and diversity of DEPs are concerning yet cannot be verified as valid diagnoses and the definitions of the reported DEPs cannot be retrospectively confirmed. Beyond the DEPs, large numbers of events (i.e., symptoms, side-effects, and adverse events) were reported by patients to the MDT, which were mostly mild but required either reassurance or treatment by one or more members of the MDT. The large number and sizable diversity of DEPs, events, and nutritional deficiencies identified and managed by the MDT emphasizes the importance of intensive MDT support not only for safety but also for complex behavior change and to achieve value-based care.

Specific DEPs were not found to be associated with clinical outcomes in either cohort, except for night eating, non-hungry eating, and low protein intake. In the LSG cohort, there was convincing evidence against the null hypothesis for the association of night eating and non-hungry eating with a higher frequency of events. Non-hungry eating was also associated with the total number of events in the ESG cohort. The evidence for the association between low protein content and higher odds of attrition was not convincing due to a weak p-value and wide confidence intervals. Although other analyses in this exploratory study also presented some evidence against the null hypothesis ($p < 0.05$) this was unconvincing due to a weak p-value, especially if a Bonferroni correction were to be applied, imprecise 95%CIs, and/or irrelevant clinical significance.

Some of the routinely identified DEPs identified in this study aligned with non-eating disorder 'problematic eating behaviors' as described by Conceição et al.,[11] suggesting that the DEPs were not unique to the study setting but were relevant to bariatric populations generally. However, the current study identified many DEPs not

TABLE 3 Association between types of events and specific disordered eating patterns (DEPs) identified at any timepoint.

Disordered eating pattern[a]	Had gastrointestinal event[b]	Had surgical or medical event[b]	Had nutrition event[b]	Total number of events[c]	Had new nutrient deficiency[d]
Laparoscopic sleeve gastrectomy (n = 215)					
Binge eating				0.888	0.424 (0.515)
Day of surgery	0.390 (0.621)	0.390 (0.621)	-		
6-month	0.751 (0.457)	2.793 (0.095)	0.005 (1.000)		
12-month	0.675 (0.411)	3.400 (0.073)	2.608 (0.106)		
Large portion sizes				0.511	0.026 (1.000)
Day of surgery	0.554 (0.412)	0.564 (1.000)	-		
6-month	0.801 (0.704)	0.141 (0.707)	0.189 (1.000)		
12-month	0.203 (0.761)	0.222 (0.645)	0.142 (0.660)		
Lacks satiety				0.278	0.663 (0.416)
Day of surgery	1.498 (0.600)	0.032 (1.000)	-		
6-month	0.476 (0.490)	1.813 (0.178)	1.326 (0.250)		
12-month	0.001 (0.980)	0.296 (0.525)	0.059 (1.000)		
Poor adherence to prescribed diets				0.784	0.855 (0.355)
Day of surgery	1.774 (0.342)	0.431 (0.617)	-		
6-month	0.128 (0.720)	0.430 (0.512)	0.458 (0.499)		
12-month	1.296 (0.255)	0.810 (0.525)	2.689 (0.124)		
Meal skipping				0.572	0.035 (0.851)
Day of surgery	0.605 (0.668)	0.014 (1.000)	-		
6-month	1.628 (0.202)	0.732 (0.392)	1.558 (0.279)		
12-month	0.161 (0.688)	0.453 (0.584)	1.865 (0.172)		
Emotional eating				0.134	0.165 (0.685)
Day of surgery	0.040 (1.000)	0.432 (0.673)	-		
6-month	0.023 (0.879)	3.078 (0.079)	0.034 (0.853)		
12-month	3.434 (0.064)	0.081 (0.777)	0.214 (0.643)		
Irregular meal patterns				0.907	1.032 (0.310)
Day of surgery	0.338 (0.678)	0.072 (1.000)	-		
6-month	1.528 (0.216)	1.118 (0.290)	0.762 (0.383)		
12-month	0.630 (0.427)	2.038 (0.153)	0.017 (0.897)		
Grazing				0.263	0.092 (0.761)
Day of surgery	0.050 (1.000)	1.160 (0.413)	-		
6-month	0.416 (0.519)	0.212 (0.645)	0.052 (0.820)		
12-month	0.014 (0.907)	0.504 (0.478)	0.224 (0.636)		
Non-hungry eating				0.639	1.069 (0.301)
Day of surgery	0.961 (0.423)	0.023 (1.000)	-		
6-month	0.031 (0.861)	7.929 (0.005)	1.300 (0.254)		
12-month	0.049 (0.824)	0.007 (0.933)	0.739 (0.390)		
Low protein				0.888	0.742 (0.389)
Day of surgery	2.860 (0.091)	0.745 (0.388)	-		
6-month	0.928 (0.335)	0.232 (0.630)	0.457 (0.499)		
12-month	0.965 (0.326)	0.151 (0.697)	0.162 (0.687)		

TABLE 3 (Continued)

Disordered eating pattern[a]	Had gastrointestinal event[b]	Had surgical or medical event[b]	Had nutrition event[b]	Total number of events[c]	Had new nutrient deficiency[d]
Night eating				0.092	0.476 (0.490)
Day of surgery	0.000 (1.000)	0.000 (1.000)	-		
6-month	10.921 (<0.001)	9.234 (0.002)	8.234 (0.005)		
12-month	0.174 (0.676)	0.251 (0.617)	7.858 (0.008)		
Frequent dieting				0.605	0.663 (0.416)
Day of surgery	0.055 (0.815)	0.055 (1.000)	-		
6-month	0.168 (0.682)	2.670 (0.102)	0.931 (0.534)		
12-month	0.076 (0.782)	0.001 (1.000)	0.010 (1.000)		
Extreme non-adherence to AGHE				0.520	0.195 (0.659)
Day of surgery	0.001 (1.000)	0.823 (0.666)	-		
6-month	1.380 (0.240)	1.896 (0.169)	0.006 (0.940)		
12-month	0.058 (0.810)	1.016 (0.313)	1.710 (0.191)		
Total number of DEP				$r = -0.048$ (0.561)	-
Day of surgery	0.400	0.656	-		
6-month	0.272	0.049[e]	0.075		
12-month	0.254	0.943	0.720		
Endoscopic sleeve gastroplasty (n = 32)[f]					
Binge eating: 6-month	0.344 (1.000)	0.711 (0.433)	0.344 (1.000)	0.076	-
Large portion sizes: 6-month	0.147 (1.000)	0.305 (1.000)	0.147 (1.000)	0.668	-
Poor adherence to prescribed diets: 6-month	3.687 (0.219)	0.110 (1.000)	3.687 (0.219)	0.303	-
Meal skipping: 6-month	0.191 (1.000)	0.016 (1.000)	0.191 (1.000)	0.188	-
Emotional eating: 6-month	1.170 (0.569)	0.075 (1.000)	1.170 (0.469)	0.470	-
Irregular meal patterns: 6-month	0.706 (1.000)	2.496 (0.114)	0.706 (1.000)	0.332	-
Grazing: 6-month	0.911 (1.000)	0.209 (0.647)	0.911 (1.000)	0.668	-
Non-hungry eating: 6-month	0.911 (1.000)	3.020 (0.144)	0.911 (1.000)	<0.001[g]	-
Low protein: 6-month	0.619 (1.000)	1.280 (0.258)	0.619 (1.000)	0.525	-
Night eating: 6-month	0.469 (1.000)	0.039 (1.000)	0.469 (1.000)	0.989	-
Frequent dieting: 6-month	4.473 (0.188)	0.055 (1.000)	4.473 (0.188)	0.634	-
Extreme non-adherence to AGHE: 6-month	0.469 (1.000)	0.039 (1.000)	0.469 (1.000)	0.303	-
Total number of DEPs: 6-month[h]	-	0.004[i]	-	$r = 0.227$ (0.366)	-

Abbreviations: AGHE, Australian Guide to Healthy Eating; DEP, disordered eating pattern.

[a]Timepoints presented for the DEP refer to the timepoint the event occurred and not the timepoint the DEP occurred. DEPs were included in this analysis if they had a prevalence of ≥20% (cumulative prevalence from all timepoints).

[b]Data were presented as Pearson chi-square statistic (*p*-value).

[c]*p*-value presented for comparison of median or rank sums of total number of events (i.e., cumulative events from all timepoints) or correlation statistic (*p*-value) with total DEP.

[d]Data were presented as Pearson chi-square statistic (*p*-value) for comparison of had nutrient deficiency (yes/no at any postprocedural timepoint) and incidence of DEP (yes/no at any timepoint).

[e]Both groups had a median of 6 DEPs.

[f]Too few events on the day of procedure and at 12-month for analysis. Attrition for pathology (incidence of nutrient deficiency) was too high for analysis.

[g]Mean difference 2.02 (95%CI: 1.0, 3.1) with patients who had non-hungry eating having a higher number of events (4.6 [SD: 1.1] vs. 2.6 [SD: 0.9]).

[h]*t*-tests could not be computed for nutritional or gastrointestinal events because of insufficient data in each group.

[i]Mean difference 1.78 (95%CI: 0.67, 2.89) with patients who had one or more medical or surgical events having a higher number of DEPs (4.22 [SD: 1.30] vs. 2.45 [SD: 0.88]).

otherwise described in the literature, such as low protein intake, use of pre-prepared meals, and poor food and cooking skills. This reveals that the MDT maintained a focus on both disordered eating and dietary patterns, bringing a new perspective to the literature about the focus of MDT bariatric care. Although some DEPs are not clearly problematic based on their name (e.g., use of pre-prepared meals, family commitments), they were included as DEPs because the MDT made a judgment call that intervention was required to correct the DEP. Exploring the meaning of DEPs encountered in the real world setting via a qualitative study would assist in addressing evidence-practice gaps.

Some findings of the study align with the literature; for example, there was unconvincing evidence to reject the null hypothesis that binge eating pattern and large food portions were associated with clinical outcomes. Recent studies have suggested that bariatric candidates with binge eating patterns or loss of control (large portions) before surgery will more likely demonstrate grazing and non-hungry eating due to the food volume restrictions of the surgery.[22,23] While the literature has consistently found grazing to be associated with a high risk of poor bariatric surgery outcome and gastrointestinal symptoms,[11–13,23,24] this study found no such association. This may be due to how the MDT categorized DEPs in this study and/or due to a lack of sensitivity by the team in identifying grazing without a specific assessment. This study found convincing evidence that non-hungry eating and night eating were associated with a poorer clinical outcome, such as a higher frequency of events.

As eating behaviors are complex, it is important to note that many DEPs work together in a disorganized pattern rather than as individual factors.[11] Despite insufficient evidence to link DEPs such as meal skipping and non-adherence to prescribed diets with gastrointestinal- or nutrition-related events, these are likely to have contributed to events such as constipation, reflux, fatigue, and nutritional deficiencies. Specialist bariatric MDT recognize that certain DEPs are interconnected. For example, meal skipping behaviors and irregular meal patterns may lead to consuming large portions, grazing, or night eating. These DEPs can directly impact nutritional intake and lead to increased vomiting and abdominal pain incidents.[25,26]

The lack of any strong association between DEPs and clinical outcomes beyond night eating and non-hungry eating suggests that, in the routine practice setting, the MDT's focus should be on behavior change, safety, and value-based care rather than using DEPs to triage intensity and type of support. However, as there was convincing evidence against the null hypothesis for the association of night eating and non-hungry eating with events, the MDT should ensure to routinely assess for these DEPs with their patients and ensure adequate follow-up is planned for the postprocedural period.

Further research is required to determine whether utilizing validated and routine assessments for DEPs associated with negative outcomes is feasible and useful in routine care. As not all 20+ DEPs identified can feasibly be assessed for each patient, additional examinations of routine care settings should be undertaken to confirm the priority DEPs. Currently, this study suggests that a more routine assessment of non-hungry eating and night eating may be warranted.

This paper is strengthened by its pragmatic real-world approach, giving a rare insight into routine care with a whole population sample due to imposing no exclusion criteria and having a 100% recruitment rate due to the waiver of consent. The non-standardized approach to identifying DEPs was a strength of the study as it was able to meet a research gap; but no DEP can be considered as a valid or accurate diagnosis and further research is needed to understand and define the DEPs. Although recruitment was complete, the high attrition rate negatively impacted the accuracy of other outcomes such as weight loss, nutrient deficiencies, and events. Reflecting the relative novelty of the ESG, patient numbers were low and the sample likely underpowered. The outcome data were likely limited due to inconsistencies in the quality and quantity of information recorded in medical notes within and across health care professionals; however, no single health professional was found to have a bias toward identifying specific DEPs. As an exploratory study, multiple outcome variables were analyzed to answer the research question, increasing the chance of type I errors. To address this, an evaluation of certainty based on multiple statistical factors including *p*-value, variance, and effect size was used to inform study conclusions rather than a *p*-value cut-off for statistical significance.[27]

Adults living in Australia who elected an LSG or ESG were believed to have experienced a wide variety and high frequency of DEPs as described by the MDT during routine care. Patients further reported a high frequency of symptoms, side-effects, or complications, especially gastrointestinal-related events and nutrient deficiencies, which required action by the MDT. Patients believed to have experienced non-hungry eating and night eating had poorer outcomes and a higher need for support following an LSG or ESG procedure. Intensive pre- and postprocedural support by the MDT is required to identify and address DEPs, events, and nutrient deficiencies not only for safety but also for eating behavior change and to achieve value-based care.

AUTHOR CONTRIBUTIONS

Skye Marshall, Brianna Fear-Keen, Jennifer Hoult, and Isabella R. Maimone developed the study concept. Brianna Fear-Keen, Jennifer Hoult, and Isabella R. Maimone assisted with access to data. Georgia Spry, Ashleigh McIntosh, and Skye Marshall drafted the manuscript. Georgia Spry, Ashleigh McIntosh, Nicola Gadd, and Zoe Martin contributed equally to data collection, data entry, and data checking. Georgia Spry, Patrice Jones, and Skye Marshall led the data analyses. All authors critically reviewed the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no financial or other conflicts interests. It is acknowledged for authors Brianna Fear-Keen, Jennifer Hoult, and Isabella R. Maimone were clinicians at the study site who provided care to the patients as part of routine care. Brianna Fear-Keen, Jennifer Hoult, and Isabella R. Maimone were not involved in data collection, data analysis, or interpretation of clinical outcome.

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