Building the Science Behind the Design and Development of Nutrition-Focused Behavioural Interventions Adjunct to Metabolic Bariatric Surgery

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A Thesis
In the Department
of
Health, Kinesiology, and Applied Physiology

Presented in Partial Fulfillment of the Requirements
For the Degree of
Doctor of Philosophy (Health and Exercise Science)
at
Concordia University
Montreal, Quebec, Canada

October 2024

CONCORDIA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

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prepared by: Reyhaneh Yousefi

Entitled: Building the Science Behind the Design and Development of Nutrition-Focused Behavioural Interventions Adjunct to Metabolic Bariatric Surgery

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DOCTOR OF PHILOSOPHY (Health and Exercise Science)

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ABSTRACT

Building the Science Behind the Design and Development of Nutrition-Focused Behavioural Interventions Adjunct to Metabolic Bariatric Surgery

Reyhaneh Yousefi
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Concordia University, 2024

This thesis aims to explore the basic behavioural science guiding the design and development of nutrition-focused behavioural interventions adjunct to metabolic bariatric surgery (MBS). It comprises three systematic reviews to; 1) evaluate the quality of intervention reporting; 2) identify the potentially active content of interventions; and 3) explore perceived barriers and enablers to modifying post-operative dietary behaviours.

In Study one, the Template for Intervention Description and Replication (TIDieR) checklist was applied to evaluate the completeness of intervention reporting. In Study two, intervention materials were coded using the Behaviour Change Technique Taxonomy version 1 (BCTTv1). In addition to descriptive methods, effect size calculations were used to assess the impact of the interventions on weight outcomes. In Study three, data reporting barriers and enablers to modifying diet after MBS were analysed using the Theoretical Domains Framework (TDF). Barriers/enablers were mapped to BCTs to identify potential intervention strategies.

Among the 22 included interventions, none of them completely reported all intervention descriptors in the TIDieR checklist, with an average of 6.6/12 items being fully reported. The areas where reporting required improvement were; providing adequate details of the materials and procedures of the interventions; intervention personalisation; and modifications during the study. Common BCTs reported in interventions included: Instruction on how to perform a behaviour; Self-monitoring of behaviour; Goal setting (behaviour); Problem solving; Social support (unspecified); and Action planning. The BCTs that were only found in the most efficacious interventions (Monitoring of behaviour by others without feedback and Information about antecedents) were not among the most frequent techniques. Key factors influencing post-

operative dietary behaviour change were in the categories of Environmental Context and Resources; Behavioural Regulation; Emotions; Beliefs about Consequences; and Social Influences. Potential strategies (BCTs) to support postoperative dietary behaviour change are in line with our findings in study two.

The poor quality of intervention reporting in the current literature limits the potential for evidence synthesis across studies. Addressing barriers to post-operative dietary change, ensuring transparent intervention reporting through behavioural science tools, and frameworks will contribute to the development of interventions that not only engage and mobilise patients towards positive behaviour change but also produce replicable evidence to inform clinical practice.

ACKNOWLEDGEMENTS

I would like to thank my supervisor, Dr. Simon Bacon, for his support and encouragement throughout my graduate studies. His assistance has been pivotal to my academic and personal growth as a first-time international student experiencing life and study abroad. His insightful feedback and mentorship have been crucial to realising my initial idea for this project. His patience throughout this long journey helped me complete this degree, and I am incredibly grateful for the opportunity to learn from him.

I've been so lucky to work alongside an amazing group of individuals for my committee members: Dr. Kim Lavoie, Dr. Tamara Cohen, and Dr. Sylvia Santosa. Thank you for providing such insightful feedback and for your continued willingness to help.

A special thanks to Dr. Fabiana Lorencatto and Dr. Tair Ben-Porat, who have always provided me with timely support amidst all of their other responsibilities, and to the MBMC lab for their assistance in the implementation of my project.

I am grateful to the Fonds de Recherche du Québec - Santé (FRQS) for their generosity in funding me throughout my doctoral studies.

I would also like to thank Concordia University whose academic support, resources, and vibrant community have played a pivotal role in shaping my journey and fostering my growth as a scholar

Lastly, I extend my heartfelt thanks to my family and friends for their emotional support and understanding during the challenging times of my PhD.

DEDICATION

This thesis is dedicated to my mother, whose unwavering love and support have been my constant source of strength and inspiration even from the long physical distance between us. Your belief in my abilities, Mom, has propelled me forward during moments of doubt. Your sacrifices and encouragement have shaped not only my academic achievements but also my character. I am deeply grateful for your endless patience, guidance, and faith in me. Thank you, Mom, for being my greatest cheerleader and role model throughout this journey.
You were my first actual client seeking weight loss, but I always caught you red-handed while cheating on a dessert or a sweat, hope after this many years of research I'll have some better tips for you!

This thesis is also dedicated to my extended family, whose collective support and encouragement have been instrumental in my personal and academic growth. Your wisdom, kindness, and belief in my potential have fueled my determination and perseverance. Each of you has contributed to my journey in unique ways, and I am profoundly grateful for the love and motivation you have provided. Thank you for being my foundation and for inspiring me to reach for my dreams.

CONTRIBUTION OF AUTHORS

My supervisor, Dr. Simon Bacon, and Dr. Fabianna Lorencatto, as well as a group of current and former MBMC members have worked with me throughout the different phases of my doctoral dissertation. Therefore, their involvement has been varied across each of the papers. They are as follows.

Paper 1 (Chapter 2): Reyhaneh Yousefi, Simon L. Bacon, and Kim L. Lavoie designed the study, including its conceptualisation and methodology. Reyhaneh Yousefi developed the search strategy and conducted the literature search. She also performed screenings and data extraction, which were peer-reviewed by Tair Ben-Porat, Jovana Stojanovic, John O'Neil, Vincent Gosselin Boucher, and Annabelle Fortin. Reyhaneh Yousefi graded the studies using the checklists, with peer review by Tair Ben-Porat. Reyhaneh Yousefi also conducted the analysis. All authors contributed to writing the paper, with Reyhaneh Yousefi and Simon L. Bacon having primary responsibility for the final content. All authors read and approved the final manuscript.

Paper 2 (Chapter 3): Reyhaneh Yousefi, Simon L. Bacon, and Kim L. Lavoie designed the study, including its conceptualisation and methodology. Reyhaneh Yousefi developed the search strategy and conducted the literature search. She also performed the screenings and data extraction, which were peer-reviewed by Tair Ben-Porat, John O'Neil, Vincent Gosselin Boucher, and Annabelle Fortin. Reyhaneh Yousefi coded the BCTs, with peer review by Tair Ben-Porat and John O'Neil. Reyhaneh Yousefi also performed the Risk of Bias assessment, which was peer-reviewed by Ariany Marques Vieira. Reyhaneh Yousefi conducted the analysis. All authors contributed to writing the paper, with Reyhaneh Yousefi and Simon L. Bacon having primary responsibility for the final content. All authors read and approved the final manuscript.

Paper 3 (Chapter 4): Reyhaneh Yousefi, Simon L. Bacon, and Fabiana Lorencatto designed the study, including its conceptualisation and methodology. Reyhaneh Yousefi developed the search strategy and conducted the literature search. She performed the screenings, data extraction, and deductive analysis, which were peer-reviewed by Vincent Gosselin Boucher, Patricia F.C. Acosta, John O'Neill, Manuela González-González, and Florence Coulombe Raymond. Reyhaneh Yousefi also conducted the inductive thematic synthesis, peer-reviewed by Vincent

Gosselin Boucher and Fabiana Lorencatto. The risk of bias assessment was performed by Reyhaneh Yousefi and peer-reviewed by Vincent Gosselin Boucher, Patricia F.C. Acosta, John O'Neill, and Manuela González-González. Reyhaneh Yousefi conducted the analysis. All authors contributed to writing the paper, with Reyhaneh Yousefi and Fabiana Lorencatto having primary responsibility for the final content. All authors read and approved the final manuscript.

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CHAPTER 1: Introduction

Obesity and the Role of Metabolic Bariatric Surgery

Obesity is a chronic multi-system disease in which abnormal or excess body fat impairs health, increases the risk of long-term medical complications, and reduces lifespan.[1] Based on the latest World Health Organisation reports, about 16% and 43% of adults aged 18 years and over were living with obesity or overweight in 2022 (respectively), presenting a twofold worldwide increase in the prevalence of obesity between 1990 and 2022.[2,3] Data from the 2022 Canadian Community Health Survey suggest that close to one in three Canadian adults (30%) had obesity in 2022, up from just over one in five (21%) in 2003.[4] The rise in healthcare costs is the inevitable consequence of the obesity pandemic, costing Canada roughly $4.6 billion annually.[5] The most recent statement of the American Society for Metabolic Bariatric Surgery (ASMBS) and the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) recommended metabolic bariatric surgery (MBS) for individuals with a body mass index (BMI) ≥35 kg/m^2, regardless of the presence or severity of co-morbidities. They also suggested that MBS should be considered for individuals with metabolic disease and a BMI of 30-34.9 kg/m^2.

MBS is an umbrella term used to describe the surgical modifications of the gastrointestinal tract by limiting its size and reducing the absorption of food.[6] The most common categories of MBS procedures in Canada are: 1) restrictive procedures, such as sleeve gastrectomy, which limit food intake by reducing the size of the stomach; and 2) procedures that both reduce food intake and induce malabsorption, such as Roux-en-Y gastric bypass and biliopancreatic diversion with duodenal switch.[6,7]

Outcomes Following Metabolic Bariatric Surgery

Despite the lack of standardisation in the definition of "success," MBS is associated with significant short-term (less than 1 year) and some medium-term (1-5 years)[8] improvements, including reductions in body weight and decreased comorbidities.[9-12] In a primary analysis of a longitudinal data set, we examined changes in quality of life (QoL) during the initial postoperative year and demonstrated significant improvements in weight and the physical

aspects of QoL (see Appendix 1. for the entire manuscript). However, there is considerable individual variability in clinical outcomes,[13-15] with more than 50% of patients experiencing significant weight regain after the first year following MBS.[16] This weight regain may lead to the recurrence of previously controlled obesity-related comorbidities and may require additional weight loss procedures,[17-22] potentially resulting in surgery-induced complications and a significant increase in healthcare costs.[23-26] Additionally, several non-weight-related outcomes have been shown to worsen post-surgery, including notable negative impacts on overall health-related QoL,[27] as well as maladaptive psychological adjustment and a worsening of mental health.[28-30] A substantial proportion of patients also experience recurrent or new maladaptive eating behaviours (8%-50%) and nutritional deterioration (15%-70%).[31-38] A key factor contributing to post-operative weight regain is the failure to adopt or maintain appropriate weight-related health behaviours or return of high-risk behaviours e.g., lack of adherence to long-term follow-up, having a sedentary lifestyle, and insufficient dietary changes.[16,17,39-43]

Nutrition-Focused Behavioural Interventions in MBS Care

A nutrition-focused behavioural intervention may include a varied range of structured approaches aimed at modifying an individual's eating behaviours and dietary habits. These interventions often combine nutrition principles with behavioural strategies to encourage lasting changes in different aspects of one's dietary behaviour e.g., food choices and eating patterns.[44] These interventions are structured to use behaviour change techniques (BCTs) as the core drivers of change, with a unique focus on altering eating behaviours, dietary habits, and patterns.[45] Dietary behaviours, in particular, are recognised as core modifiable health behaviours that are closely linked to post-surgical health outcomes,[46,47] which is partly because maladaptive eating behaviours and low diet quality are resistant to weight loss surgical interventions in the long-term.[16] However, MBS-induced anatomical and physiological modifications may result in early restrictive impacts on the quantity of food intake, alterations in the quality of consumption, and improvements in satiety hormones.[40] Therefore, the early post-operative period is a time when patients need to manage surgery-enforced modifications in their health behaviours, specifically eating behaviours, dietary choices, and their relationship with food.[48-50] This experience may create an opportunity for patients to value the importance of changing maladaptive eating habits and believe that the time and effort expended in a behavioural intervention will "pay off" (e.g.,

result in improved weight loss and QoL).[50,51] Thus, adjunct nutrition-focused behavioural interventions may shape a momentum favouring patients' engagement and receptivity toward persistent maintenance behaviours, leading to optimal post-operative health outcomes.[52,53]

There is conflicting evidence around nutrition-focused behavioural interventions in MBS care leading to a lack of a solid basis for interventions adjunct to MBS. Some studies suggest that certain dietary strategies, such as following low-calorie structured diets, can improve weight loss and metabolic outcomes post-MBS.[12] However, other research indicates that the effectiveness of current interventions varies significantly between individuals, with some patients experiencing minimal benefits or even weight regain.[22,47,54] These heterogeneous and modest findings raise the question of whether the observed outcomes are due to a true lack of intervention efficacy, or if the interventions have been poorly designed, developed, and delivered to achieve their objectives.[55] The most recent clinical practice guidelines from Obesity Canada for MBS care management provide high-level recommendations for the behaviour change aspects of dietary management.[56] Some of these recommendations include following a structured diet involving small portions, three to five balanced and structured meals, and healthy snacks (e.g., avoiding sweets). Patients are advised to chew foods slowly, avoid eating and drinking simultaneously, and abstain from carbonated beverages and caffeinated drinks. Post-MBS patients are also recommended to follow a low-fat, moderate-carbohydrate, and high-protein diet, ensuring a daily protein intake of 1.2 to 1.5 g/kg based on goal body weight. However, from a behaviour change perspective, these recommendations resemble a list of high-priority target behaviours without sufficient detail on how to implement these changes. As a result, these guidelines do not seem adequate to empower clinicians to design and deliver interventions that address the challenges of weight management or actively involve patients in the behaviour change process.[57]

The critical clinical problem of weight regain after MBS raises the question: “What is the optimal nutrition-focused behavioural intervention to prevent weight regain after MBS?” One reason for the current challenges is the lack of a structured development process in the design, development, and implementation of interventions.[61] This gap highlights the need for a transition to a systematic development framework with a focus on specific behaviours (e.g., change in diet) and outcomes (e.g., weight loss, improved micronutrient status, or enhanced quality of life). Frameworks provide a structured, evidence-based approach that guides the entire process of

intervention development from conceptualisation to delivery.[58] By integrating behavioural science with practical application, these frameworks ensure that interventions are not only grounded in theory but are also tested and refined based on ongoing evaluation. [59] This kind of structure is crucial for generating clear, evidence-based recommendations about the content and characteristics of effective interventions, ultimately guiding clinical practice and improving patient outcomes.[58] Without such a transition, interventions may continue to suffer from inconsistencies, limiting their potential to produce lasting change in post-MBS patients.

A framework for Behavioural Intervention Development

This thesis is guided by the International Behavioural Trials Network - Obesity Related Behavioural Intervention Trials (IBTN-ORBIT)[59] model of behavioural intervention development and testing (Figure 1.1) (see Appendix 2. for the Publisher's copyright permission). This framework centers on patient or knowledge-user-informed clinical questions and incorporates principles from implementation science. The model highlights the essence of the preliminary phase of basic behavioural research and the application of behavioural science theories as the central concept to inform the initial design of interventions. After this initial design phase, the model advocates for systematic refinement (Phase I), followed by proof-of-concept, feasibility, and pilot studies (Phase II). Following these preparation steps for behavioural interventions, efficacy (Phase III) and effectiveness (Phase IV) trials will be conducted to rigorously assess the final intervention.[59-62]

The current thesis has been designed within this framework and is consistent with shaping the basic behavioural science knowledge needed for the design and development of nutrition-focused behavioural interventions adjunct to MBS. This step involves conducting fundamental research to understand the behaviours, contexts, and mechanisms that are relevant to the target population. It lays the groundwork for designing effective behavioural interventions by identifying the key behavioural patterns, psychological factors, and environmental influences that need to be addressed in the intervention. During this stage, researchers leverage theoretical models and frameworks from behavioural science to generate hypotheses about how behaviour change occurs and which techniques may be most effective. This exploration may include qualitative research, observational studies, experimental research, and evidence syntheses to

assess the underlying behavioural determinants and barriers that influence the desired outcomes.[63]

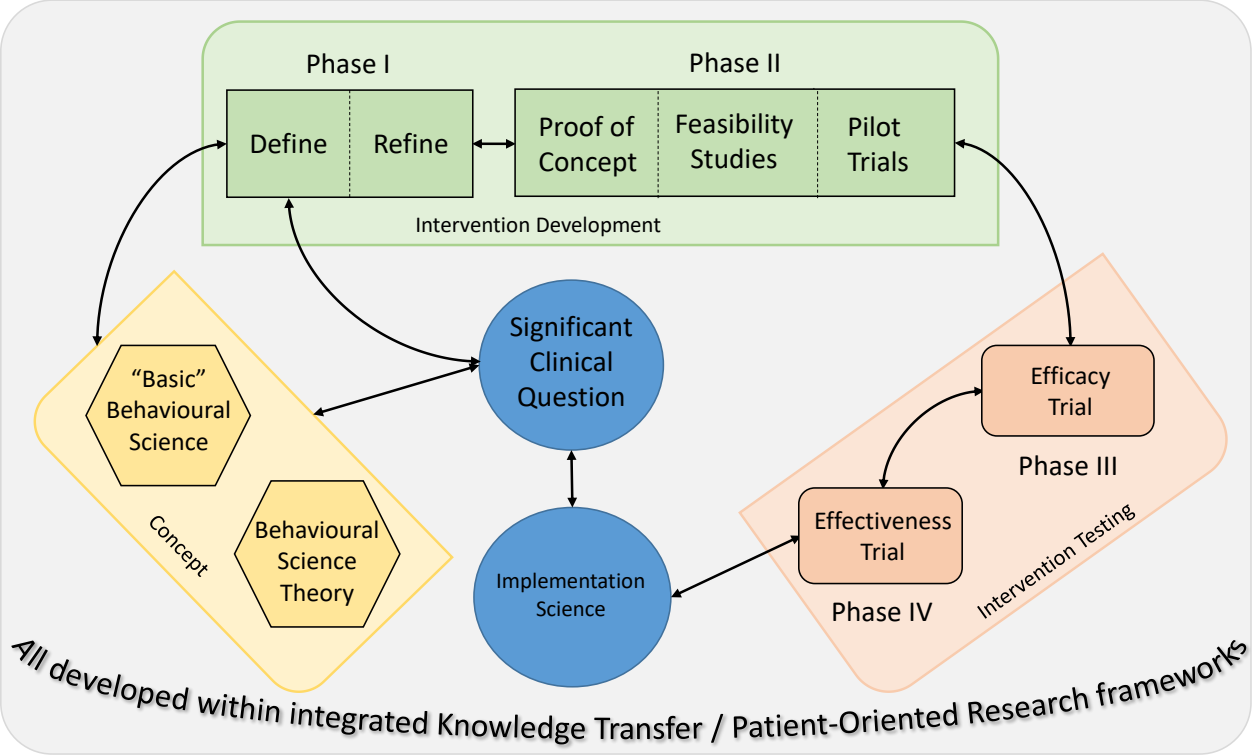

Figure 1.1 Adapted from the IBTN-ORBIT model of behaviour change[59]

The Application of Behavioural Science Research Tools

Initiating and maintaining a healthy lifestyle involves making a complex series of behavioural changes.[62,64,65] Obesity-related behavioural interventions tend to be complex[66] and may target several behaviours such as dietary change, meal planning, emotional eating, etc. On top of that, interventions may have several interacting behaviour change techniques (BCTs), which are the irreducible active ingredients designed to change a specific behaviour(s).[65] Consequently, determining which BCTs effectively modify an individual's eating behaviours and dietary habits can be challenging, as different combinations of BCTs may impact individuals differently and produce varying health outcomes.[67] Common language hierarchies help specify intervention components, identify commonalities in seemingly disparate interventions, and ultimately uncover cross-study findings associated with desired outcomes.[68,69] One commonly used tool is the Behaviour Change Technique Taxonomy version 1 (BCTTv1), a hierarchically organised,

cross-behaviour taxonomy that was created to describe BCTs.[65] This taxonomy includes 93 BCTs and can help identify the active ingredients in behavioural interventions and prepare the ground for the examination of BCTs associated with positive outcomes. Close to the end of this thesis, newer frameworks for categorising behaviour change interventions have emerged, including the Behaviour Change Intervention Ontology (BCIO)[70] and the Behaviour Change Technique Ontology (BCTO)[71]. These newer ontologies offer a more detailed and systematic approach to understanding and classifying BCTs. While the BCTTv1 taxonomy provided a foundational structure for identifying the active components of interventions, BCIO and BCTO extend this work by refining the categorisation and broadening its application in behaviour change research.[70,71] However, these were introduced close to the completion of this thesis and, as such, are not used in the subsequent chapters and are included here to acknowledge that the science has since moved forward.

The implementation of reporting guidelines is essential in behavioural interventions because they provide us more usable information to help understand the results, inform the development of future interventions, and/or help with the implementation of an intervention.[72] Two main guidelines in this area are the Template for Intervention Description and Replication (TIDieR), and the Consolidated Standards of Reporting Trials extension for nonpharmacologic therapies (CONSORT-NPT). TIDieR, introduced in 2014, is a 12-item checklist which details how to report specific components of the interventions. Despite its potential to improve reporting, TIDieR's implementation has been limited, especially within obesity research.[73] The updated CONSORT-NPT checklist, revised in 2017, includes 27 items that cover behavioural intervention trials, enhancing overall trial design reporting.[74] Since CONSORT-NPT is designed to address the complexities of intervention delivery, adherence, and participant behaviour, its application is recommended to enhance transparency in the design, conduct, and reporting of nutrition-focused behavioural trials, ultimately contributing to the development of more replicable interventions.[75]

In this work, we also utilised the Theoretical Domains Framework (TDF) to categorise the barriers and enablers reported by patients.[76] The TDF is a comprehensive framework of 14 construct domains, synthesised from 33 theories of behaviour that was developed to study determinants of behaviour and to design interventions to improve evidence-based healthcare

practices.[77] It provides a theoretical lens through which to view the cognitive, individual, social and environmental influences on behaviours and helps healthcare professionals to increase their confidence in undertaking projects, providing a broad perspective, and a means of understanding the implementation problem and potential solutions in theoretical terms.[78,79] One of the key advantages of the TDF is that it can be mapped to BCT taxonomy's and the Behaviour Change Wheel,[61] providing a structured approach to identifying which techniques and strategies may be most effective in addressing specific behavioural determinants, ultimately contributing to the development of more tailored and impactful interventions[80]. This integration is especially beneficial in the complex field of healthcare, where behaviour change is often influenced by a multitude of factors.[81]

Summary

While MBS offers significant benefits in weight reduction and comorbidity management, there remain considerable challenges in long-term outcomes, particularly with respect to weight regain and the recurrence of obesity-related complications. The evidence supporting the effectiveness of nutrition-focused behavioural interventions in post-MBS care is inconsistent. Current clinical practice guidelines lack sufficient detail on how to change behaviour and how to implement interventions, limiting their utility in guiding clinicians toward effective patient care. Furthermore, no behavioural frameworks seem to have been applied to develop the existing literature for designing and developing nutrition-focused interventions that address the specific behavioural challenges faced by patients undergoing MBS.[82,83] To improve the effectiveness of future interventions, it is essential to adopt a structured framework that leverages existing literature, ontologies, and behavioural science theory, ensuring that nutrition-focused behavioural interventions are rigorously developed, tested, and refined based on a solid foundation of evidence.

Aims and Objectives of the Thesis

This thesis aims to provide new insights into the design and development of nutrition-focused behavioural interventions adjunct to MBS, informed by exploring the basic behavioural science within the field of nutrition in MBS care. The research will focus on the quality of reporting, understanding intervention components, and exploring patient perceptions of barriers and enablers to post-surgical dietary behaviours. By addressing these areas, this work seeks to contribute to the development of more effective, evidence-based interventions that support long-term success for individuals undergoing MBS.

The specific questions this thesis aimed to answer include:

1. What is the quality of reporting in nutrition-focused behavioural interventions adjunct to MBS? This will be assessed by evaluating the completeness of intervention and study reporting using the TIDieR and CONSORT-NPT checklists that have been identified through a systematic review of the topic.

2. What are the BCTs utilised in nutrition-focused behavioural interventions adjunct to MBS? Understanding the techniques used in interventions will be achieved by applying the BCTTv1 to code the intervention materials of the studies identified through the systematic review.

3. What are patients' perceptions of the barriers and enablers to modifying post-MBS dietary behaviours? This will be explored through the application of the TDF, which provides context for organising patients' experiences with dietary behaviours, including what they eat, how much they eat, and how they eat, to studies identified in a different systematic review.

Figure 1.2 illustrates how each section of the project aligns with the “basic behavioural science” exploration phase in the IBTN-ORBIT model of behaviour change.

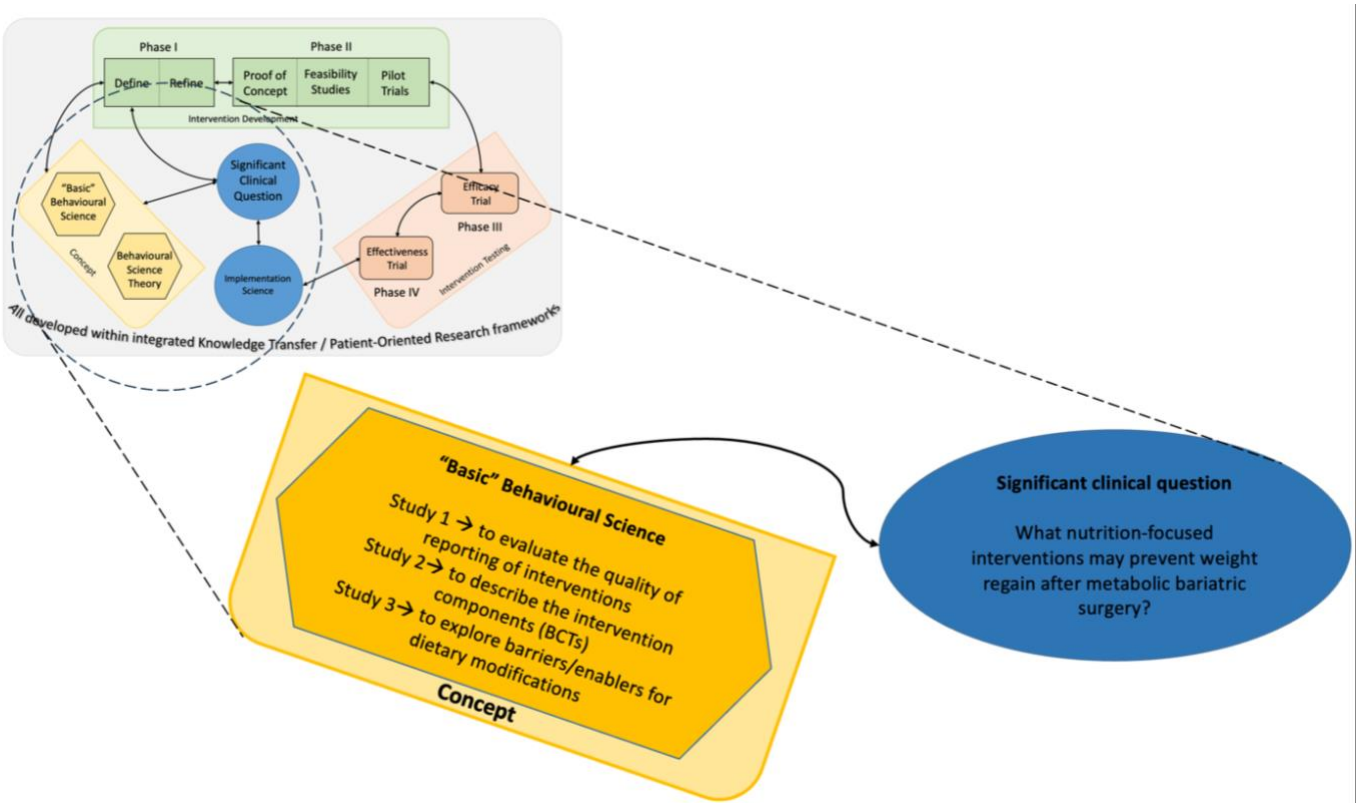

Figure 1.2 Conceptual model of the project embedded in the IBTN-ORBIT model of behaviour change

Organisation of the Thesis

This thesis is organised into five chapters, three of which are papers, with their publication status shown in Table 1-2. The concluding chapter (Chapter Five) summarises the key findings of the thesis, discusses how these findings contribute to advancing the field, outlines the strengths and limitations of the research, and provides recommendations for future research directions.

Table 1.2 Manuscript status

Chapter/Paper	**Targeted Journal**	**Status**
Chapter 2: Completeness of intervention reporting of nutrition-focused weight management interventions adjunct to metabolic bariatric surgery: effect of the TIDieR checklist	*International Journal of Obesity*	Published
Chapter 3: Understanding the Components of Nutrition-Focused Weight Management Interventions Adjunct to Metabolic Bariatric Surgery: Systematic Review of published Literature	*Current Obesity Reports*	Submitted on 30th August, 2024
Chapter 4: Barriers to and enablers of modifying diet after metabolic bariatric surgery: a systematic review of published literature	*Obesity reviews*	Submitted on 8th August 2024 (minor revisions required)

CHAPTER 2: Completeness of Intervention Reporting of Nutrition-focused Weight Management Interventions Adjunct to Metabolic Bariatric Surgery: Effect of the TIDieR Checklist

Journal: International Journal of Obesity

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Abstract

Nutrition-focused interventions are essential to optimize the bariatric care process and improve health and weight outcomes over time. Clear and detailed reporting of these interventions in research reports is crucial for understanding and applying the findings effectively in clinical practice and research replication. Given the importance of reporting transparency in research, this study aimed to use the Template for Intervention Description and Replication (TIDieR) checklist to evaluate the completeness of intervention reporting in nutritional weight management interventions adjunct to metabolic/bariatric surgery (MBS). The secondary aim was to examine the factors associated with better reporting. A literature search in PubMed, PsychINFO, EMBASE, Scopus, and the Cochrane Controlled Register of Trials was conducted to include randomized controlled trials (RCT), quasi-RCTs and parallel group trials. A total of 22 trials were included in the final analysis. Among the TIDieR 12 items, 6.6±1.9 items were fully reported by all studies. None of the studies completely reported all intervention descriptors. The main areas where reporting required improvement were providing adequate details of the materials and procedures of the interventions, intervention personalization, and intervention modifications during the study. The quality of intervention reporting remained the same after vs. before the release of the TIDieR guidelines. Receiving funds from industrial organizations (p = 0.02) and having the study recorded within a registry platform (p = 0.08) were associated with better intervention reporting. Nutritional weight management interventions in MBS care are still below the desirable standards for reporting. The present study highlights the need to improve adequate reporting of such interventions, which would allow for greater replicability, evaluation through evidence synthesis studies, and transferability into clinical practice.

Keywords: Metabolic/Bariatric surgery, Behavioural Weight Management, Intervention reporting, Diet, Nutrition, TIDieR, CONSORT.

Introduction

Metabolic/bariatric surgery (MBS) is currently the most effective long-term treatment for severe obesity and its related comorbidities.[84] However, in the long-term, there are significant inter-individual disparities in weight outcomes, including notable weight regain.[85-87] Some studies suggested that bahvioural weight management (BWM) interventions have been suggested to play a critical role in optimizing the MBS care process.[51,88,89] Nutrition and dietary behaviours are among the key modifiable health-related bahviours that strongly correlate with long-term surgical weight outcomes.[54,90,91] Consequently, a notable number of BWM interventions adjunct to MBS include nutrition-focused bahviour change approaches to shape their interventions.[91,92]

For interventions to be appropriately interpreted and applied to patient care and for treatment integrity to be evaluated, accurate reporting of intervention details must be provided in published trial reports.[72] The transparency of research reports allows readers to fully understand a study, researchers to replicate and expand on those publications, and develop practical guidelines to inform clinical practice.[93-95] Inadequate reporting of interventions further complicates the challenge of deriving clear conclusions from studies and establishing correlations between outcomes and the characteristics or components of the interventions.[95,96]

One solution to improve the quality and completeness of bahvioural interventions and trials is implementing and using of reporting guidelines.[72] Two of the main relevant guidelines are the *Consolidated Standards of Reporting Trials* extension for non-pharmacologic therapies and treatments (CONSORT-NPT)[74] and the *Template for Intervention Description and Replication* (TIDieR).[73] The 2017 updated version of the CONSORT-NPT is a 27-item checklist with items specific to the conduct of bahvioural intervention trials. The adoption of the CONSORT statement[97] has contributed greatly to the improvement of the overall trial design.[94] However, the CONSORT statement guidance on intervention reporting lacks specificity as it gives general recommendation for reporting interventions without providing detailed guidance on critical components (e.g., specific techniques employed or the mode of delivery).[72] The TIDieR was created to address this limitations.[73] TIDieR was published in 2014 and comprises of 12 items that detail how to report specific components of the intervention and address the generally poor reporting up to that point. Implementing the TIDieR as a means to improve intervention reporting has generally been limited, especially within obesity research.[72]

The present work is a sub-study of our original large systematic review which demonstrated that delivering BWM interventions during the postoperative period, compared to preoperative, appears to confer the most benefits on weight outcomes following MBS.[51] In the present work we exclusively investigated nutrition-focused interventions and aimed to apply the TIDieR checklist to evaluate the completeness of intervention reporting in the relevant interventions. The CONSORT-NPT checklist was used as an additional parameter for the evaluation of the overall quality of the trial reporting. Our secondary aim was to examine study factors that might be associated with better intervention reporting. We hypothesize that employing standard methodological checklists to assess the completeness of intervention reporting will uncover variations in reporting quality across studies and that specific study factors will positively be correlated with improved intervention reporting. Moreover, the publication of the methodological and reporting guides (i.e. TIDieR) is anticipated to positively influence the overall quality of evidence in the field of bahvioural interventions adjunct to MBS.

Methods

This systematic review was registered with the International Prospective Register of Systematic Reviews (PROSPERO: CRD42017049094). We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement to ensure transparency and comprehensible reporting.[96]

Inclusion criteria and database search

The inclusion and exclusion criteria for the systematic review have been previously outlined.[51] In brief, we incorporated studies that assessed BWM interventions in adults (aged >18 years) undergoing MBS. For the present analysis, we included studies with nutritional or dietary bahviours as targets of their intervention strategy. Interventions targeting psychosocial status, physical fitness or muscle strength were excluded. This was done to provide a more consistent focus for the kinds of interventions that would be included. Studies had to report an anthropometric outcome (i.e., weight, body mass index [BMI], or body composition) pre- and post-intervention with the post-intervention assessment also needed to be post-MBS. Eligible designs included randomized controlled trials (RCTs), quasi-RCTs and parallel group trials. Observational studies, reviews, book chapters, abstracts, and unpublished literature were

excluded as well as non-French or English publications. The inclusion and exclusion process are illustrated in the flow diagram in Figure 1. The latest search using keywords included in the Appendix 4. was conducted in PubMed, PsychINFO, EMBASE, Scopus, and the Cochrane Controlled Register of Trials, on July 31, 2023. The initial data base search was done in October 2021, and after that there was a search update every 3 months. Two reviewers (RY and TBP) screened titles and abstracts, and then assessed full-text articles for eligibility (Appendix 5). Any disagreements were resolved by consensus or by including a third party (SLB). In addition, reference lists of the included studies were screened to identify any further relevant publications.

Data extraction

The following data elements were recorded for each study: location; year of publication, study design, intervention target bahviour, sample size, funding source, trial registry, baseline demographics (i.e., age) and anthropometrics (i.e., weight and BMI), target outcomes of the study, duration of intervention, blinding process, duration of follow-up, interventions' characteristics, and the endorsement of the TIDieR and CONSORT checklists items.

Data analyses

Primary analyses

Reporting quality was assessed using the TIDieR[73] and the CONSORT-NPT checklists.[97] A three-point scale was used to score each item on both checklists: 0= no or ambiguous; 1= partial; or 2= yes. An item was assigned "yes" if all criteria of the item were met in the report, "no" if none of the criteria of the item were met, "ambiguous" if not enough information was provided to make a clear decision (e.g., the item was mentioned but no exact information was provided), and "partial" if some but not all criteria were included. Scoring and data extraction were completed separately by two investigators (RY & TBP), with any disagreements being resolved through discussion with the third party (SLB). Descriptive statistics (frequencies and percentages) were used to summarize adherence to individual checklist items for all included studies. We also characterized the distribution of trials by the number of *fully* reported TIDieR items using a histogram.

Secondary analyses

Studies were divided into two groups based on their year of publication for each checklist: studies published before 2015 were labelled as Group 1, and studies published in 2015 or later were placed in Group 2. This dichotomy was determined based on the date the TIDieR checklist and guide was published (i.e., the beginning of 2014), and we allowed almost a year in order for this checklist to be accessed, used, and implemented by researchers, reviewers, and journals. The secondary analysis included two subsequent steps. In the first, we applied the previously described three-point scale to test the TIDieR checklists items adherence before (group 1) and after (group 2) 2015 as presented in table 3. Then, we converted the three-point scale to a two-point scale: "positive" where the item was *fully reported*, and "negative" where the item was labeled as "no" (i.e., not reported), "ambiguous" or "partially" reported. This was done in order to calculate the average number of criteria fully (i.e., *positive*) met on TIDieR checklist before (group 1) and after (group 2) 2015. Two Sample t-tests were then used to compare TIDieR checklist adherence before (group 1) and after (group 2) 2015 based on these scoring scales and classifications. General linear models were used to evaluate whether trial characteristics were associated with intervention reporting (defined as the sum of all the items using the two-point scale). R software was used for all statistical analyses, with the Type I error (α) being set at 0.05 (two-tailed).

Results

Study selection

Our search strategy initially captured a total of 27,245 records from all databases. After duplication removal, 19,927 records were left for title and abstract screening, of which we found 693 potentially eligible studies. Following the full-text screening phase, a total of 40 studies met the inclusion criteria. Among eligible studies, a total of 22 had nutrition as an intervention target and were therefore included in the current analysis (Figure 2.1).

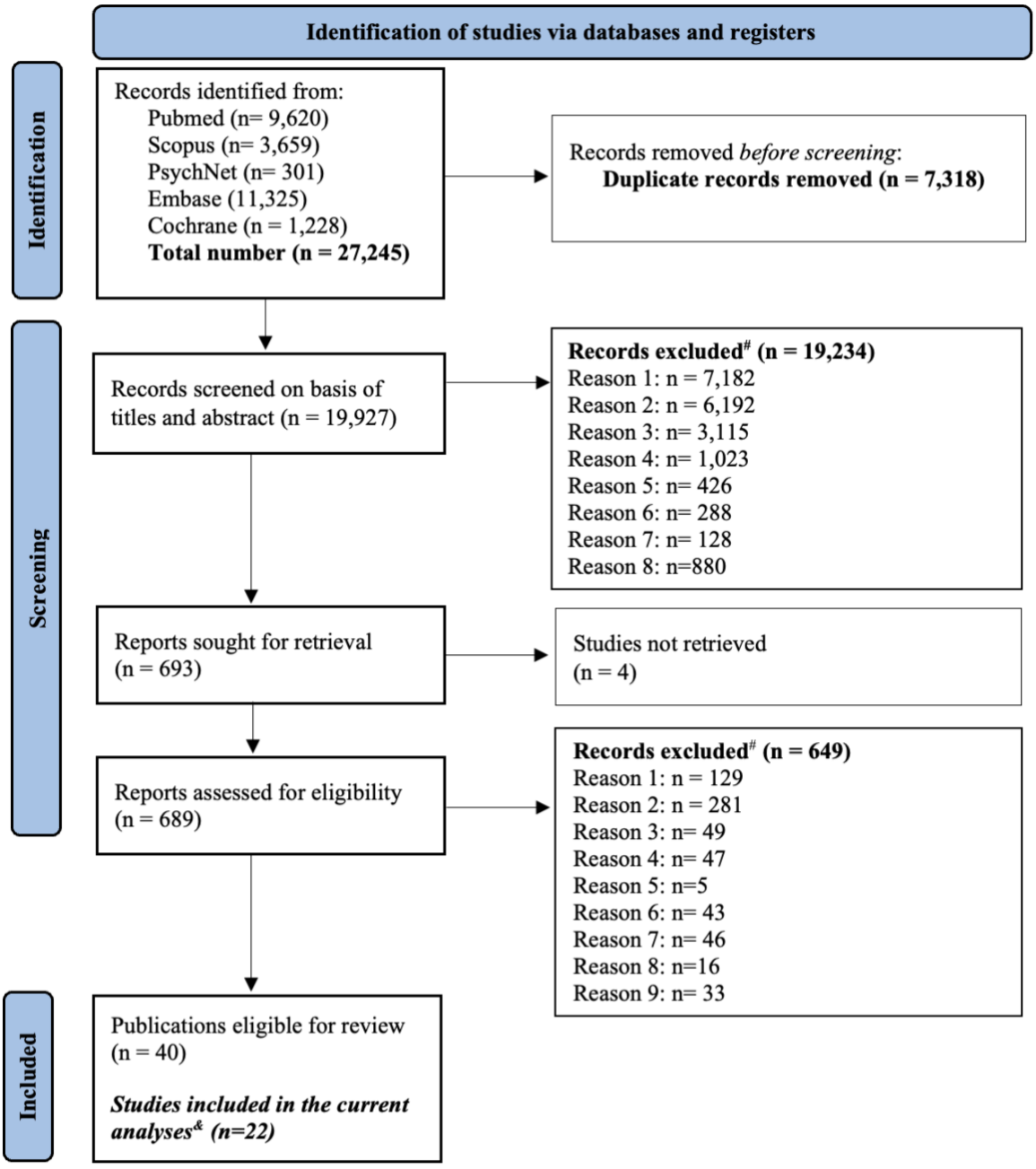

Figure 2.1 PRISMA flow diagram of included and excluded studies

Reasons for exclusion:
Reason 1: Wrong study design
Reason 2: Wrong publication type
Reason 3: Wrong population
Reason 4: Wrong intervention
Reason 5: Foreign language
Reason 6: Wrong comparison
Reason 7: Wrong outcome
Reason 8: Duplicate

Reason 9: wrong study duration
[&] These studies had at least one nutritional component to their intervention package, and were therefore included in the current report

Characteristics of the studies

Table 2.1 presents the characteristics of the included studies. The total sample size was 1,955 (ranged between 18–240), which were predominantly women (81%), with an average age range of 40.2–52.5 years, and baseline weight and BMI ranges of 87.7–152.7 kg and 30.8–51.6 kg/m^2, respectively. Most studies were from the United States (51%; n=13) or Europe (27.3%; n=6). Twenty-one studies were RCTs, among which seven were defined as proof-of-concept/pilot RCTs, and one study was a non-randomized controlled parallel-group trial. The majority (72.7%; n=16) of the interventions were delivered postoperatively. Time of the post-intervention assessment varied considerably across trials (ranged between 3-45 months), and the postoperative follow-up ranged between 6 to 48 months across studies.

Table 2.1 Characteristics of included studies

Author, Year	Country	Study design	BS type	Total randomized (n)	Total post-treatment (n)	Total women (%)	Age [mean (SD)]	Weight (kg) [mean (SD)]	BMI (kg/m^2) [mean (SD)]	Primary outcomes	Int. time[1]	Time of pre-Int. assessment [2]	Time of post-Int. assessment [2]	Total Int. duration (months)	Follow-ups [2]	Trial registry [yes/no]
Drakos 2022[98]	USA	RCT	RYGB SG	128	128	NR	NR	NR	NR	Weight	Post	Pre-op (NR when)	~3 post	Exp. 1.75 Comp. 2.25	6,12 post	No
Hany 2022[99]	Egypt	Non-randomised controlled/ parallel group trial	SG RYGB	36	36	100	NR	NR	NR	BMI, eating behaviour	Post	~ 11 post	~15 post	4	~ 18, 21 post	No
Grilo 2021[100]	USA	RCT	SG RYGB	140	124	85	45.6 (10.9)	NR	NR	Weight, eating behaviour	Post	6	9	3	None	Yes
Paul 2020[101]	Neatherlands	RCT	RYGB	127	118	74	41.7 (9.7)	NR	NR	Weight	Pre	NR	NR	2.5	12 post	Yes
Mangieri 2019[102]	USA	RCT	SG	56	56	87.5	NR	NR	NR	Weight	Post	12 post-op	24 post	12	36 post	No
Lent 2019	USA	Pilot RCT	RYGB SG BPD-DS	50	41	82	46 (8.06)	88.3 (17.32)	30.8 (5.29)	Psych functioning	Post	7 post-op	11 post	4	None	Yes
Hanvold 2019[103]	Norway	RCT	RYGB SG BPD-DS	165	142	75	45.7 (8.6)	91 (18)	30.9 (4.9)	Weight	Post	21 post	45 post	24	None	Yes
Lauti 2018[83]	New Zealand	RCT	SG	95	86	74	46 (8.06)	88.3 (17.32)	30.8 (5.29)	% EWL	Post	18 post-op	30 post	12	None	Yes
Kalarchian 2016a[104]	USA	RCT	RYGB LAGB	240	184	87	44.9 (11)	NR	47.5 (6.4)	Weight	Pre	pre-op (NR when)	6 pre	6	6,12, 24 post	Yes
Kalarchian 2016b[105]	USA	Pilot RCT	RYGB	40	31	85	46.9 (11.1)	87.7 (18.7)	31.3 (5.4)	Weight, calories intake	Post	12 post	16 post	4	18 post	No
Chacko 2016[106]	USA	Pilot RCT	SG RYGB LAGB	18	18	83	NR	NR	NR	Feasibility, acceptability	Post	32 post-op	35 post	2.5	38 post	Yes
Ogden 2015[107]	UK	RCT	RYGB	162	162	75.3	45.2 (10.8)	142.9 (27)	50.7 (7.8)	Weight	Pre & post	0.5 pre	3.8 post	3	6, 12 post	Yes
Wild 2015, 2017[108,109]	Germany	RCT	RYGB SG LAGB	117	114	70.2	NR	NR	NR	Weight, health-related	Post	Pre (NR when)	12	12	37.9 post (SD 8.2)	Yes

Author, Year	Country	Study design	BS type	Total randomized (n)	Total post-treatment (n)	Total women (%)	Age [mean (SD)]	Weight (kg) [mean (SD)]	BMI (kg/m^2) [mean (SD)]	Primary outcomes	Int. time[1]	Time of pre-Int. assessment [2]	Time of post-Int. assessment [2]	Total Int. duration (months)	Follow-ups [2]	Trial registry [yes/no]
										QoL, self-efficacy						
Parikh 2012[110]	USA	Pilot RCT	LAGB	55	23	84	46.6 (10.2)	114.3 (19.8)	45.2 (6.9)	Weight	Pre	12 pre	6 pre	6	6 post	No
Lier 2012[111]	Norway	RCT	RYGB	99	64	73	42 (10.4)	131.1 (20.9)	45.2 (5.3)	Weight	Pre	1.5 pre	12 post	NR	None	Yes
Nijamkin 2012[112]	USA	RCT	RYGB	144	133	83	44.5 (13.5)	NR	NR	EWL	Post	6 post	12 post	3	None	No
Kalarchian 2012[113]	USA	Pilot RCT	RYGB LAGB VBG Secondary-RYGB	36	33	75	52.5 (7.1)	NR	43.1 (6.2)	Weight	Post	36 post	42 post	6	48 post	No
Sarwer 2012[114]	USA	Pilot RCT	LAGB RYGB	84	48	63.1	42 (9.9)	152.7 (33.7)	51.64 (9.2)	Weight, eating behaviour	Post	0.5 pre	4 post	4	6,12,18, 24 post	No
Dodsworth 2012[115]	Australia	Pilot pseudo-RCT	LAGB	47	41	80.9	44.5 (10.5)	NR	42.1 (7.6)	Feasibility, weight, body composition	Post	0.5 post	6 post	6	12 post	Yes
Papalazarou 2010[116]	Greece	RCT	VGB	30	NR	100	NR	NR	49.5 (7.5)	weight, eating bahviour, PA, dietary patterns	Post	pre (NR when)	36 post	36	None	No
Swenson 2007[117]	USA	RCT	LGB	45	32	91	NR	NR	NR	Weight	Pre	Pre (NR when)	12 post	12	None	No
Tucker 1991[118]	USA	RCT	RYGB VBG	41	32	66	40.2	142.6	NR	Weight	Post	pre	6 post	6	12, 24 post	No

[1] Pre / Post-surgery; [2] As related to surgery (in months)

Abbreviations: Bariatric surgery, BS; BMI, Body mass index; Biliopancreatic diversion with duodenal switch, BPD-DS; Comparison arm, Comp.; Excess weight loss, EWL; Expirimental arm, Exp.; Int., Intervention; Laparoscopic Adjustable Gastric Banding, LAGB; Not reported, NR; Physical activity, PA; Quality of life, QoL; Randomised controlled trial, RCT; Roux-en-Y Gastric Bypass (RYGB), RYGB; Sleeve gastrectomy, SG; Vertical banded gastroplasty, VBG.

Primary analyses: Adherence to TIDieR and CONSORT checklists

Tables 2.2 (a) and 2.2 (b) summarize the reporting adherence per items of the TIDieR and CONSORT checklists. Appendixes 6a. and 6b. present the checklist reporting scores for each study. The level of agreement between reviewers in their initial scoring of the checklists' items was 92% and 90% (respectively for TIDieR and CONSORT). Reviewers' (RY and TBP) agreement/disagreement in TIDieR and CONSORT scoring for each of the included studies has been presented in Appendix 7a. and 7b. All analysed studies provided both a description of the intervention and rationale for the intervention, and most of the authors reported the trial's location and the modes of delivery. Nearly two-third (n=14) of the analysed studies reported assessing the fidelity or adherence of the interventions, referring to how well the intervention was delivered or received, and among these number, 86% (12/14 studies) described to what extent the delivered intervention varied from the intended intervention. However, less than half of the studies reported the expertise and background of the intervention providers. Most of the analysed trials provided incomplete information on the materials used in the intervention and on the procedures, i.e., activities, and/or processes used in the intervention, including any enabling or support activities. Additionally, only five of the studies mentioned whether the intervention was planned to be personalized, titrated, or adapted, and just one study detailed intervention modifications during the course of the study and described the changes (Table 2.2 (a)). The histogram summarizing the distribution of the number of TIDieR items (fully) reported shows a mean reporting of 6.6/12 (SD=1.9) items (Figure 2.2), with no study fully reporting all 12 TIDieR checklist items. The assessment of adherence to the CONSORT checklist (Table 2.2 (b)) demonstrates that the areas where the least number of interventions had full reporting were items referring to important changes to methods after trial commencement, details of whether and how adherence of care providers to the protocol was assessed, changes to trial outcomes after the trial commenced, the number of care providers or centres performing the intervention in each group and the number of patients treated by each care provider or in each centre, the delay between randomisation and the initiation of the intervention, and factors impacting generalisability of the trial findings.

Table 2.2 (a) TIDieR adherence across analysed articles per checklist item

Item	Yes, complete [N (%)]	Partial [N (%)]	No/ambiguous [N (%)]
1. Do the authors provide the name or a phrase that describes the intervention?	22 (100.0)	0 (0.0)	0 (0.0)
2. Do the authors describe any rationale, theory, or goal of the elements essential to the intervention?	22 (100.0)	0 (0.0)	0 (0.0)
3. Materials: Do the authors describe any physical or informational materials used in the intervention, including those provided to participants or used in intervention delivery or in training of providers? Or provide information on where the materials can be accessed (online appendix, URL, etc.)?	6 (27.3)	14 (63.6)	2 (9.1)
4. Procedures: Do the authors describe each of the procedures, activities, and/or processes used in the intervention, including any enabling or support activities?	6 (27.3)	16 (7.3)	0 (0.0)
5. For each category of intervention provider (psychologist, nursing assistant, etc.), do the authors describe their expertise, background, and any specific training given?	10 (45.5)	9 (40.1)	3 (13.6)
6. Do the authors describe the modes of delivery (face-to-face or by some mechanism, such as internet or telephone) of the intervention and whether it was provided individually or in a group?	18 (81.8)	4 (18.2)	0 (0.0)
7. Do the authors describe the type(s) of location(s) where the intervention occurred, including any necessary infrastructure or relevant features?	19 (86.4)	0 (0.0)	3 (13.6)
8. Do the authors describe the number of times the intervention was delivered and over what period of time, including the number of sessions, their schedule, and their duration, intensity, or dose?	11 (50.0)	10 (45.5)	1 (4.5)
9. If the intervention was planned to be personalized, titrated, or adapted, do the authors mention so and then describe what, why, when, and how?	5 (22.7)	1 (4.5)	16 (72.8)
10. Do the authors mention whether the intervention was modified during the course of the study and, if so, describe the changes (what, why, when, and how)?	1 (4.5)	0 (0.0)	21 (95.5)
11. Planned: If intervention adherence or fidelity was assessed, do the authors describe how and by whom, and if any strategies were used to maintain or improve fidelity, did the authors describe them?	14 (63.6)	2 (9.1)	6 (27.3)
12. (If above answer was yes) Actual: If intervention adherence or fidelity was assessed, did the authors describe the extent to which the intervention was delivered as planned?	12 (54.5)	2 (9.1)	8 (36.4)

Abbreviations: Template for Intervention Description and Replication, TIDieR

Table 2.2 (b) CONSORT adherence across analysed articles per checklist item [&]

Item	Yes, complete [N (%)]	Partial [N (%)]	No/ambiguous [N (%)]
1a: Identification as a randomised trial in the title	15 (68.2)	1 (4.5)	6 (27.3)
1b: Structured summary of trial design, methods, results, and conclusions	22 (100.0)	0 (0.0)	0 (0.0)
2a: Scientific background and explanation of rationale	22 (100.0)	0 (0.0)	0 (0.0)
2b: Specific objectives or hypotheses	22 (100.0)	0 (0.0)	0 (0.0)
3a: Description of trial design (such as parallel, factorial) including allocation ratio	20 (91.0)	0 (0.0)	2 (9.0)
3b: Important changes to methods after trial commencement (such as eligibility criteria), with reasons	1 (4.5)	0 (0.0)	21 (95.5)
4a: Eligibility criteria for participants; When applicable, eligibility criteria for centers and for care providers	17 (77.3)	3 (13.7)	2 (9.0)
4b: Settings and locations where the data were collected	0 (0.0)	2 (9.0)	20 (91.0)
5: The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	7 (31.8)	15 (68.2)	0 (0.0)
Precise details of both the experimental treatment and comparator	5 (22.7)	16 (72.8)	1 (4.5)
Description of the different components of the interventions and, when applicable, description of the procedure for tailoring the interventions to individual participants.	4 (18.2)	17 (77.3)	1(4.5)
Details of whether and how the interventions were standardized.	4 (18.2)	10 (45.5)	8 (36.3)
Details of whether and how adherence of care providers to the protocol was assessed or enhanced	0 (0.0)	3 (13.7)	19 (86.3)
Details of whether and how adherence of participants to interventions was assessed or enhanced	14 (63.7)	2 (9.0)	6 (27.3)
6a: Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	20 (91.0)	2 (9.0)	0 (0.0)
6b: Any changes to trial outcomes after the trial commenced, with reasons	0 (0.0)	0 (0.0)	22 (100.0)
7a: How sample size was determined	11 (50.0)	1 (4.5)	10 (45.5)
7b: When applicable, explanation of any interim analyses and stopping guidelines	0 (0.0)	0 (0.0)	22 (100.0)
8a: Method used to generate the random allocation sequence	9 (41.0)	0 (0.0)	13 (59.1)
8b: Type of randomization; details of any restriction (such as blocking and block size)	8 (36.3)	1 (4.5)	13 (59.1)
9: Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	6 (27.3)	1 (4.5)	15 (68.2)
10: Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	8 (36.3)	3 (13.7)	11 (50.0)
11a: If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	7 (31.9)	0 (0.0)	15 (68.2)
If done, who was blinded after assignment to interventions (e.g., participants, care providers, those administering co-interventions, those assessing outcomes) and how	7 (31.9)	0 (0.0)	15 (68.2)
11b: If relevant, description of the similarity of interventions	12 (54.5)	9 (41.0)	1 (4.5)

Item	Yes, complete [N (%)]	Partial [N (%)]	No/ambiguous [N (%)]
11c: If blinding was not possible, description of any attempts to limit bias	1 (4.5)	0 (0.0)	21 (95.5)
12a: Statistical methods used to compare groups for primary and secondary outcomes	21 (95.5)	0 (0.0)	1 (4.5)
12b: Methods for additional analyses, such as subgroup analyses and adjusted analyses	14 (63.7)	0 (0.0)	8 (36.3)
13a: For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	21 (95.5)	0 (0.0)	1 (4.5)
The number of care providers or centers performing the intervention in each group and the number of patients treated by each care provider or in each center	1 (4.5)	1 (4.5)	20 (91.0)
13b: For each group, losses and exclusions after randomization, together with reasons	15 (68.2)	2 (9.0)	5 (22.7)
13c: For each group, the delay between randomization and the initiation of the intervention	1 (4.5)	0 (0.0)	21 (95.5)
Details of the experimental treatment and comparator as they were implemented	10 (45.5)	6 (27.25)	6 (27.25)
14a: Dates defining the periods of recruitment and follow-up	10 (45.5)	4 (18.2)	8 (36.3)
14b: Why the trial ended or was stopped	0 (0.0)	0 (0.0)	22 (100.0)
15: A table showing baseline demographic and clinical characteristics for each group	18 (81.8)	0 (0.0)	4 (18.2)
When applicable, a description of care providers (case volume, qualification, expertise, etc.) and centers (volume)	3 (13.7)	11 (50.0)	8 (36.3)
16: For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	17 (77.3)	1 (4.5)	4 (18.2)
17a: For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	20 (91.0)	2 (9.0)	0 (0.0)
17b: For binary outcomes, presentation of both absolute and relative effect sizes is recommended	2 (9.0)	0 (0.0)	20 (91.0)
18: Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	14 (63.7)	0 (0.0)	8 (36.3)
19: All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	5 (22.7)	0 (0.0)	17 (77.3)
20: Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	20 (91.0)	0 (0.0)	2 (9.0)
In addition, take into account the choice of the comparator, lack of or partial blinding, and unequal expertise of care providers or centers in each group	1 (4.5)	10 (45.5)	11 (50.0)
21: Generalizability (external validity, applicability) of the trial findings	16 (72.7)	1 (4.5)	5 (22.7)
Generalizability (external validity) of the trial findings according to the intervention, comparators, patients, and care providers and centers involved in the trial	1 (4.5)	16 (72.7)	5 (22.7)
22: Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	15 (68.2)	6 (27.3)	1 (4.5)
23: Registration number and name of trial registry	11 (50.0)	0 (0.0)	11 (50.0)
24: Where the full trial protocol can be accessed, if available	4 (18.2)	0 (0.0)	18 (81.8)
25: Sources of funding and other support (such as supply of drugs), role of funders	15 (68.2)	0 (0.0)	7 (31.9)

[&] Four sub-items of CONSORT were removed from Table 2b because they were nonapplicable to any of the included studies. Abbreviations: Consolidated Standards of Reporting Trials, CONSORT.

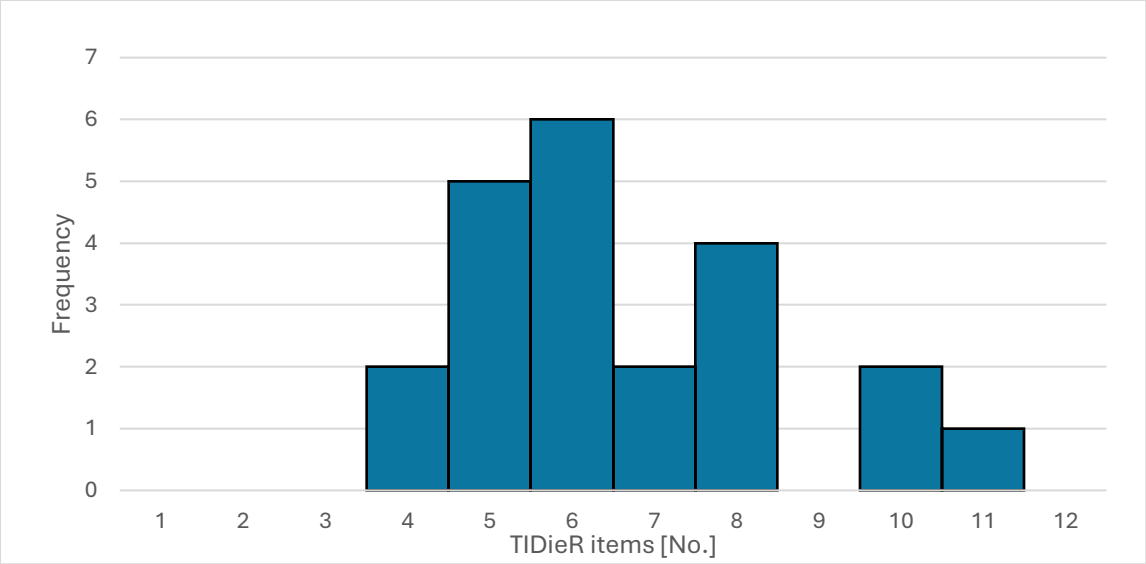

Figure 2.2 Histogram of TIDieR items compliance frequency

Abbreviations: Template for Intervention Description and Replication, TIDieR.
The frequency (Y axis) represents the number of times each item of the TIDieR (X axis) was identified as fully reported.

With regards to the CONSORT checklist (Table 2b), most of the studies met the criteria for the completion of reporting of title (68.2%), abstract (100%), and introduction (100%). In the methods section, almost all the studies (91%) reported a description of trial design; however, they rarely reported changes to methods after trial commencement. Eligibility criteria were clearly defined by the majority of studies; however, details of the interventions were only partially reported in most of the studies. Half of the studies provided information about how the sample size was determined, but only a few (36.3%) reported details on randomization or provided information about blinding. Although most of the studies (95.5%) reported the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome, other sub-items related to participants flow (e.g., methods to generate and implement random allocation sequence, and the responsible person for that) and blinding were poorly reported (31.9%). Moreover, only a few of the studies reported details of interventions' harms (22.7%). Finally, about half of the studies reported on trial registration (50%) and source of funding (68.25%), and only 18.2% of the studies had an accessible full trial protocol (Table 2b).

Secondary analyses

Table 2.3 summarizes the results for the TIDieR checklists adherence before (group 1, *n*= 9) and after (group 2, *n*= 13) 2015. The average scores for group 1 and 2 were 1.4 (0.8) and 1.3 (0.8), respectively, with no statistical difference between the groups (t(df)= 0.95(20, *p*= 0.35). Figure 2.3 demonstrates the average number of criteria fully (i.e., *positive*) met on TIDieR checklist before (group 1) and after (group 2) 2015, which also depicts no statical significance. Results of the general linear models for the associations between study characteristics and reporting adherence are presented in Tables 2.4 (a) and 2.4 (b) Specific variables that were correlated with TIDieR intervention reporting were: receiving funds from industrial organizations positively impacted the quality of reporting of studies (*p*=0.02); and a trend was observed for the impact of having the study recorded in a registry of trials (*p*=0.08).

Table 2.3 Analysis results for the TIDieR checklists adherence before (group 1) and after (group 2) 2015 [&]

TIDieR checklist item	Group 1 mean score (SD)	Group 2 mean score (SD)	t, df	P-value
1. Do the authors provide the name or a phrase that describes the intervention?	2.0 (0.0)	2.0 (0.0)	N/A	N/A
2. Do the authors describe any rationale, theory, or goal of the elements essential to the intervention?	2.0 (0.0)	2.0 (0.0)	N/A	N/A
3. Materials: Do the authors describe any physical or informational materials used in the intervention, including those provided to participants or used in intervention delivery or in training of providers? Or provide information on where the materials can be accessed (online appendix, URL, etc.)?	1.2 (0.7)	1.2 (0.6)	0.3, 15.2	0.804
4. Procedures: Do the authors describe each of the procedures, activities, and/or processes used in the intervention, including any enabling or support activities?	1.3 (0.5)	1.2 (0.4)	0.5, 15.8	0.626
5. For each category of intervention provider (psychologist, nursing assistant, etc.), do the authors describe their expertise, background, and any specific training given?	1.6 (0.5)	1.3 (0.8)	1.1, 18.9	0.288
6. Do the authors describe the modes of delivery (face-to-face or by some mechanism, such as internet or telephone) of the intervention and whether it was provided individually or in a group?	1.9 (0.3)	1.8 (0.4)	0.7, 19.8	0.476
7. Do the authors describe the type(s) of location(s) where the intervention occurred, including any necessary infrastructure or relevant features?	1.6 (0.9)	1.8 (0.6)	-0.9, 12.4	0.397
8. Do the authors describe the number of times the intervention was delivered and over what period of time, including the number of sessions, their schedule, and their duration, intensity, or dose?	1.3 (0.7)	1.5 (0.5)	-0.7, 13.8	0.470
9. If the intervention was planned to be personalized, titrated, or adapted, do the authors mention so and then describe what, why, when, and how?	0.4 (0.9)	0.5 (0.9)	-0.2, 17.3	0.808
10. Do the authors mention whether the intervention was modified during the course of the study and, if so, describe the changes (what, why, when, and how)?	0.2 (0.7)	0.0 (0.0)	1.0, 8.0	0.347

11. Planned: If intervention adherence or fidelity was assessed, do the authors describe how and by whom, and if any strategies were used to maintain or improve fidelity, did the authors describe them?	1.3 (1.0)	1.4 (0.9)	-0.1, 15.7	0.902
12. (If above answer was yes) Actual: If intervention adherence or fidelity was assessed, did the authors describe the extent to which the intervention was delivered as planned?	1.6 (0.9)	0.9 (0.9)	1.6, 18.2	0.127
Overall score of all items on the checklist	1.4 (0.8)	1.3 (0.8)	0.7, 228.5	0.516

[&] For the purpose of secondary outcomes analyses, a three-point scale was created, as follows:

0=No (none of the criteria of the item meet in the report) OR ambiguous (not enough information is provided to make a clear decision, e.g., the item is mentioned but no exact information is provided)

1=Partial (some, but not all of the criteria of the item are included)

2=Yes (all criteria of the item were meet in the report)

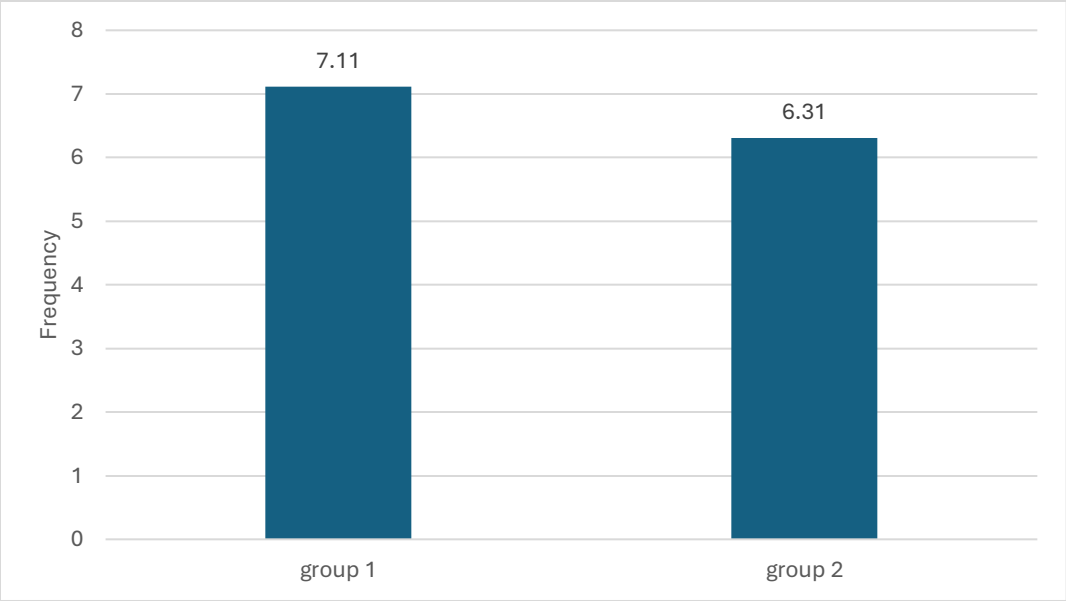

Figure 2.3 The average number of criteria fully (i.e., positive) met on TIDieR checklist before (group 1) and after (group 2) 2015

Significant at $p < 0.05$.
Abbreviations: Template for Intervention Description and Replication, TIDieR

Table 2.4 Factors related to completeness of intervention reporting

Table 2.4 (a) Correlations between studies characteristics and intervention reporting [&]

Factor [Variable]	B (SE)	P - value	R-Square
Number of authors			
Intercept	6.47 (0.98)	<0.0001	0.002
Number of authors	0.03 (0.13)	0.849	
Sample size			
Intercept	6.61 (0.81)	<0.0001	0.001
Sample size	-0.01 (0.01)	0.952	
Funding source			
Intercept	11.33 (1.85)	<0.0001	0.311
Non-industry funding	-2.58 (1.02)	0.025	
Trial registry			
Intercept	5.91 (0.55)	<0.0001	0.147
Registry [yes]	1.45 (0.78)	0.078	
Duration of intervention			
Intercept	6.14 (0.56)	<0.0001	0.066
Duration	0.06 (0.05)	0.260	
Blinding			
Intercept	6.53 (0.51)	<0.0001	0.006
Blinding [yes]	0.32 (0.91)	0.725	
[#]*CONSORT integration within the study design and/or reporting*			
Intercept	6.33 (0.44)	<0.0001	0.115
CONSORT integration [yes]	1.67 (1.03)	0.123	

Table 2.4 (b) A linear regression for the predictive factors related to the intervention reporting [&]

Factor [Variable]	B (SE)	P - value	95% CI
Intercept	0.59 (2.38)	0.046	0.12, 11.77
[*]*Group TIDieR*	-0.62 (1.61)	0.712	-4.56, 3.31
Number of authors	0.15 (0.19)	0.473	-0.32, 0.61
Sample size	-0.01 (0.01)	0.610	-0.04, 0.03
Funding source [non-industry]	-0.99 (1.99)	0.635	-5.87, 3.89
Trial registry [yes]	1.79 (1.61)	0.309	-2.15, 5.73
Duration of intervention	0.06 (0.11)	0.612	-0.22, 0.34
Blinding [yes]	-0.89 (1.95)	0.665	-5.66, 3.89
[#] *CONSORT integration*	1.26 (2.06)	0.563	-3.79, 6.32

[&] Intervention reporting score for the current analyses relayed on a reporting score system in which "0" represented no/ambiguous reporting of the item, "1" represented a partial reporting of the item, and "2" represented a full reporting of the item. Based on this scale, a further categorization was created, in which "0" was considered to either ambiguously, partially or no report of an item, and "1" was scored if the item was fully reported. The final score was obtained by summing the scores in the latter dichotomic scale. R-Square of this regression was 0.532.

[#] CONSORT integration: defines as the mentioning of the CONSORT checklist for study design or reporting purposes within included studies, as described through the published papers.

Abbreviations: Consolidated Standards of Reporting Trials, CONSORT; Template for Intervention Description and Replication, TIDieR.

Discussion

The present study reveal that nutrition-focused interventions are not adequately reported in BWM trials in the MBS field. In particular, the least frequently reported TIDieR items were the ones referring to details of materials and procedures of the interventions (fully reported by 6 studies), as well as their personalization (fully reported by 5 studies) and modifications during the study (fully reported by one study). Importantly, such elements can be fundamental for enabling adequate replication, comparison, and transferability of interventions into clinical practice.[72,119] Though the TIDieR checklist and guide were published in 2014, we did not observe an improvement in reporting when comparing studies published before and about 1 year after its release. Features that might be related to a better quality of reporting included being financially supported by an industrial organization and having the intervention filed in a registry platform.

To the best of our knowledge, this is the first review evaluating the quality of reporting on nutrition-focused interventions in the field of BS. Nutritional care is one of the cornerstones of bahvioural interventions for weight management in this population.[120] However, the multifaceted nature of nutrition-focused interventions can add to the complexity of describing them.[121] Importantly, only when detailed reports and explanations are provided, can clinical research lead to evidence-based clinical guidelines and reliable interventions in practice.[122] Consequently, the lack of details can compromise the reproducibility and the comparability of the research, thus reducing its transferability into practice.[119]

We found no statistically significant difference in the quality of intervention reporting before and after the release of TIDieR guidelines, which is similar to what Rauh et al. presented in their review on the completeness of intervention reporting in obesity-related RCTs.[72] This finding not only points to the current gap in the literature but also potentially highlights the lack of structured ongoing initiatives to improve the quality of intervention reporting. There may be a need for more editorial direction in journals that publish nutrition-focused and other bahvioural intervention studies about the benefits of the CONSORT-NPT and TIDieR guidelines. This

might help increase the awareness of authors, peer reviewers, and the journal's editorial board about such tools, which should then lead to a more comprehensive application of these guidelines.[72] Moreover, journals should require the use of both the CONSORT-NPT and TIDieR as part of their publication guidance for these kinds of studies, and, as previously suggested, designing automated sites to populate (for the authors) and guide review of (for reviewers and editors) CONSORT-NPT and TIDieR checklist components could further enhance their uptake.[72]

The current analysis of 22 studies showed that none of the studies reported all descriptors developed in the TIDieR checklist. These results are consistent with previous findings reported by Rauh et al.[72], who demonstrated that urgent intervention is warranted to improve the quality of reporting in obesity research, raising the issue regarding providing details about the expertise and background of intervention providers, as well as assessing the fidelity of the intervention. Specifically, in the context of behavioural interventions, assessing adherence to the intended implementation (i.e., fidelity) is a crucial element, as it ensures that observed trial effects genuinely result from the investigated intervention, not variations in implementation.[123] A comprehensive evaluation also helps with understanding the adaptations made during the trial, guiding intervention refinement. This information is valuable for assessing the feasibility of extending the intervention beyond the trial setting into other contexts.[124] Previously the treatment fidelity framework developed by Borrelli et al.[125] was introduced as a useful supplement to CONSORT and it has been also recommended that treatment fidelity should become an integral part of the conduct and evaluation of all health bahviour intervention research.[126] Jaka et al.[127] also found that 69% of studies on paediatric obesity interventions inadequately described the expertise of treatment providers. Moreover, reviews on bahvioural interventions in other fields of medicine found similar results around the quality of reporting. For example, Giagio et al.[128] assessed the completeness of reporting in exercise-focused intervention studies and demonstrated that only 7 items of the overall TIDieR items were completely reported more than 50% of the time. Frequent shortcomings were items related to the reporting of information regarding tailoring and modifications of exercises and their adherence.[128] Furthermore, in another review examining the completeness of reporting in education-focused interventions, Albarqouni et al.[129] showed that none of the studies completely reported all the TiDieR items, and that the item most frequently missing was 'intervention materials', which was reported in only 4% of publications.

Our results indicate that receiving industry funding was associated with higher quality of trial reporting compared to interventions without industry funders. In line with our findings, Thomas et al.[130] reviewed long-term weight loss trials and showed that, when compared to non-industry funded studies, those funded by industry were associated with higher quality of reporting score based on expanded criteria from the CONSORT checklist. The evidence of better reporting quality by industry-funded studies might be explained by the greater need for regulatory practices in industry sponsored research or through the additional capacity afford to researchers due to the more significant funding offered.[131] In such context, it is worth contemplating the proactive engagement of government funding agencies. Encouraging government funders to mandate adherence to reporting standards that align with established guidelines such as TIDieR and CONSORT holds significant promise leading to collective effort of researchers and endusers to enhance research integrity and, ultimately, the reliability of evidence-informed practices.[132,133] Ultimately, greater training on rigorous methodology and reporting may enhance the overall reporting quality in the future literature,[134] with a special emphasis on researchers who don't undertake industry-funded work. [135]

In the current study we also observed a trend of an association between having the study recorded in a trial registry and higher reporting quality. It may reflect the impacts of clinical trial registration as an important step toward improving transparency in clinical trial conduct.[136] Once the authors have prepared key information about the trial protocol within the registry domain, it can increase the probability of integrating such information in the final paper.[137] Importantly, to be eligible for publication, the International Committee of Medical Journal Editors has mandated prospective clinical research trials to be registered before recruitment commences.[138] For behavioural interventions, it is also suggested that recording complete and accurate information in a registry can help improve transparency in reporting, bolster the credibility and impact/uptake of the intervention.[139] One solution to mandate the trial registration requirement for behavioural interventions is for journal editors and grant reviewers to consider only those clinical trials for publication that have been registered before the start of patient recruitment.[140] To meet the trial registration criteria, clinical trial applicants should provide a set of mandatory data items (pre-requisite information). These data items include key information about the type of study, inclusion and exclusion criteria, names and descriptions of interventions, primary and secondary

outcomes, sponsors, contact persons, and other relevant data crucial for the overall understanding of the trial by the public domain.[141]

Limitations and Strengths

One limitation to our study is that we did not calculate the level of agreement between reviewers after each step of the review process. Since this study was limited to nutrition-focused studies published in the MBS field, our findings may not be generalizable to other areas. Another limitation stems from the fact that both checklists were developed as reporting tools and not as assessment approaches which might make the judgment about quality of reporting inconsistent.[142] The first strength of our study is the comprehensive literature review design leading to capture all relevant publications. Other strengths of our study include its blinded peer-review methodology, which minimized bias and increased its validity and fidelity. In addition, it is the first study addressing the quality of reporting in the field of developing bahvioural interventions adjunct to MBS and will hopefully contribute to the improvement in reporting quality of future publications.

Conclusions

Our results indicate that nutrition-focused interventions for patients undergoing MBS are not sufficiently and adequately reported to enable replication, comparison, and transferability into clinical practice. There is a need for future strategies to improve the quality of reporting in research on these interventions, which are the cornerstone components of weight management in patients' undergoing MBS. Such strategies should probably be focused on increasing the application of existing intervention reporting tools by researchers, as well as on checking relative adherence by peer-reviewers and journal editors.

CHAPTER 3: Understanding the Components of Nutrition-Focused Weight Management Interventions Adjunct to Metabolic Bariatric Surgery: A Systematic Review of published Literature

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Abstract

Nutrition-focused interventions are essential for improving health and weight-related outcomes in patients undergoing metabolic bariatric surgery (MBS). This work aims to examine the content of nutrition-focused weight management interventions adjunct to MBS in terms of the type and quantity of behaviour change techniques (BCTs). A literature search retrieved randomised controlled and parallel group trials up to March 2024. A total of 25 trials were included in the final analysis. Trained coders used Michie's BCT taxonomy v1.0 to code intervention components from each trial and applied descriptive methods to report the types and frequency of BCTs. Calculated effect sizes were used to compare the impact of the experimental and comparator arms. Common BCTs applied in nutrition-focused interventions were '4.1 Instruction on how to perform a behaviour' (68%), '2.3 Self-monitoring of behaviour' (56%), '1.1 Goal setting (behaviour)' (52%), '1.2 Problem solving' (44%), '3.1 Social support (unspecified)' (40%), and '1.4 Action planning' (40%). However, the BCTs associated with the largest intervention effect sizes (2.1. Monitoring of behaviour by others without feedback and 4.2. Information about antecedents) were not among the most frequently employed techniques. Only one study described the intervention explicitly using BCT taxonomy groupings. In more than half of the studies (52%), authors did not use BCTs to describe interventions. This work highlights the importance of using standard frameworks for reporting the components of behavioural interventions to enhance scientific replication, evidence synthesis, and the ability to test interventions' effectiveness in the future.

Keywords: Metabolic bariatric surgery, weight management, intervention, nutrition, behaviour change techniques

Introduction

Metabolic bariatric surgery (MBS) is currently the most effective and durable treatment for severe obesity and its associated metabolic diseases.[143,144] However, long-term data suggest that up to 87% of patients report varying degrees of weight regain and return of comorbidities within 2-5 postoperative years.[16,18] There is a wide range of weight-related health behaviours that can affect postoperative outcomes, including medication adherence, physical activity levels, and dietary behaviours. Among these, nutritional behaviours such as consuming a low-quality diet and maladaptive eating behaviours have been recognised as key modifiable factors associated with postoperative weight regain and poor health outcomes.[16,47,145,146]

The available data on nutrition-focused behavioural interventions in this population is limited, so the exact nature and composition of intervention treatment components remain unclear.[145,147] The lack of specific evidence-based nutrition-focused guidelines in MBS might also derive from the fact that behavioural interventions, including nutrition-focused interventions, are highly complex and often comprise several interacting active components.[148] This complexity requires researchers to provide clear and detailed reports on their intervention's active components and their mechanisms of action.[149] However, interventions are not usually well described which not only limits scientific replication,[150] but also constrains the identification of elements of promising interventions and non-efficacious interventions, ultimately limiting the uptake of successful nutrition-focused interventions into practice.[151] The *Behaviour Change Technique Taxonomy version 1* (BCTTv1) is a widely used tool to describe the irreducible components or 'active ingredients' designed to bring about change in an intervention, known as behaviour change techniques (BCTs).[71] This taxonomy can help identify the 'active components' in behavioural interventions and examine which BCTs are associated with more successful outcomes.[65]

The present work extends of our previous systematic review of behavioural weight management interventions adjunct to MBS.[51,152] In the current study, we aimed to define the active components of nutrition-focused weight management interventions adjunct to MBS by utilising the BCTTv1.[71] We had three specific objectives: (i) to use the BCTTv1 to characterise the

interventions; (ii) to examine which BCT(s) were most frequently used; and (iii) to assess which BCTs were associated with the greatest positive impact on weight change.

Methods

The main systematic review was registered with the International Prospective Register of Systematic Reviews (PROSPERO number: CRD42017049094).[96] We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement to ensure transparency and comprehensive reporting.[153]

Inclusion criteria

The inclusion criteria for the main review have been published elsewhere.[51] in the current analysis, studies testing any pre and/or postoperative interventions designed explicitly to promote weight management in adults (≥18 years) undergoing metabolic bariatric surgical or endoscopic weight loss procedures (e.g., Roux-en-Y gastric bypass [RYGB/GBP], sleeve gastrectomy [SG], gastric band, biliopancreatic diversion) were included. For this sub-analysis, the interventions needed to target changes in dietary or eating behaviours (e.g., reducing calorie intake, changing food choices, or dietary patterns).[154] Eligible comparators were usual care, the standard of care, or treatments not including the hypothesised active ingredient(s) of the experimental intervention. Studies had to report at least one of the prespecified anthropometric outcome measures (i.e., weight, body mass index [BMI], or body composition including fat mass, fat-free mass, and lean body mass) before and after the intervention. Eligible designs included experimental studies with at least two interventional arms, e.g., randomised controlled trials (RCT), non-randomised controlled trials (experiment group vs. comparison group), parallel-group trials, and quasi-randomised trials. We had no limitation for the minimum duration of the intervention; however, we included studies that had at least one post-operative assessment for the desired outcome(s) that was after the completion of the intervention. Observational studies, reviews, book chapters, abstracts, and unpublished literature as well as non-French/English publications were excluded.

Search method and screenings

The latest database search was conducted in PubMed, PsychNet, EMBASE, Scopus, and the Cochrane Controlled Register of Trials in March 2024. Appendix 4. presents the keywords and search strategy for each database. After removing duplicates in Endnote (version 20.6), five trained independent peer-reviewers screened titles and abstracts and then assessed full-text articles for eligibility. The decision about including or excluding a record was made based on a detailed screening guide (Appendix 5). Peer reviewers (RY, TBP, VGB, JO, AF) had previously reached a minimum agreement level of 85% based on 2-phase pilot library of 60 records. Inter-reviewer agreement rates for the titles & abstract and full-text screening phases were 85.4% and 87.1%, respectively. Any disagreements were resolved by reaching a consensus or by a third party (SLB). We also screened the reference lists of all included articles and relevant systematic reviews to identify any additional studies.

Data extraction and process of coding

Reviewers (RY, TBP, JO) independently retrieved characteristics of the studies based on a standardised template including details on study design; location; the number of participants included in intervention and comparison arms; target behaviours(s); outcome(s); population baseline characteristics (i.e., age, weight, BMI, female%); intervention and assessments/follow-ups timing as related to the surgery; trial characteristics (program description, delivery format, intervention provider, modes of delivery); and results (i.e., values for weight-related measures in study timepoints). Study authors were contacted up to three times for missing information. Where more than one paper was published from the same trial, results were presented for the overall trial, including all relevant individual papers.

Since the process of coding BCTs involves making a series of complex interpretative judgments and requires familiarity with the BCT labels and definitions, BCT coders (RY, TBP, JO) completed the online BCT taxonomy tutorial training (see Appendix 8 for details on training).[155] To capture the total number and type of BCTs used in each active arm, intervention details within the manuscripts and any published supplementary material related to the intervention were analysed and coded. If the intervention was reported to be described in a prior publication or protocol, this record was also sourced and coded. Trained reviewers made judgments about

the presence or absence of each specific technique through a deductive process of categorising the content of the intervention and comparison arms and applying BCTTv1. A BCT was only coded when there was clear evidence of its direct application to a specific target behaviour (e.g., "calorie goals for one to two pounds weekly weight loss" was included, whereas "behavioural strategies including goal setting" was not). The total number of BCTs used in each active condition was also registered. Inter-rater reliability for BCT coding, using percent agreement, was high (87.2%). Full consensus on BCT was reached following a discussion between the coders, thus consultation with a third party was not necessary.

Quality assessment

Quality assessment was independently conducted for each study by two researchers (RY, AMV) using the Cochrane Collaboration's Risk of Bias (ROB)-2 tool for RCTs,[156] and the risk of bias tool for non-randomised studies for interventions (ROBINS-I).[157] Risk of bias was applied to the two main primary outcomes (i.e., BMI and weight) and presented by each trial where appropriate. Where multiple studies were published from a single trial and no protocol was available for a trial, selective reporting rating was based on an agreement between methods and results sections of included papers.

Statistical analysis

To examine the use of BCTs in interventions, we calculated the percentage of individual BCTs across all trials and the total number of BCTs per intervention. We evaluated the impact of active components delivered to the experiment arms compared to the comparator arms by identifying the different effect sizes using the Cohen's d.[158] Due to the considerable heterogeneity in outcomes examined and interventions used, we did not conduct a meta-analysis for intervention effectiveness.[159]

Results

The flow of study inclusion and exclusion is illustrated in Figure 3.1. Our original search identified 29,798 publications from all databases. After duplication removal, 21,477 records were left for title and abstract screening, of which we found 723 potentially eligible studies. Following the full-text screening phase, a total of 49 publications met the inclusion criteria.

Among the eligible records, 27 were nutrition-focused weight management interventions and had dietary change as an intervention target behaviour, therefore were included in the current analysis. Two of the publications were follow-up reports of already included original studies, thus we included 25 interventions in our final analysis (Table 3.1). The percentage of total females in each intervention is included in Table 3.2. RY contacted the corresponding authors of 12 trials that did not have a full description of the target primary outcomes (weight or BMI). Despite this effort, eight of the interventions could not be included within the effect sizes calculation as there was no access to pre- and post-intervention values of weight and/or BMI, either from the publications or by contacting the authors.[98,102,106,108,109,111,114,116,160]

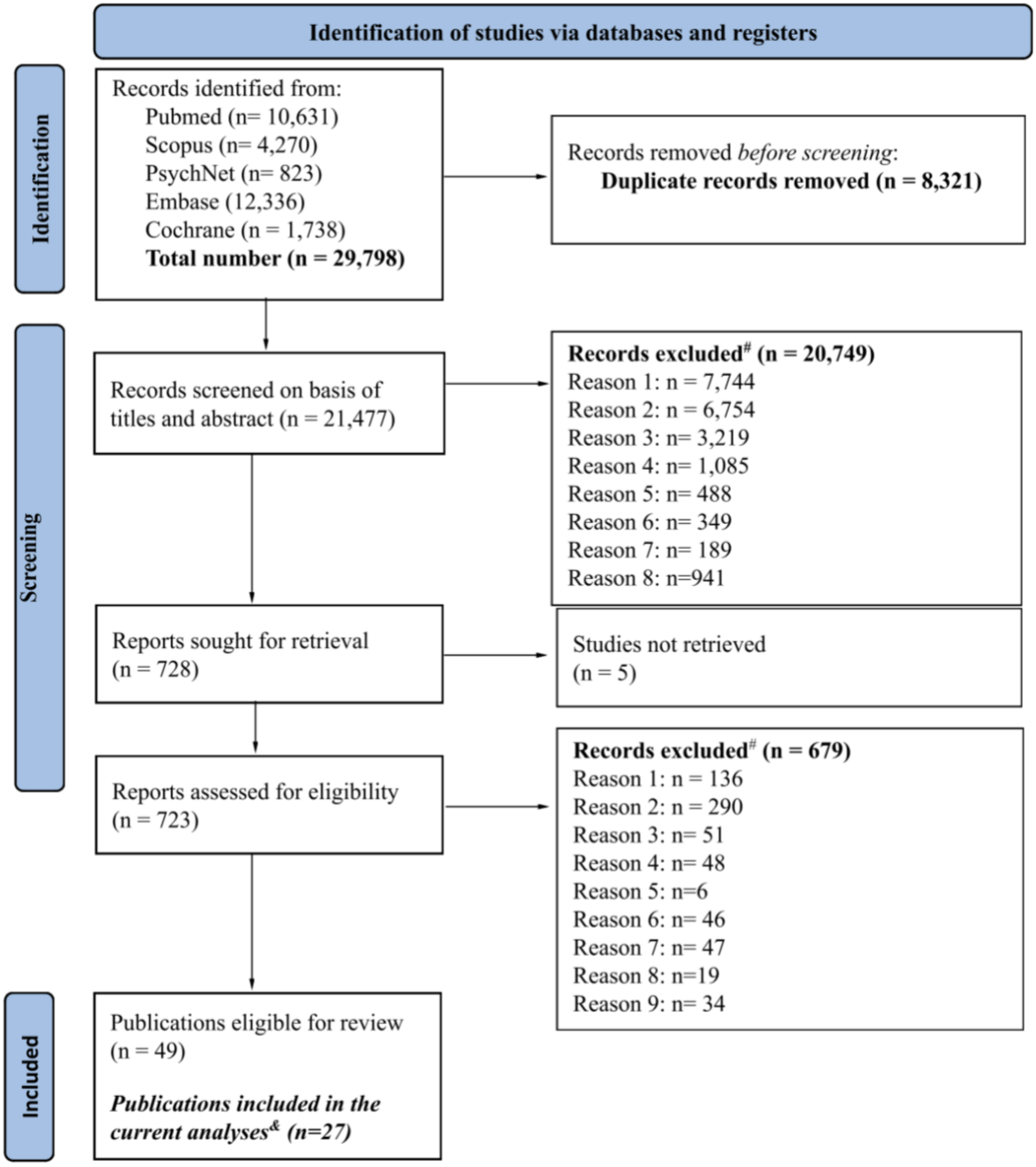

Figure 3.1 PRISMA flow diagram of included and excluded studies

Reasons for exclusion:
Reason 1: Wrong study design
Reason 2: Wrong publication type
Reason 3: Wrong population
Reason 4: Wrong intervention
Reason 5: Foreign language
Reason 6: Wrong comparison
Reason 7: Wrong outcome
Reason 8: Duplicate
Reason 9: wrong study duration

[&] These studies had at least one nutritional component to their intervention package, and were therefore included in the current report

Table 3.1 Characteristics of included 25 interventions

tudy ID	Countr y	Study desig n	Type of BS	Target behaviou r	Primary outcome	Int. time[1]	Time of pre-Int. assessme nt[2]	Time of post-Int. assessme nt[2]	Total Int. duratio n[3]	Time of follow-up(s)[2]	Total n of sessio ns	Each session's duration (min)	Modality	Modes of delivery	Provider
Rashidbey gi 2024[161]	Iran	RCT	SG	Diet	Weight , body composit ion	Post	24	28	4	0	4	NR	Individua lly	Face to face	NR
Nambiar 2023[162]	India	RCT	LMG B	Diet	Weight loss, Quality of life	NR	Pre-op	3	3	0	NR	NR	NR	Face to face, tel, written material, video conference	NR
Sockaling ham 2023[82]	Canada	RCT	RYG B, SG	Psychosoc ial aspects of eating behaviour	Weight loss	Post	12	15	3	18 post	7	60	Individua lly	Tel	Psycholog ists
Jassil 2023[163]	England	RCT	SG, RYG B, OAG B	Diet + exercise	Weight loss	Post	0	12	12	None	29	15-60	Individua lly	Face to face & tel	Nutritioni st, & PA specialist
Drakos 2022[98]	USA	RCT	RYG B, SG	Diet+ psychosoc ial aspects of eating behaviour + exercise	Weight	Post	Pre-op	~3 post	Exp. 1.75 Comp. 2.25	6,12 post	7	NR	individua lly & group	Face to face & tel	Nutritioni st, PA specialist, other
Hany 2022[99]	Egypt	Non-rando mised contro lled trial	RYG B, SG	Psychosoc ial aspects of eating behaviour	BMI, eating behaviou r	Post	~ 11 post	~15 post	4	~ 18, 21 post	16	135	Individua lly & group	Face to face	NR
Grilo 2021[100]	USA	RCT	RYG B, SG	Psychosoc ial aspects of eating behaviour + diet + exercise	Weight, eating behaviou r	Post	6	9	3	None	6	25-30	Individua lly	Face to face	Allied health clinicians
Paul 2020, 2022[101]	Netherla nds	RCT	RYG B	Psychosoc ial aspects of eating behaviour + diet + exercise	Weight	Pre	NR	NR	2.5	12 post	10	45	Individua lly	Face to face & written material	Psycholog ist

Mangieri 2019[102]	USA	RCT	SG	Diet + exercise	Weight	Post	12 post-op	24 post	12	36 post	2	60	Individually	Face to face & internet	Study author
Hanvold 2019[103]	Norway	RCT	RYGB, SG, BPD-DS	Diet + exercise	Weight	Post	21 post	45 post	24	None	19	120	Individually & group	Face to face	Nutritionist, PA specialist, other
Lauti 2018[83]	New Zealand	RCT	SG	Psychosocial aspects of eating behaviour and exercise	% EWL	Post	18 post-op	30 post	12	None	NA	NA	Individually	Text message	NR
Kalarchian 2016a[104]	USA	RCT	RYGB, LAGB	Diet + exercise	Weight	Pre	pre-op (NR when)	6 pre	6	6,12, 24 post	24	60/15-20	Individually	Face fo face & tel	Psychologist
Kalarchian 2016b[105]	USA	Pilot RCT	RYGB	Diet	Weight, calories intake	Post	12 post	16 post	4	18 post	5	60/15	Individually & group	Face fo face & tel	NR
Chacko 2016[106]	USA	Pilot RCT	SG, RYGB, LAGB	Psychosocial aspects of eating behaviour and exercise	Weight	Post	32 post-op	35 post	2.5	38 post	10	90	Group	Face to face	Mindfulness instructor
Ogden 2015[107]	England	RCT	RYGB	Psychosocial aspects of eating behaviour	Weight	Pre & post	0.5 pre	3.8 post	3	6, 12 post	8	50	Individually	Face to face	Psychologist
Wild 2015, 2017[108,109]	Germany	RCT	RYGB, SG, LAGB	Psychosocial + diet + exercise	Weight, health-related QoL, self-efficacy	Post	Pre (NR when)	12	12	37.9 post (SD 8.2)	14	90/50	Group	Face to face & videoconference	Multidisciplinary team
Parikh 2012[110]	USA	Pilot RCT	LAGB	Diet + exercise	Weight	Pre	12 pre	6 pre	6	6 post	12	NR	Individually & group	Face to face	Nutritionist, surgeon
Lier 2012[111]	Norway	RCT	RYGB	Psychosocial + diet + exercise	Weight	Pre	1.5 pre	12 post	NR	None	9	180	Group	Face to face	Psychologist
Nijamkin 2012[112]	USA	RCT	RYGB	Psychosocial + diet	EWL	Post	6 post	12 post	3	None	6	90	Individually & group	Face to face	Nutritionist
Kalarchian 2012[113]	USA	Pilot RCT	RYGB, LAGB, VBG,	Psychosocial + diet + exercise	Weight	Post	36 post	42 post	6	48 post	17	60/15-20	Individually & group	Face fo face & tel	Other

			secondary GB												
Sarwer 2012[114]	USA	Pilot RCT	LAGB, RYGB	Diet	Weight, eating behaviour	Post	0.5 pre	4 post	4	6,12,18, 24 post	8	15	Individually	Face to face & tel	Nutritionist
Dodsworth 2012[115]	Australia	Pilot pseudo-RCT	LAGB	Diet	Feasibility, weight, body composition	Post	0.5 post	6 post	6	12 post	NR	NR	NR	Face to face & tel	Nutritionist
Papalazarou 2010[116]	Greece	RCT	Vertical banded gastroplasty (VBG)	Psychosocial + diet + exercise	weight, eating behaviour, PA, dietary patterns	Post	pre (NR when)	36 post	36	None	30	40	Individually	Face to face	Nutritionist
Swenson 2007[117]	USA	RCT	LGB	Diet	Weight	Pre	Pre (NR when)	12 post	12	None	NR	NR	Individually	Face to face, tel & written material	Nutritionist
Tucker 1991[118]	USA	RCT	RYGB, VBG	Psychosocial + diet + exercise	Weight	Post	pre	6 post	6	12, 24 post	20	NR	Individually	Face to face & written material	Psychologist

[1] Pre and/or Post-surgery; [2] As related to surgery (in months); [3] in months

Abbreviations: Bariatric surgery, BS; BMI, Body mass index; Biliopancreatic diversion with duodenal switch, BPD-DS; Excess weight loss, EWL; Gastric band, GB; Int., Intervention; Laparoscopic Adjustable Gastric Banding, LAGB; laparoscopic mini gastric bypass, LMGB; Not reported, NR; One-anastomosis gastric bypass, OAGB; Physical activity, PA; Quality of life, QoL; Randomised controlled trial, RCT; Roux-en-Y Gastric Bypass (RYGB), RYGB; Sleeve gastrectomy, SG; Vertical banded gastroplasty, VBG.

Table 3.2 Percentage of total female participants in each intervention

Study ID	Total female %
Rashidbeygi 2024[161]	72.45
Nambiar 2023[162]	58
Sockalingham 2023[82]	83.3
Jassil 2023[163]	78.4
Drakos 2022[98]	Not reported
Hany 2022[99]	100
Grilo 2021[100]	85
Paul 2020, 2022[101]	74
Mangieri 2019[102]	87.5
Hanvold 2019[103]	75
Lauti 2018[83]	74
Kalarchian 2016a[104]	87
Kalarchian 2016b[105]	85
Chacko 2016[106]	83
Ogden 2015[107]	75.3
Wild 2015, 2017[108,109]	70.2
Parikh 2012[110]	84
Lier 2012[111]	73
Nijamkin 2012[112]	83
Kalarchian 2012[113]	75
Sarwer 2012[114]	63
Dodsworth 2012[115]	81
Papalazarou 2010[116]	100
Swenson 2007[117]	91
Tucker 1991[118]	66

Interventions' characteristics and design

Except for two non-randomised controlled trials, all other studies were RCTs. Only one study had a 3-arm design (two experimental arms vs. a comparison arm) with the rest having two arms (an experimental group vs. a comparison group). Among the included interventions, 18 (72%) were delivered after MBS, 5 (20%) were delivered before MBS, only one was delivered both pre- and post-operatively, and one study did not explicitly report the intervention timeline. The timing of data collection varied from a few weeks before or after the surgery to several years afterward. The interventions widely differed in terms of duration (ranging from 3 to 36 months), total number of sessions (5 to 29 sessions), sessions' length (15 minutes to more than an hour), and delivery modes (face-to-face, telephone, videoconferencing, provided written material, etc.), and modality (group or individual). For five interventions, the target behaviour was solely

dietary change; however, for the remaining (80%), they were multi-behavioural interventions targeting a combination of dietary change, and/or psychosocial aspects of eating, and/or exercise. Providers of the interventions also varied from nutritionists to physical activity therapists, psychologists, and surgeons (Table 3.1).

Use of behaviour change techniques

Table 3.3 presents the identified BCTs in each arm of the included studies. The total number of BCTs used across all studies was 32. The number of BCTs varied widely across studies, ranging from one to 18 BCTs. The most frequent BCTs appearing across the interventions were: '4.1 Instruction on how to perform the behaviour' (used in 18 [68%] of the studies); '2.3 Self-monitoring of behaviour' (used in 14 [56%] of the interventions); '1.1 Goal setting (behaviour)' (used in 13 [52%] of the interventions); '1.2 Problem-solving' (used in 11 [44%] of the interventions); '3.1 Social support (unspecified)' (used in 10 [40%] of the interventions); and '1.4 Action planning' (used in 10 [40%] of the interventions) (Table 3.3, Appendix 9).

Among the 25 interventions, only one study explicitly described the intervention using the BCTTv1, though they only reported the BCT groupings without detailing the actual individual techniques used.[83] In 44% of the studies, the authors used some of the BCTTv1-related wording to explain the content of their interventions, without explicitly referring to the taxonomy.[82,99-102,104,106,108,109,112,116,160] In more than half of the studies (52%), researchers had to subjectively code intervention descriptions, since the authors did not report using any BCTs to describe the interventions nor did they use comparable wording.[98,103,105,107,110,111,113-115,117,161-163]

Table 3.3 represents studies in order of positive larger to smaller effect size, followed by negative smaller to larger effect size studies. The values of effect sizes describe the impacts of the experimental arms on weight or BMI compared to the comparison arm. Studies whose interventions used the following BCTs were associated with large, positive effect sizes; '1.1 Goal setting (behaviour)' and '1.4 Action planning'. Studies whose interventions used the following BCTs were associated with medium, positive effect sizes; '1.1 Goal setting (behaviour)', '1.2 Problem solving', '1.4 Action planning', '2.1. Monitoring of behaviour', '2.3. Self-monitoring of behaviour', '2.5. Monitoring of outcome(s) of behaviour', '3.1. Social support (unspecified)', '4.1. Instruction on how to perform the behaviour', '4.2. Information

about antecedents', '5.1. Information about health consequences', '8.1. Behavioural practice/rehearsal', and '11.2. Reduce negative emotions'. All the BCTs included in positive large and medium effect intervention arms were also included in small effect size interventions or negative effect size interventions, except for '2.1. Monitoring of behaviour by others without feedback' and '4.2. Information about antecedents' (which appeared in positive medium effect size interventions).

Table 3.3 Coded behaviour change techniques according to BCTTv1 for each intervention arms of the included interventions and values of effect sizes

Study ID[1]	Effect size [2]			Arms	1.1.	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.3	4.1	4.2	4.3	5.1	5.4	5.6	6.1	8.1	8.2	8.4	8.7	9.1	9.2	10.9	11.2	11.3	12.3	12.5	12.6	13.2
	Target variable	Effect sizes																																		
Swenson 2007	BMI	0.925	L	E	✓			✓																												
				C																																
Nijamkin 2012	Wt	0.354	M	E	✓	✓		✓									✓			✓										✓					
				C																✓															
Nambiar 2023	Wtt	0.316	M	E											✓			✓																	
				C																																
Kalarchian 2016a	Wt	0.241	M	E	✓	✓		✓		✓		✓		✓	✓		✓							✓												
				C																																
Tucker 1991	Wt	0.215	M	E		✓														✓															
				C																																
	Wt		S	E								✓					✓																			

Rashidbeigi 2024		0.172		C													✓																				
Grilo 2021	Wt	0.156	S	E3	✓							✓					✓																				
				C								✓																										
Jassil 2023	Wt	0.146	S	E	✓							✓	✓				✓						✓	✓			✓							✓				
				C																														✓				
Dodsworth 2012	Wt	0.127	S	E	✓			✓									✓																	✓				
				C													✓																				
Lauti 2018	BMI	0.114	S	E											✓		✓			✓					✓	✓					✓						
				C																																	
Paul 2020, 2022	BMI	0.075	S	E	✓	✓					✓	✓			✓		✓			✓	✓		✓	✓	✓	✓	✓		✓		✓	✓	✓			✓	
				C																																	
Hany 2022	Wt	0.071	S	E	✓	✓						✓					✓				✓		✓	✓							✓				✓		
				C																																	
Hanvold 2019	Wt	-0.016	Small	E	✓	✓		✓	✓			✓		✓	✓		✓			✓			✓	✓	✓			✓	✓		✓			✓				
				C																																	

Grilo 2021	Wt	-0.037	Small	E[4]								✓			✓		✓			✓																		
				C								✓																										
Ogden 2015	Wt	-0.054	Small	E	✓												✓														✓						
				C													✓																				
Sockalingham 2023	Wt	-0.140	Small	E	✓	✓		✓				✓	✓	✓																							
				C									✓																								
Kalarchian 2016b	Wt	-0.145	Small	E			✓	✓	✓								✓																	✓		
				C			✓	✓	✓																											
Parikh 2012	Wt	-0.552	Large	E										✓																							
				C																																
Drakos 2022	NA	NA	NA	E								✓					✓			✓				✓												
				C																																
Mangieri 2019	NA	NA	NA	E								✓			✓																			✓		
				C																																
	NA		NA	E		✓									✓	✓	✓						✓	✓							✓				✓	✓

Chacko 2016		NA		C													✓																			
Wild 2015, 2017	NA	NA	NA	E		✓									✓	✓	✓						✓	✓							✓				✓	
				C																																
Lier 2012	NA	NA	NA	Exp				✓				✓					✓						✓					✓			✓				✓	
				C																								✓								
Kalarchian 2012	NA	NA	NA	E	✓	✓		✓		✓		✓		✓	✓		✓							✓												
				C																																
Sarwer 2012	NA	NA	NA	E							✓	✓		✓			✓																			
				C																																
Papalazarou 2010	NA	NA	NA	E	✓	✓		✓	✓			✓	✓						✓	✓		✓								✓						
				C																																
Total number of studies included each BCT					13	11	1	10	3	2	2	14	3	6	10	2	18	1	1	8	2	1	7	9	3	2	2	2	2	1	9	1	1	5	4	2

[1] Interventions are listed in order of those with larger positive affect size to smaller positive effect size (above the solid line) implying more effectiveness for the experimental arm compared to the comparison arm), and smaller negative effect size to larger negative effect size (below the solid line) implying more effectiveness for the comparison arm compared to the experimental arm

[2] Effect size calculation was done by Cohen's d (Morris's effect size d) for studies reporting pre-and post-intervention weight or BMI

[3] Guided self-help behavioural weight loss arm

[4] Guided self-help CBT arm

Abbreviations: BMI Body mass index, C Comparison arm, E Experimental arm, L Large, M Medium, S Small, Wt Weight, NA not applicable (explaining where we could not calculate effect size because of lack of data on pre- and post-intervention values for weight or BMI)

Risk of bias of included studies

Overall, studies demonstrate a varied range of risk-of-bias (Appendix 10). Collectively, bias was low (n = 9 studies), had some concerns (n = 7 studies), or high (n= 7 studies) in RCTs, and serious (n=1) and critical (n=1) in non-randomised trials. In RCTs, the risk of bias for the 'randomisation process', 'measurement of the outcome', and 'selection of reported results' was generally low. For non-randomised trials, the risk of bias in 'selection of participants into the study' and 'classification of interventions' was low.

Discussion

In this paper, we utilised the BCTTv1 to understand the active components of nutrition-focused behavioural interventions targeting weight loss for patients undergoing MBS. Our findings highlight the fact that interventions lack clear specifications of BCTs as a structure for designing and reporting the content of interventions. Among the studies included in our review, only one trial explicitly described their intervention components using the BCTTv1; however, even in that single publication, the authors only reported the BCT groupings without detailing the actual techniques used. In the remaining studies, approximately half of them used terminology close to the taxonomy vocabulary (e.g., "self-monitoring" for utilizing food diaries) but did not report the actual techniques or did not reference the taxonomy. The other half of the studies neither employed professional terminology (e.g., "journaling" to explain self-monitoring of dietary intake) nor reported the application of BCTs. This highlights the important limitation of poor intervention description across this literature, which contributes to the challenge of identifying potentially effective components (i.e., BCTs) and replicating those in future interventions, leading to difficulties in translating research into practice and slowing advancements in research and clinical improvement.[149] Our group has also previously analysed the completeness of intervention reporting in terms of methodological aspects and demonstrated that nutrition-focused weight management interventions adjunct to MBS are still below the desirable standards for reporting.[152] Given that, we emphasise the importance of researchers focusing their efforts on reporting intervention components according to available valid and reliable frameworks and journal editors mandating explicit and evidence-based descriptions of interventions.[71] This

practice facilitates high-quality intervention reporting and aids future synthesis projects in ascertaining the effectiveness of specific BCTs.

Common language hierarchies help specify intervention components, identify commonalities in seemingly disparate interventions, and ultimately uncover cross-study findings on techniques associated with desired outcomes. The Behaviour Change Technique Ontology (BCTO) is an advanced framework that extends the BCTTv1 by incorporating a formal ontology structure.[71] The BCTO standardises the terminology and classification of BCTs, making them more precise and systematically organised. This ontology includes 281 BCT components, hierarchically arranged into 20 higher-level groups, allowing for better clarity and specificity in describing the active elements of interventions. The BCTO is designed to be both human-readable and computer-readable, enabling its application in various domains, including intervention design, evidence synthesis, and computational analysis using machine learning and artificial intelligence. Since BCTO has been published only recently, it will take some time for researchers to adhere to this new structure. Therefore, in the current work, we applied the BCTTv1.[71] However, the integration of BCTO in future research will enhance the reproducibility and effectiveness of behaviour change interventions by providing an even more comprehensive and standardised approach to identifying and reporting intervention's active components, ultimately facilitating the development of more effective health interventions.

The results revealed that the BCTs appearing in large and medium effect-size interventions also appear in small effect-size interventions, with the exception of two BCTs: 'Monitoring of behaviour by others without feedback' and providing 'Information about antecedents'. Interestingly, these two BCTs are not among the most frequently used. This observation suggests several key points. The fact that most BCTs appear across interventions with varying effect sizes indicates that common BCTs are widely used, probably regardless of their impact on outcomes. This widespread use may be due to their perceived effectiveness or ease of implementation.[164] The two BCTs that are exclusive to higher effect-size interventions, and not frequently used overall, may represent particularly impactful techniques that are underutilised in the context of MBS. Their presence in more effective interventions highlights their potential importance for driving significant weight outcomes. The observation that these two BCTs are not among the most frequently used suggests that the frequency of use does not necessarily correlate with

effectiveness. This indicates a possible gap in the current application of BCTs, where more effective but less frequently used techniques may not be well-known or routinely incorporated into interventions. Future interventions could benefit from incorporating these less frequently used but potentially more effective BCTs. Additional research is needed to explore why these two BCTs are more effective and to understand the barriers to their frequent use. Importantly, we didn't directly or formerly assess the impact of the combinations of BCT in the interventions, as well as the frequency and intensity of delivery of the BCTs. Thus, there may be other underlying factors that we could not take into account while studying the impact of BCTs and their relationships with intervention effect sizes.

To the best of our knowledge, no previous studies have evaluated the efficacy of BCTs in nutrition-focused weight management interventions adjunct to MBS. However, in the field of obesity management, previous analyses have investigated the most effective BCTs targeting physical activity and eating behaviour.[69,165] These studies found that certain BCTs, including goal setting and self-monitoring of behaviour, providing information on the consequences of behaviour to the individual, and prompting practice, and general communication skills training were associated with more efficacious interventions for weight loss.[69,165] These findings to some extent overlap with the list of most common BCTs that we found in nutrition-focused interventions in MBS settings, including self-monitoring of behaviour and goal setting (behaviour). While behavioural techniques like goal setting and self-monitoring are effective in general weight management, patients undergoing MBS may need more specific strategies due to these unique post-surgical evolutions. Patients undergoing MBS experience unique physiological and psychological challenges, compared to non-surgical populations, such as rapid changes in appetite regulation and body image,[40] which may necessitate emotional support and environmental modifications.[166,167] Our findings highlight the importance of addressing environmental context, behavioural regulation, and emotional factors to ensure sustainable, effective post-operative interventions.

In terms of the quality of reporting of BCTs, we found that only one intervention used the taxonomy, and in more than half the interventions the authors did not use taxonomy-related wording, which demonstrates poor application of the BCTTv1 for describing interventions. BCTTv1 has been previously applied to code behavioural interventions for modifying health

behaviours or improving chronic conditions.[168-170] These assessments also noted the limited use of the taxonomy in original interventions to report their content. This highlights the poor reporting of BCTs in interventions and the importance of refining coding to capture the complexities of behavioural interventions. The insights gained from MBS research also inform broader health behaviour change interventions, addressing the persistent problem of inadequate reporting on elements of the behavioural interventions. [h)]. The use of precise reporting of BCTs and utilising standardised terminologies (i.e., BCTO) is important because behavioural interventions are inherently complex, involving multiple interacting components that collectively influence outcomes.[71] In this context, precise reporting enhances transparency and a greater opportunity for replicability of interventions, ultimately ensuring that these interventions can better contribute to the foundation of evidence-informed clinical practice.

Ideally, we would have conducted a meta-analysis to formally assess the associations between BCTs and effect sizes; however, due to the large heterogeneity among the included studies that was not possible. Attempting to collapse multiple irreconcilable BCTs and constructs from a small number of trials into categories for inclusion in a meta-analysis would not provide robust, reliable, or useful insight into intervention effects, nor would it add value to the knowledge in this area. Nevertheless, we performed effect size calculations to compensate for the lack of quantitative approaches which did provide some useful information. A potential limitation of the study was that the coding of the BCTs depended on the reporting quality, quantity and accuracy within the publications, which might impact the extraction of BCTs. Additionally, the target outcomes in our analysis were weight and weight-related measures (i.e., BMI, weight, and body composition), because these variables are commonly reported in most publications, and in clinical practice, the success of MBS is predominantly defined by weight loss. However, other health measures also compose the core outcome set for MBS, including quality of life, mental health outcomes, micronutrient status, comorbidity status, and the need for re-operation.[171] This raises the issue for future interventions to include such essential outcomes when exploring the efficacy of interventions beyond weight measures.

A key strength of this work is the novelty of our perspective and connecting the presence of BCTs to intervention effect sizes, as well as providing valuable insight into the issue of problematic reporting of interventions and outcomes in the existing literature. In this work, two

independent reviewers performed the selection and rating process, and a third independent reviewer resolved any disagreements adding to the accuracy of the findings. For the majority of the publications, reviewers screened protocol papers and available supplementary material explaining the intervention content and procedures. BCT coders completed online coder training programs which requires coders to obtain a high enough competency to 'pass' the course. Completion of this course has been reported to be effective in increasing coders' competence in coding techniques when applied to similar reviews.[172,173] Moreover, we specifically included nutrition-focused interventions (i.e., a specific target behaviour) within parallel group interventional designs (i.e., a specific study design) promoting weight loss (i.e., a specific target outcome). This level of granularity unifies the characteristics of the included studies, making the behavioural interventions comparable and allowing future researchers to replicate methodologies.

Conclusion

The insufficient implementation and reporting of BCTs across nutrition-focused interventions adjunct to MBS raise concerns about the interpretation and replicability of such trials. This gap in the literature highlights the importance of having more comprehensive descriptions of interventions, with particular emphasis on identifying the target participant(s), behaviour(s), and outcome(s). As previously demonstrated in other fields including obesity, adopting the BCTTv1 (or BCTO) while designing behavioural interventions could lead to the development of efficacious interventions and enhance the long-term benefits of MBS. This descriptive review constitutes an initial step towards optimising intervention designs and further evidence synthesis analyses to recognise BCTs associated with better post-MBS health outcomes.

CHAPTER 4: Barriers to And Enablers of Modifying Diet after Metabolic Bariatric Surgery: A Systematic Review of Published Literature

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Abstract

We investigated barriers and enablers influencing dietary behaviour change after metabolic bariatric surgery (MBS). Database searches retrieved publications reporting perceived factors influencing dietary behaviour change post-MBS. Data (quotes, survey results, interpretative summaries) were extracted and analysed using combined deductive and inductive thematic analyses. The generated barrier/enabler themes mapped to the Theoretical Domains Framework and then behaviour change techniques to identify potential strategies to improve post-operative dietary behaviour. Thirty-four publications were included. Key barriers fell within the domains of 'Environmental Context and Resources' (e.g., insufficient and unreliable healthcare services), 'Behavioural Regulation' (e.g., lack of self-discipline), 'Emotions' (e.g., eating as a strategy to overcome negative emotions), 'Beliefs about Consequences' (e.g., the extent of realistic expectations from MBS), and 'Social Influences' (e.g., challenge of eating at social events). Key enablers were also identified within 'Environmental Context and Resources' (e.g. self-access internet-based resources), 'Behavioural Regulation' (e.g. learning how to develop new dietary strategies), 'Beliefs about Consequences' (e.g., positive impacts of surgery-induced food intolerances), and 'Social Influences' (e.g., support from social/group sessions). Potential strategies to change postoperative dietary behaviour include *social support, problem-solving, goal setting, and self-monitoring of behaviour.* This provides insight into the targets for future post-operative nutrition-focused interventions.

Keywords: Metabolic bariatric surgery, behaviour change, diet, barrier, enabler

Introduction

Metabolic bariatric surgery (MBS) is considered the most effective weight loss treatment for individuals living with a wide spectrum of obesity and comorbid metabolic diseases.[174] However, the positive impacts of MBS can often be short-lived and there are notable inter-individual disparities in weight and health outcomes,[16] with more than 50% of patients experiencing significant weight regain, recurrence of comorbid conditions, or requiring additional MBSs within 2-5 years.[18] Therefore, surgery alone is unlikely to achieve and maintain target weight and health outcomes. A key driver of postoperative health benefits is engaging in or maintaining appropriate weight-related health behaviours, including physical activity, medication adherence, and crucially, modifications to dietary and eating behaviours.[47]

Post-operative dietary stages encompass fluid, puree, soft, and solid/regular diets, with the duration of each stage varying according to the patient's tolerance. In the regular diet phase, patients are broadly encouraged to eat three to five small meals, while chewing foods slowly and aiming for 60-120g protein/day based on the type of MBS. Additionally, patients are asked to separate liquids and solids by 30 minutes and to avoid carbonated/caffeinated beverages and alcohol.[56] However, following dietary guidelines is likely to be challenging since most patients continue to have nutritional complications after MBS.[145] This highlights the need to develop and implement effective nutrition-focused behaviour change interventions adjunct to MBS.

Effective strategies to support dietary behaviour change in patients undergoing MBS must be based on underlying factors that influence why people behave in a certain way, and why they may struggle (i.e., barriers) or flourish (i.e., enablers) to achieve a target behaviour/outcome.[146] The application of behavioural sciences theories can facilitate the identification of such barriers and enablers.[175] One such framework is the Theoretical Domains Framework (TDF), which integrates constructs from 33 behaviour change theories into 14 ‘theoretical domains’ representing the broad range of potential types of factors influencing behaviour (e.g. ‘Knowledge,’ ‘Social Influence,’ and ‘Emotions’).[76] The TDF has been applied to investigate factors influencing a wide range of behaviours, including eating behaviours,[176] and also as a coding framework for evidence synthesis in systematic reviews (e.g. exploring barriers to diabetic retinopathy screening attendance).[177] The benefit of the TDF is that it is mapped to

taxonomies of behaviour change techniques (BCTs) [71] and the Behaviour Change Wheel [61] helping to move from understanding what is driving behaviour in context, to selecting and designing intervention strategies to target key influences.[178]

This systematic review, therefore, aimed to apply the TDF to identify and synthesis factors influencing patients' dietary behaviour change following MBS and map theoretical domains to BCTs suggesting potential interventions to address key barriers and enablers.

Materials & methods

This is a registered systematic review (PROSPERO: CRD42023442679), conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. [96]

Inclusion/exclusion criteria

In this work, we included studies reporting primary data related to modifiable factors that might hinder or facilitate dietary behaviour change after MBS from any participant's point of view, including adult patients undergoing all types of MBS. Studies were included if they used qualitative or quantitative designs to assess barriers and enablers to modifying dietary behaviours. Studies reported in either English or French were considered. Since this is not an effectiveness or intervention review, a formal control group or exposure comparison was not defined (Appendix 11).

Search strategy

We searched the following databases to identify published literature: PubMed; EMBASE; PsycINFO; CENTRAL in the Cochrane Library; and Scopus. The keywords were categorised into three main groups to include terms related to: 1) MBS; 2) barrier/enablers; and 3) dietary behaviours (Appendix 12). Reference lists of included publications were screened for additional studies. The initial database search was conducted in July 2023 and updated in February 2024.

Screening for inclusion

Peer reviewers (RY, VGB, PFCA, JO, MG, FCR) had previously reached a minimum agreement level of 85% on a small pilot library of records. After removing duplicates, peer reviewers screened titles and abstracts against the inclusion/exclusion criteria. Subsequently, full-text articles were assessed for eligibility (Appendix 11). Inter-reviewer agreement rates for the titles/abstract and full-text screening phase were 88.4% and 91.0%, respectively. Any disagreements were resolved by consensus or by including a third party.

Data extraction

Peer reviewers (RY, VGB, PFCA, JO, MG, FCR) extracted data on study characteristics independently. Data reporting patients' perceptions of modifiable barriers/enablers associated with dietary behaviour change were also identified and extracted. This included participant quotations from qualitative studies, questionnaires and surveys from quantitative studies, as well as authors' interpretive descriptions and summaries of findings. Conflicts were resolved by discussions.

Data analysis

We adopted the analysis methods used in previous studies that applied the TDF to semi-structured interview transcripts and systematic reviews.[177,179] These methods encompass a combined content and framework analysis approach, involving four steps: 1) deductive analysis (TDF coding); 2) inductive analysis (thematic synthesis); 3) identification of significant domains; and 4) mapping to intervention strategies (BCTs).

Deductive analysis

Peer review authors (RY, VGB, PFCA, JO, MG, FCR) independently coded the extracted data into the theoretical domains they deemed to be most appropriate. For example, the qualitative excerpt of "It's so much easier to eat carbs than protein and it's cheaper" [180] was coded into the ‘Environmental context and resources’ domain and the survey result of “poor family support (11%)” [181] was coded into the ‘Social influences domain’. When excerpts were relevant to multiple domains, they were coded accordingly. Inter-rater agreement for this phase was

assessed using percentage agreement before resolving conflicts, demonstrating an agreement of 86.2%. Any discrepancies were discussed until consensus was achieved.

Inductive thematic synthesis

According to a framework analysis approach, step 2 focused on sifting and sorting the data within each domain to synthesise thematically and generate emerging content themes. RY grouped similar data regarding perceived barriers of/enablers to dietary behaviour change, within each of the 14 domains. Theme labels (describing broad content themes) and, where appropriate, sub-theme labels (nested within the themes, describing more detailed content) were then inductively generated for each cluster of similar data to express these shared views. To ensure consistency, authors (RY, FL, VGB) reviewed data based on: 1) grouping; 2) generation of themes; and 3) categorisation of the TDF domain. Each theme/sub-theme was classified as: 1) a barrier if the data within it related to barriers only (e.g., insufficient income to be able to afford healthy food); 2) an enabler if the data within it related to enablers only (e.g., support from local community groups/networks); and 3) mixed influence- both a barrier and an enabler if it related to both [e.g., (un)helpful post-operative food intolerances].

Identifying important domains

Each TDF domain was evaluated using the set of three importance criteria:[175] 1) frequency- the number of studies in which that domain was identified; 2) elaboration- the number of themes and sub-themes generated within each domain; and 3) expressed importance- involving either a statement from the authors' interpretation or direct quotes from study participants highlighting the significance of the domain.

Mapping to intervention strategies

A similar approach to previous reviews was utilised to map themes from qualitative analysis to potential intervention approaches.[179,182] This was conducted using the Theory and Techniques tool [183] and previous evidence from the literature.[121] Selection from the list of potential techniques was informed by a recently published review of nutrition-focused interventions for patients undergoing MBS.[121] Furthermore, these approaches were evaluated using the APEASE

criteria, focusing on **A**cceptability, **P**racticability, **E**ffectiveness, **A**ffordability, **S**ide-effects, and **E**quity.[184]

Risk of bias assessment

The included studies were assessed using the Critical Appraisal Skills Programme Qualitative Checklist (http://www.casp-uk.net/casp-tools-checklists) and the Mixed Methods Appraisal Tool (https://www.mcgill.ca/familymed/research/projects/mmat). Mixed methods studies were appraised using both appraisal tools.

Results

Study characteristics

Database searches yielded a total of 4,649 publications. After removing duplicates, 3,506 titles and abstracts were screened, followed by 68 full-text articles. A total of 34 publications met the inclusion criteria and were included in the review (Figure 4.1). Three of the records reported on the same study (Table 4.1).

A total of 1,813 patients were recruited across the included studies, with one study that included both patients and healthcare providers from the MBS team. A total of 29 studies employed a qualitative methodology, utilising either interviews or a focus group approach for data collection. Four studies utilised a quantitative methodology, including surveys, while two studies utilised a mixed methodology and one was a case study.

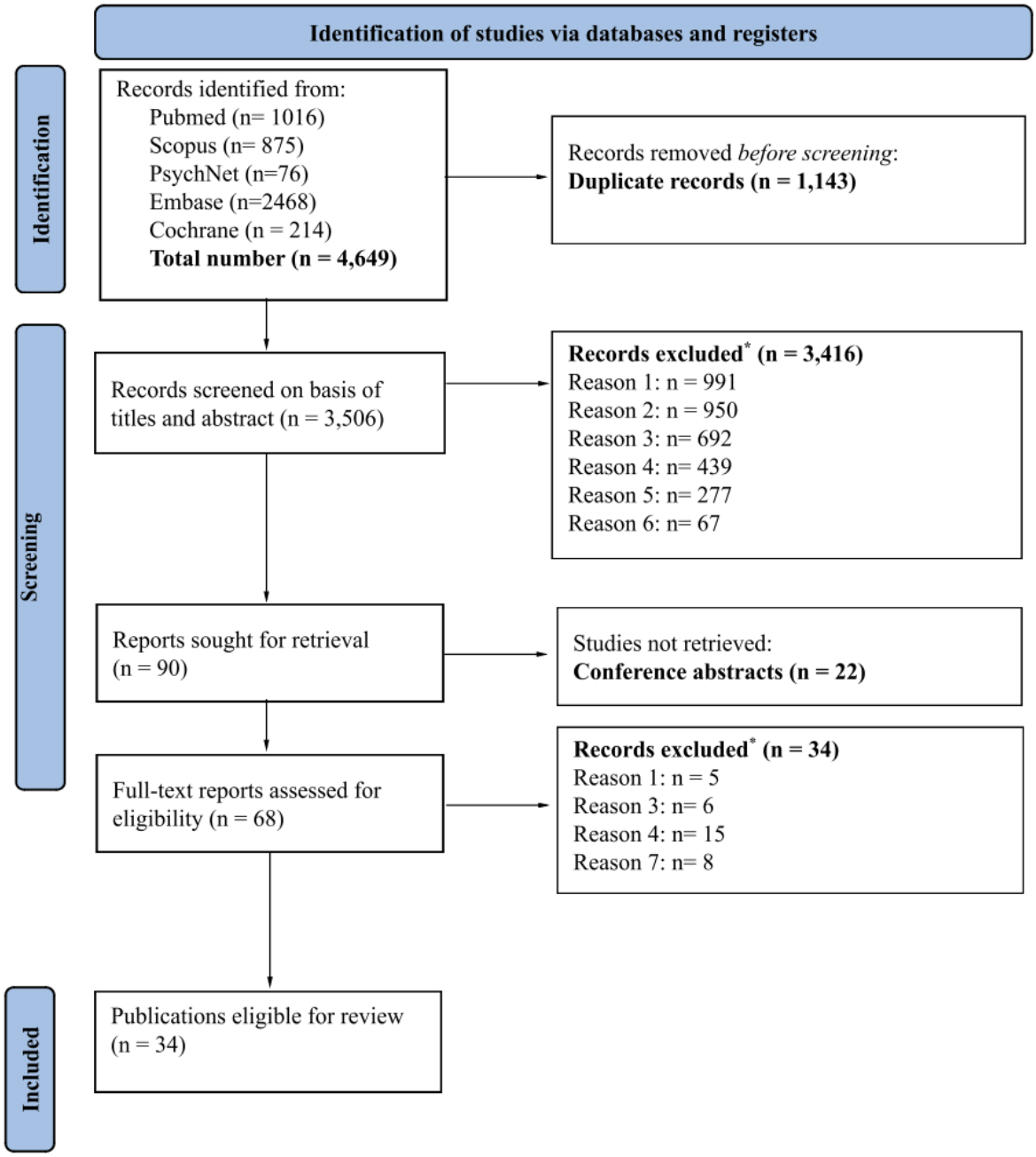

Figure 4.1. PRISMA flow diagram of included and excluded studies

* Reasons for exclusion:
Reason 1: Wrong population
Reason 2: Wrong publication type
Reason 3: Wrong exposure (not targeting dietary behaviours)
Reason 4: wrong outcome (not including perceptions on barriers/enablers)
Reason 5: Duplicate retrieve
Reason 6: Foreign language
Reason 7: Wrong study design

Table 4.1 Characteristics of 32 included studies

Author/ year	Country	Focus of assessment	Methodology	Behaviour change theories	Data collection method	Time of assessment as related to MBS	Type of MBS	Sample size (n)	Total women (%)	Age (yr) [mean, SD]	Weight (kg)	BMI (kg/m2)
Funk 2023[185]	USA	Weight management	Qualitative	NR	Semi-structured interview	4.1 years (median)	GB, SG	24	83	50.6 (10.7)	NR	NR
Tolvanen 2023/2022/2021[186-188]	Sweden	Weight management & post-op life experience	Qualitative	NR	Semi-structured individual interviews	10 years (3-15)	RYGB	16	75	49	NR	NR
Wright 2022[189]	Australia	Post-op psychosocial aspects	Qualitative	Theoretical domains framework, Reflexive thematic analysis	Semi-structured interview	NR	RYGB, SLGB, SG	15	60	57	NR	NR
Billing-Bullen 2022[190]	New Zealand	Weight management	Qualitative	NR	Focus group	21 months	SG, Revision from GB to SG	28	71.4	49.7 (8.8)	94.4 (77.9, 106.5)_ median (percentile)	NR
Jarvholm 2021[191]	Sweden	Post-op life experience	Qualitative	NR	Semi-structured interview	10 years	RYGB, BPD-DS	18	61	48 (6)	NR	40.2 (7.40)
Athanasiadis 2021[192]	USA	Psychosocial aspects	Mixed-method	NR	Telephone interview & survey	NR	NR	30	NR	NR	NR	NR
Coulman 2020[193]	England	Post-op life experience	Qualitative	NR	Semi-structured interview	4 months- 9 years (mean 3.11 y)	RYGB, SG, AGB	17	63	51.1	NR	NR
Yates 2020[194]	Australia	Post-op life experience	Qualitative	Theoretical framework for using thematic analysis	In-depth telephone interviews	1, 2 or 3 years	SG	22	86	43.9	NR	41.5 (35.2-55.2)

Yu 2020[195]	China	Diet & exercise	Qualitative	NR	Semi-structured interview	37.0 (17.2) months	SG	15	53.3	38.5	NR	NR
Assakran 2020[181]	Saudi Arabia	Diet & exercise	Mixed-method	NR	Telephone interview	> 6 months	SG, mini GB	399	55.4	35.21(10.45)	NR	30.91 (6.54)
Lin 2018[196]	Taiwan	Psychosocial aspects	Qualitative	Grounded theory	In-depth interview	21.8 months	SG, RYGB	17	64.7	34.5	NR	41.8 kg/m2 (range, 35.9~54 kg/m2)
Opozda 2018[197]	Australia	Diet & psychosocial aspects	Qualitative	NR	Questionnaire	2.1 months- 18.4 years	RYGB, AGB, SG	206	94	45.9 (10)	NR	NR
Graham 2017[198]	England	Post-op life experience	Qualitative	Grounded theory	Semi-structured interview	5-24 months	RYGB, SG	18	61	NR	NR	NR
Liu 2017[199]	Canada	Follow up care	Quantitative descriptive (cross-sectional)	NR	Questionnaires	NR	RYGB, SG, DS	119	93	NR	NR	NR
Schiavo 2017[200]	Italy	Follow-up adherence	Quantitative descriptive (cross-sectional)	NR	Recall Questionnaire + Interview	12 months	LSG	96	75	46 (11.8)	Male: 116 (19.6) Female: 102 (12.4)	Male: 37.4 (19.3) Female: 37.5 (13.4)
Moura de Oliveira 2016[201]	Brazil	Post-op life experience	Qualitative	Social Phenomenology	Interview	6- 36 months	NR	8	100	23-53	NR	NR
Hillersdal 2016[202]	Denmark	Diet	Qualitative	Grounded theory	Interview	1.5 months- 2 years	RYGB	24	62.5	26-61	NR	NR
Lauti 2016[180]	New Zealand	Weight management & Follow up care	Qualitative	NR	Focus group	At least 24 [mean(SD): 3.9 (1.6) (range 2–7) year]	SG	38	68.4	51.4 (6.7)	103.17 (21.1)	NR
Lynch 2016[203]	USA	Diet	Qualitative	Life Course Concept/Food Choice Process Model	In-depth interview	14-120 (36.6) months	GB	16	81	NR	86.63	32

Peacock 2016[204]	USA	Diet & exercise	Mixed-method	NR	Survey	NR	NR	440	NR	NR	NR	NR
Raves 2016[205]	USA	Psychosocial aspect	Quantitative descriptive (cross-sectional)	NR	Survey	NR	Survey	35	80	52.7 (11.9)	NR	NR
Sharman 2015[206]	Australia	Post-op life experience	Qualitative	NR	Semi-structured focus group interviews	72 months	LAGB	41	63	54	NR	35
Geraci 2014[207]	USA	Post-op life experience	Qualitative	NR	Semi-structured interview	Median 3 (2-7yrs)	RYGB, SG	9	100	median 42 (27-57)	NR	NR
Lynch 2014[208]	USA	Diet	Qualitative	Grounded theory and constructivist perspective	In-depth interviews	NR	GB	16	81.3	32-62	NR	NR
Natvik 2014[209]	Norway	Diet & psychosocial aspect	Qualitative	NR	In-depth interviews	> 5 years	DS	14	50%	NR	NR	NR
Benson-Davies 2013[210]	USA	Diet	Case study	NR	NR	1.75 months (7 weeks)	RYGB	1	100	58	93	NR
Da silva 2012[211]	Portugal	Post-op experience of adaptation	Qualitative	Grounded theory method	Interview	12 months	SG, GB	30	66.6	40.17 (8.81)	NR	41.5 (5.7)
Knutsen 2012[212]	Norway	Post-op experience of adaptation	Qualitative	Discursive action model	Semi-structured interview	2 weeks- 9 months	GB	9	88.90	37-56	NR	NR
Stewart 2010[213]	USA	Weight management	Qualitative	NR	Group sessions	>18 months	RYGB	14	100	32-67	NR	NR
Zijlstra 2009[214]	Netherlands	weight management & psychosocial aspects	Qualitative	NR	Semi-structured interview	1-5 years	GB	11	91	46	NR	50

Ogden 2006[215]	England	Diet & psychosocial aspects	Qualitative	NR	In-depth interview	<33 (5-33) months	NR	15	93%	25-54	NR	28-31
Bocchieri 2002[216]	USA	Diet & psychosocial aspects	Qualitative	grounded theory	Semi-structured interviews & in-depth focus groups	6 months-11 years (mean 28m)	GB	31	74.2	41(30-53)	NR	NR

Abbreviations: Metabolic bariatric surgery, MBS; BMI, Body mass index; Biliopancreatic diversion with duodenal switch, BPD-DS; Gastric bypass, GB; Laparoscopic Adjustable Gastric Banding, LAGB; Not reported, NR; Roux-en-Y Gastric Bypass, RYGB; Sleeve gastrectomy, SG; Single loop gastric bypass, SLGB.

Risk of bias

The studies were rated based on the risk of bias as low (33.3%), medium (30.3%), high (24.2%) or unclear (12.1%) (Appendix 13).

Deductive analysis

A total of 643 units of data, composed of 627 qualitative units (432 quotations from study participants and 195 authors' interpretations) and 16 quantitative units (e.g., percentages of participants agreeing with a questionnaire item, or odds ratios) were extracted. Influences were not identified in the 'Social/professional role and identity', 'Optimism', and 'Reinforcement' TDF domains. When comparing the total number of themes/sub-themes, it was found that barriers were more than twice as prevalent as enablers (21 for barriers vs. 8 for enablers). Additionally, eleven themes/sub-themes were identified as both barriers and enablers (Table 4.2).

Table 4.2 Frequency and elaboration within each of the TDF domains, presented in rank order from most important to least important

TDF domain (rank order)	Frequency of influences (themes/sub-themes)			Number of studies identified	Level of elaboration	
	Barriers only	Enablers only	Mixed		Number of themes	Number of sub-themes
1. Environmental context and resources	8	1	1	19	6	4
2. Behavioural regulation	2	2	0	19	4	0
3. Emotions	1	0	1	18	2	0
4. Beliefs about consequences	2	2	1	17	5	0
5. Social influences	5	1	3	12	5	5
6. Memory, attention and decision processes	0	1	2	7	3	0
7. Knowledge	1	0	1	6	2	0
8. Beliefs about capabilities	1	0	1	6	2	0
9. Intentions	1	0	0	3	1	0
10. Skills	0	0	1	2	1	0
11. Goals	0	1	0	1	1	0

Abbreviations: TDF Theoretical Domains Framework, TDF

Inductive analysis

Table 4.3 lists all themes generated within each TDF domain, alongside supporting examples of extracted data. Below, we have presented a narrative description of the themes within domains that were identified as high in importance.

Table 4.3 Key themes, corresponding data excerpt(s), and quotes of barriers and enablers coded to each of the domains of the Theoretical Domains Framework

Theme	**Barrier/Enabler/ Mixed influence**	**Exemplar data excerpt(s)**
Environmental context and resources		
Services provided by the healthcare system	Barrier	*Author interpretation*: Participants expressed the need for frequent, reliable, and consistent support (e.g., follow-up sessions providing information and instruction) regarding dietary, psychological and mental aspects of post-operative adjustments *Quotes:* "It was [nurse's name] who was in charge of all these patients [undergoing bariatric surgery], but she was not a good person. She was completely uninterested. She didn't give advice, food lists, restrictions, or anything else that patients get nowadays."[186]
Self-access internet-based methods	Enabler	*Author interpretation*: Patients found online and e-Health resources as helpful to motivate and engage them in the process of positive dietary modification *Quotes:* "Online information. I could access at any time and look up the topics that were relevant to my journey at that very time. Things like Daily Plate, or Fit Day were great, as they helped me identify things like sneaky carbs, and learn to be mindful of the little stuff that you can forget about."[204]
The negative impacts of medical conditions or life circumstances	Barrier	*Author interpretation*: Health conditions such as injuries, mental health problem, dentition and joint problems, as well as life circumstances like pregnancy, deaths of family members, getting married, and having young children were perceived as factors negatively influencing eating behaviours *Quote:* "I think other health issues have been my downfall"[180]
Financial stressors	Barrier	*Author interpretation*: Patients mentioned high costs of healthy food and limited income as a barrier to make positive dietary behaviour modifications *Quote:* "The prices of vegetables and that sort of thing. Everyone is telling you to eat healthy, but it is cheaper for us all to go and get a MacDonald's or a Burger King or something, whereas we would rather have cucumbers and tomatoes"[190]

Accessibility and travelling issues	Barrier	*Author interpretation:* Patients who did not have their own car or another form of reliable transportation faced challenges to attending follow-up visits or purchasing healthy food *Quote:* "We're fairly rural here; Walmart is 30 miles away. Local grocery stores … There's only one in the county. There are dozens of convenience stores. So, being rural definitely makes it harder to get to a quality food source."[185]
Employment situation/setting	Barrier	*Author interpretation:* Employment-related barriers such as hectic work schedule, easy access to vending machines, and using office snacks as a strategy to avoid unpleasant work tasks negatively impacted patients' dietary behaviour modification *Quote:* "you have to eat fruit with carbohydrates or eat every three hours but daily, when you have to work it is not possible"[211]
Time limitation	Barrier	*Author interpretation:* Lack of time was mentioned as a barrier impacting healthy food decision-making and preparation *Quote:* "Cooking – still have very little time and need quick meal ideas…"[204]
Behavioural regulation		
Patient struggling with adapting to the new lifestyle	Barrier	*Author interpretation:* Patients experienced difficulties with developing new coping strategies to manage eating behaviours *Quote:* "…all your insides are different but your brain…no different whatsoever…that for me was the hardest thing to adjust to, because my brain was still telling my stomach I was hungry but obviously I couldn't [eat]…"[193]
Developing new strategies and habits	Enabler	*Author interpretation:* Some participants gradually learned how to handle their post-operative dietary requirements and improve their eating behaviours *Quote:* "I had a huge problem getting the amount of vegetables they say you need to have after the operation…it was difficult, but I make soup and you can get them all in there…because you boil them and blend it…they're all in there"[198] "I don't eat out of a packet, I always put my food in a bowl."[189]
Lack of self-regulation/	Barrier	*Author interpretation*: Poor self-discipline and self-regulation negatively impacts

self-discipline		post-operative dietary behaviour modification Quote: "I tend not to have a lot of self-control and I buy rubbish a lot" [Opozda 2018] "Binge now is like a little bag of chips and a biscuit because you can't get anything down. But, I mean, that mind-set is still there".[190]
Emotions		
Negative emotions	Barrier	*Author interpretation:* Participants explained a wide range of negative feelings such as shame, sadness, and abandonment, exhaustion, discomfort, fear, guilt, and anguish leading to disordered eating behaviours, such as grazing, obsession with eating, boredom eating, bingeing, emotional and night time eating, and difficulty distinguishing head hunger and physical hunger *Quote:* "I am an emotional eater. I hoped it would stop that or curve [sic] the habit but I have realised I probably need counselling to explain why I do it and learn techniques to not get to that point" [Opozda 2018]'then comes a day when you cannot fight any more, when you quit and eat.' [Da Silva 2012] "During the follow-up visit at the surgical clinic, I was caught up with feeling ashamed about having to learn how to eat right" [Tolvanen, 2023]
Eating as a strategy to overcome negative emotions vs. eating in response to biological triggers	Barrier	*Author interpretation*: The struggle to find new ways of coping with negative emotions was reported to be a challenging process *Quote*: "I still have an awkward relationship with food…still have the same demons…I probably rely on food to deal with certain emotions" [Coulman 2020] "Food was coziness. Food was my friend. There aren't great amounts of food here anymore, like there used to be. It was so cozy all the time. That is over. Well, we make dinner every day, but the portions are smaller" [Knutsen 2012]
Beliefs about consequences		
Impact of surgery-induced food intolerance and taste	Mix	*Author interpretation*: Many patients emphasised that they were not adequately informed and prepared for the food intolerances induced by surgery, which significantly impacted the quality of their diet. They experienced resistance to

changes		recommended healthy food items like protein-rich foods, breads, fruits, and vegetables. Some individuals also reported having unrealistic expectations regarding the role of surgery, perceiving that surgery would handle their dieting for them and negate the need for further efforts to modify their diet or eating behaviours *Quote:* "I can't eat bread or meat…That's one of the small prices I have to pay…my intake of food is nowhere near balanced…" [Coulman 2020] "If I eat too much I start to feel sick and full up and uncomfortable so it's not worth it now"[215] The unfortunate thing is the easy-to-eat foods are the ones that are bad for you like chocolate ice cream because they dissolve in your mouth"[190]
Extent of realistic expectations from surgery	Barrier	*Author interpretation*: Their own role in controlling health behaviours and outcomes after the operation seemed undervalued as they relied on the effect of surgery to curb their eating and do the dieting for them. *Quote:* "I had hoped that the surgery would put a stop to my sweet tooth, that I would be unable to eat sweets and fat and able to stick to small meals. But that quickly became a letdown."[186] "I expected that it would be easier to choose what to eat; that I would be able to choose the sandwich instead of the chocolate, cookie, crisps, etc. I thought I would manage this easily and that in the next year I would lose thirty kilograms. That it would work out that way…"[214]
Positive health benefits impacting dietary behaviour	Enabler	*Author interpretation*: Accordingly, some participants described surgery not only as an option for or comparable to sustained lifestyle change, but as an embodied reconnection. This means that the participants became sensitive to their own body and bodily expressions/impressions while eating. *Quote:* "I feel hunger now. Since I'm no longer having large portion sizes and eat every three hours, like I should, then I feel hungry. Then I like to wait. I like feeling hungry, it gives me great satisfaction. Then I know that I'm the one controlling my hunger, and hunger is not controlling me"[202]
Avoiding surgery-induced nutritional side effect	Enabler	*Quote:* "Nutrition injections are expensive and painful. So I need to eat meat and get more protein"[196]

Social Influences		
Impact of family and friends	Mix	*Author interpretation:* Some patients reported receiving positive support from family and friends, some others, however, reported lack of support and experienced judgement, pressure, and criticism. *Quotes:* "it's good to catch up with people, but some people will put pressure on you to try and get you to eat things that you don't want to eat"[189] "Family support is everything—they will be there and witness bariatric surgery 'weirdness'—things like being unable to eat more than an appetizer sized meal at a sitting"[199]
Support from social/group sessions	Enabler	*Author interpretation:* Participants stated they found the group setting extremely helpful. The main reason was having a sense of not being alone and learning through others' journeys, as well as valuable ideas on diet and mindset from peers. *Quotes:*"It was nice to know that someone else was going through the same kind of thing and to get ideas off other people you know that's really valuable."[190]
Eating in social events	Barrier	*Author interpretation:* Social eating was perceived as particularly challenging leading to consumption of high-energy-dense foods and drinks *Quotes:* "I think it's just society in general. Even in work meetings and things, it is almost rude not to eat something, even if you are not hungry or you don't feel like it. It is odd to have food in front of you and sit there and not have anything". "When I'm around people, I behave myself but as soon as that door shuts or I am on my own, it's like let me loose". [190]
Encouragement and support from HCPs	Enabler	*Author interpretation:* Some patients reported receiving support from hospital staff *Quotes:* ''[The] hospital staff was second to none. [They were] very knowledgeable about post-bypass procedures and diet and were emotionally supportive during the initial upheaval and fluid diet, etc.''[199]
Impact of media, e.g. marketing and advertising	Barrier	*Quotes:* "Being influenced by food product advertisements e.g., chocolates at Easter" [190]

Importance of TDF domains

Domain frequency

The data units were coded most frequently into the following domains: 1) 'Environmental context and resources' (n=19 studies, [57.6%]); 2) 'Behavioural regulation' (n=19, [57.6%]); 3) 'Emotions' (n=18, [54.5%]); 4) 'Beliefs about consequences' (n=17, [51.5%]); and 5) 'Social influences' (n=12, [36.4%]) (Table 2).

Level of elaboration

Approximately 85% of themes/sub-themes relating to barriers, 75% relating to enablers, and 58% relating to mixed themes were captured in the same five theoretical domains (Table 2).

The rank order of domain importance

The 14 theoretical domains are presented in rank order (Table 2). In general, there was good convergence between frequency (the number of studies in which the domain was evident) and elaboration (the number of themes and sub-themes based on the inductive analysis).

Expressed importance

The number of studies that identified specific domains based on expressed importance was counted, with higher counts indicating greater significance. The most significant domains identified were 'Social influences' (n=10), 'Environmental context and resources' (n=8), 'Behavioural regulation' (n=3), 'Emotions' (n=1), 'Skills' (n=1), and 'Beliefs about consequences' (n=1). This list encompasses all five domains of high importance identified by the criteria of frequency and elaboration (excluding skills) (Appendix 14).

Thematic synthesis for domains identified as having high importance

The most frequent content themes within the five important TDF domains identified as potentially influencing post-operative dietary behaviour change are summarised below (Table 3 for the important domains; Appendix 15. for an exhaustive list of all domains).

Environmental context and resources (n=19 studies)

This domain primarily presented a barrier to post-operative dietary behaviour change. Patients implied that shortcomings in the healthcare system led to unmet needs for nutrition-focused and psychological programs. They found the support from healthcare practitioners (HCPs) to be infrequent as well as inconsistent across different healthcare divisions. Additionally, they referred to the advice from HCPs as generic, making clinical procedures adjunct to MBS non-applicable to their situations.[180,188,191,193] Patients highlighted the need for guidance on postoperative dietary practices, such as meal planning, and understanding what and how to eat. These issues are also closely tied to the domain of 'Social Influences', presented below. On the other hand, patients identified self-access internet-based and e-Health methods as facilitators, through which they could benefit from a wide range of online resources providing them with guidance on "do's and don'ts". [46,121,204] Another predominant barrier in this domain was financial concerns, as patients linked the high cost of healthier and more nutritious food to post-operative challenges of dietary behaviour change. [181,185,190,200,204]

Behavioural Regulation (19 studies)

Patients reported struggling with adapting to the new life changes post-MBS which looks like going on a "lifelong diet". Over time, they experienced increased hunger and the ability to consume increasingly large portions, along with the recurrence of maladaptive eating behaviours such as compulsive eating, grazing, emotional eating, and night eating. [188,197,198,203,204,210] Lack of self-discipline was also mentioned as a barrier related to behavioural regulation, [181,200] often accompanied by feelings of lacking self-control over eating.[190,197,198,214] In contrast, many patients reported shaping new positive habits and employing strategies to manage both the mental and physical aspects of their post-MBS diet leading to renewed relationships with food. Some of these include eating slowly, controlling portion sizes, consuming fewer carbohydrate-heavy foods, reducing processed sugar and fat intake, increasing protein consumption, eating only when hungry, trying new foods, and preparing and planning food.[187,191,196-198,203,208,209,212,213,215] Self-monitoring of food intake was also among the most common techniques affecting dietary intake, helping maintain consistency of healthier eating behaviours.[121]

Emotions (18 studies)

A barrier to dietary change for patients was experiencing negative emotions such as stress, shame, abandonment, disappointment, lack of enjoyment, guilt, exhaustion, and obsession with food and weight. These emotions impacted their eating behaviours and stemmed from various sources, including the thought of not being able to achieve their weight loss goals, lack of emotional/social support, difficult life circumstances, psychosocial challenges, or severe illness.[180,181,186,188,190,197,209,211,213] As a response to negative emotions, many patients reported eating as a coping strategy.[187,193,207,212,216] For some patients, surgery altered their experience of eating, leading to diminished enjoyment and satisfaction, attributed to a restricted gastric pouch and bodily reactions to eating (e.g., food intolerance).[197,209] Consequently, participants often lacked the "comfort blanket" (i.e., using food as a coping mechanism), and had a hard time finding more adaptive alternative new coping mechanisms.[186,204,207,210] In contrast, a few patients described how the surgery had resulted in a fundamental shift in their relationship with food helping them to retrain their minds to focus on "eating more sensibly" rather than feeling like they were "on a diet".[193] Notably, food and eating became increasingly associated with biological necessity rather than psychological support.[215] Food no longer provided pleasure or satisfaction "because there's no quantity of food anymore"; instead, it was perceived as "preventative medication".[121]

Beliefs about Consequences (17 studies)

One influence in this domain was the role of surgery-induced food intolerances. Many patients reported developing multiple food intolerances and experiencing frequent gastrointestinal symptoms even years after surgery, which contributed to a poorly balanced diet.[193,201] As participants transitioned to solid foods, they entered a "trial and error" phase, where they had to "experiment" with food and relearn eating habits.[203] This phase often revealed unexpected symptoms including nausea, vomiting, and reflux, particularly with eggs, water, and meat.[190] As a result, many patients resorted to strict diets and consumed less healthy foods out of fear of experiencing these symptoms,[206,215] especially because foods high in sugar and fat content were often more manageable.[190,197,212] On the other hand, some patients associated problems with dumping syndrome with the consumption of refined carbohydrates, sugars, and fats, or from less adaptive eating behaviours such as eating too quickly or consuming large portion sizes.[191,197,207,215] These physical responses served as cues for patients to adjust their eating habits

such as planning, choosing appropriate foods, timing meals effectively, and eating slowly in small bites to avoid intolerance symptoms, which facilitate the development of strategies for dietary choices.[191,195,196,202,203,212,214,215] Another aspect of this domain referred to the extent of patients' realistic expectations from surgery. Many participants were unprepared for the continued challenges with their weight and health after the surgery, highlighting the gap between their expectations and the realities of post-operative health management. It was found that patients were not well informed about the role of dietary guidelines in achieving long-term health outcomes. By believing that the MBS would control their eating and manage their dieting, they undervalued their own role in post-operative dietary management.[186,188,212,214]

Social Influences (12 studies)

The impact of family and friends was highlighted as a central social influence. In some cases, patients' small food intake and MBS became topics of discussion at family and social gatherings (increased awareness of food), leading to a feeling of exclusion due to new dietary restrictions and a tendency to keep their surgery secret for fear of judgment or criticism.[190] Some also reported feeling tempted or pressured to overeat in social settings. [186,190,204,213] Many also described the feedback from friends and family as stigmatising or discouraging.[181,186,188,200,204] Patients also discussed the need for caution and restraint or responsible eating in front of others, which could be a factor in binge-eating episodes when alone, as a way to cope with feelings of shame and judgement during social gatherings.[190] In contrast, family and friends could also positively influence patients by encouraging healthier habits, such as joining them in eating healthier meals or attending healthcare visits.[188,196,199] Some patients mentioned the positive influence of receiving support from social/group sessions. Nutrition-focused group sessions were described as motivating and informative,[46,180] helping them feel less isolated and providing valuable diet and mindset strategies.[190,204,213]

Mapping identified barriers/enablers to intervention strategies

We mapped barriers and enablers to proposed strategies for improving postoperative dietary change for the subset of influences identified as important based on spontaneity and elaboration (Table 4.4). Among the range of identified potential strategies, some target individual-level factors such as developing new dietary strategies through setting incremental goals, practicing

self-reflection to recognise problematic or helpful behaviours, adopting a problem-solving approach for experienced difficulties, and using stress management techniques to reduce negative emotions. Some strategies operate at the service provision level, such as integrating psychosocial and nutritional support to offer consistent service to patients. Other strategies necessitate change at the sociocultural level, such as providing social support via group sessions/activities to raise patients' awareness of different aspects of postoperative outcomes or dietary change and fostering compassion by creating a sense of social integration.

Table 4.4 Mapping of barriers/enablers to proposed intervention strategies

Identified barrier/enabler	**Corresponding TDF domain**	**Intervention function (Behaviour Change Wheel)**	**Behaviour Change Techniques**	**Proposed operationalisation of selected intervention components**	**Intervention priority group**
Need for sufficient, frequent, consistent psychosocial and nutrition-focused support The negative impacts of employment situation/setting and medical conditions/life circumstances	Environmental context and resources	Environmental restructuring Modelling Restrictions	**Social support (practical)** [a] **Prompts/cues** [a] Remove aversive stimulus Restructuring the physical environment Restructuring the social environment Avoidance/reducing exposure to cues for the behaviour Adding objects to the environment	Offering psychological/ nutrition-focused programs to help patients getting engaged in the process of dietary behaviour change Setting alarms reminders (e.g., on phones or using meal-planning apps) to help them stay on track for recommended dietary modifications Preparing pre-portioned, nutritious meals and snacks in advance and store them in easy-to-grab containers in their sight as a visual cue to choose healthier options when cravings arise	Service level Patients undergoing MBS
Need for adapting to the new lifestyle Lack of self-regulation/ self-discipline	Behavioural regulation	Restrictions Persuasion Incentivisation Coercion Enablement	**Problem solving** [a] **Self-monitoring of behaviour** [a] Information about antecedents **Behaviour substitution** [a] **Reduce negative emotions** [a] Conserving mental	Offering programs to helping patients develop and sustain new dietary strategies (e.g., focusing on one issue at a time by setting incremental goals) Utilising self- monitoring tools (e.g., food journaling applications)	Service level Patients undergoing MBS

			resources		
Negative emotions Eating as a tool to overcome negative emotions vs. eating in response to biological triggers	Emotions	Persuasion	**Reduce negative emotions** [a]	Offering psychosocial programs including stress management techniques to reduce emotional eating, e.g., mindfulness-based stress reduction, cognitive behavioural therapy, emotional regulation skills training, distraction techniques	Service level
Impact of surgery-induced food intolerance or taste change Extent of realistic expectations from surgery	Beliefs about consequences	Education Modelling	Information about health consequences Salience of consequences Information about social and environmental consequences Anticipated regret Information about emotional consequences Pros and cons Comparative imagining of future outcomes Material incentive (behaviour) Incentive (outcome)	Providing information on the potential extent of surgery-induced food intolerances and taste change Offering strategies to overcome the surgery-induced food intolerances and physiological side effects of surgery (e.g, avoiding drinking with meals) Offering preoperative counselling sessions to help patients develop realistic expectations for surgery	Service level

			Reward (outcome)		
Impact of family and friends Support from social/group sessions Eating in social events	Social influences	Education Enablement Modelling	**Social support (unspecified)[a]** **Social support (practical)[a]** Social comparison Information about others' approval Social reward	Offering family sessions to help reduce stigma, and finding family-scale solutions for patients issues Social media campaign including blogs and videos of patients undergoing MBS discussing their experiences. This could include 'influencers' or celebrities. Offering peer support groups for patients, including facilitated discussion about postoperative dietary experiences for example having patients talk to each other about their experience issues, practising group-based problem solving, and sharing of advice and positive experiences	Communication/ Patients undergoing MBS

Abbreviations: Metabolic Bariatric Surgery, MBS

[a] Common BCTs reported in the review of nutrition-focused interventions for patients undergoing MBS

Discussion

We applied a systematic, theory-informed, and replicable approach to identify barriers and enablers associated with dietary behaviour modification after MBS. The combined content and framework analysis identified five key TDF domains based on frequency, elaboration, and expressed importance including: 'Environmental Context and Resources'; 'Behavioural Regulation'; 'Emotions'; 'Beliefs about Consequences'; and 'Social Influences'. Interventions that address these domains via certain BCTs including social support, problem-solving, reducing negative emotions might be more likely to increase the chance of engaging patients in the process of improving dietary behaviours and practice.

The post-operative period is a critical time to change health behaviours,[51] yet many patients find it a challenge to modify their health behaviours, specifically dietary behaviours. In such a context, adjunct nutrition-focused behaviour change interventions may create momentum favouring patients' engagement and receptivity toward persistent maintenance behaviours.[46] However, there is minimal and conflicting evidence around nutrition in MBS care leading to a lack of a solid basis for tailored adjunct nutrition-focused behaviour change interventions. It has been suggested that these heterogeneous and modest findings might due to the fact that the interventions have been ineffectively developed and tested, meaning that they are unable to address the underlying factors influencing why people behave in certain ways.[59]

Implications for practice

Based on the findings from the thematic synthesis, key recommendations to facilitate positive behaviour change include: 1) restructure patients' environment; 2) assist patients in managing eating behaviours; 3) address emotional eating; 4) prepare patients for realistic expectations regarding postoperative outcomes; and 5) increase a sense of social support.

Restructure patients' environment

The initial approach would be delivering multidisciplinary programs with a focus on getting individualised practical support from the healthcare system to address the nutritional and psychological needs of patients. Utilising self-access e-Health methods could be a preferred

mode of delivery to address accessibility limitations, providing consistent, and personalised nutrition-focused behaviour change interventions.[82] At an individual level, prompts and cues that stimulate healthier eating behaviours, such as setting reminders for meal planning and keeping prepackaged foods readily available could be implemented.[112]

Assist patients in managing eating behaviours

MBS requires patients to discipline their lives to engage in positive health behaviours and establish new post-operative dietary habits. Problem-solving, self-monitoring, and behaviour substitution are techniques that help them develop and sustain new dietary habits. Evidence has demonstrated the effectiveness of involving patients in cognitive restructuring, defining strategies for healthier eating, setting incremental goals, and providing tools to aid in self-monitoring.[101,103]

Address emotional eating

Many patients experience the challenge of turning to food as a tool to comfort themselves during emotional challenges. Thus, they need support to address the psychosocial aspects of eating via negative emotion-reducing techniques helping them to be cognisant of physical signs of hunger. Some examples are mindfulness-based stress reduction strategies, cognitive behavioural therapy, emotional regulation skills, and distraction techniques.[107,111]

Prepare patients for having realistic expectations regarding postoperative outcomes

It is pivotal for patients to have a rational understanding of the post-MBS outcomes. This can be achieved through information-giving on the global rates of MBS success, mechanisms of action for MBS, and the role of patients in maximising benefits from MBS. Setting up counselling sessions can help patients draw a realistic personalised picture of their post-operative journey.[98,101]

Increase sense of social support

Positive social interactions would be a source of support aiding patients to navigate dietary change. This highlights the importance of involving close family members in the MBS care journey and channeling their support toward patients through reducing stigma. Additionally,

including patients in social groups, rather than individual sessions, might be beneficial. This can be done via group intervention sessions, peer support groups, and social media campaigns including blogs and videos of patients undergoing MBS. [102,109]

The current review did not explore disparities in barriers and enablers based on the type of MBS, timing of the assessment as related to surgery, or demographic diversities (e.g., sex, ethnicity, economic status, etc.). This is notably due to the inconsistency between studies in terms of the characteristics of their included populations and the lack of reporting barriers/enablers specifically for different categories of patients. Therefore, recommendations on how barriers/enablers vary according to demographics or how interventions might be tailored accordingly could not be evaluated. Finally, the included studies predominantly identified barriers/enablers from the perspective of the patients rather than the perspective of the organisations or HCPs. However, HCPs might also face barriers/enablers to supporting patients to change their post-operative diet.

Strengths and limitations

One strength of this review is applying a theoretical framework (i.e., the TDF) which is linked to two complementary frameworks including the Behaviour Change Wheel [61] and the Behaviour Change Technique (BCT) Taxonomy [65], guiding us to systematically progress from understanding what is driving the behaviour to designing more targeted strategies to change the behaviour and therefore linking barriers to solutions. Furthermore, another strength of this study is applying the combination of deductive coding (informed by a theoretical framework), and inductive analysis (to allow for more granular content themes). We were also able to code all extracted data from the 32 studies into theoretical domains, thus demonstrating that the framework provides comprehensive coverage of barriers and enablers.

This review also had some limitations. We extracted and analysed the data that were reported, analysed, and interpreted by the study authors. In this context, authors may have selectively reported findings on perceived barriers/enablers that were more prevalent, interesting, or had a better fit with the stated research question. As a result, it is possible that our dataset may have been biased. Another limitation is that TDF does not specify relationships between domains, hence the likely strength of the direct impact of influences on behaviour is not known.

Conclusion

Post-MBS dietary behaviour change is influenced by a complex set of interacting individual-level, socio-cultural, and environmental factors. Interventions to increase patients' engagement in dietary behaviour change should target these factors (barriers and enablers), for example, focusing on restructuring patients' environment, assisting patients in managing eating behaviours, addressing emotional eating, preparing patients for realistic expectations regarding post-operative outcomes, and increasing a sense of social support. Future research should identify which domains are most important for subgroups of people undergoing MBS.

CHAPTER 5: Conclusion

Summary of Findings and Thesis Implications

The work in this thesis established some elements of the basic behavioural science that need to be considered when designing and developing future implementable and effective nutrition-focused behavioural interventions adjunct to MBS. The research was conducted in three key steps: 1) assessing the quality of reporting in currently published nutrition-focused behavioural interventions; 2) describing the BCTs of current interventions; and 3) exploring the barriers and enablers to modifying post-operative dietary behaviours as perceived by patients.

The findings revealed significant gaps in the reporting of essential elements of interventions. Inconsistent reporting according to the TIDieR checklist highlighted major underreported areas, particularly in detailing intervention materials and procedures, explaining how interventions were personalised, and describing modifications made to the intervention during the course of the study. A comparison of reporting quality before and after the release of the TIDieR checklist demonstrated no improvement in the quality of reporting. This suggests that researchers may have undervalued the importance of adhering to a standard for reporting essential intervention details and/or TIDieR may be underrepresented as a methodological tool. The assessment of adherence to the CONSORT-NPT checklist demonstrated that studies receiving industrial funding and those recorded in a trial registry were positively correlated with better reporting quality. This highlights the importance of setting external requirements for researchers to provide adequate information to improve the transparency and replicability of interventions. To build better interventions in the future, these findings underscore the necessity of integrating rigorous reporting standards from the outset of intervention design. By ensuring that the essential intervention components are clearly documented, researchers can enhance replicability and build a stronger evidence base.[73] For example, when an intervention with a high positive impact experiment fails to clearly report what was delivered,[117] readers struggle to interpret what active elements specifically drove the positive change. Furthermore, promoting the widespread use of tools like TIDieR and prioritising adherence to reporting standards by funding bodies and journals could lead to more consistent, high-quality reporting.[73] This will not only improve the

transparency of interventions but also contribute to the development of more tailored and effective behavioural interventions that can be replicated.[217]

The study of intervention components revealed wide variation in the frequency of BCTs reported to be used, with some interventions reported employing up to 12 BCTs, while others reported only using one, and some did not report using any. The most commonly reported BCTs were '4.1 Instruction on how to perform a behaviour,' '2.3 Self-monitoring of behaviour,' '1.1 Goal setting (behaviour),' '1.2 Problem-solving,' '3.1 Social support (unspecified),' and '1.4 Action planning'. However, the interventions with higher impact on weight outcomes reported using BCTs of '2.1 Monitoring of behaviour by others without feedback' and '4.2 Information about antecedents.' This list of BCTs provides valuable insights into techniques that may be worth testing in future interventions and should be studied more rigorously to further understand their effectiveness in clinical practice.

A central finding was that none of the studies, except for one that reported BCT groupings, utilised the BCTTv1 (the most up-to-date tool at the time) to explain the content of interventions. This represents a significant issue for the replication of interventions and for understanding which BCTs are actively driving behaviour change and contributing to the outcomes. It suggests that the time and resources invested in a large body of interventions cannot adequately inform future research or clinical practice because the details of what was delivered and how patients were engaged in the behaviour change process are unclear. To address these gaps, future intervention development should prioritise the use of the most up-to-date frameworks like the BCTO and the BCIO.[70,71] By leveraging BCTO and BCIO, researchers can move beyond simply listing techniques and instead focus on how these techniques interact within interventions and influence outcomes. This approach will not only enhance the replicability of studies but also improve the precision with which interventions are designed and tested. Incorporating these ontologies will allow for a more standardised language, enabling clearer communication of intervention components and their intended mechanisms of action, which is essential for building a strong evidence base that can inform clinical practice.[70,71]

The analysis of barriers and enablers to postoperative dietary modification identified five key domains influencing dietary change: 'Environmental context and resources,' 'Behavioural

regulation,' 'Emotions,' 'Beliefs about consequences,' and 'Social influences'. Barriers were more prevalent than enablers, with patients frequently reporting challenges such as inconsistent healthcare support, financial constraints, and emotional struggles (e.g., stress and shame). Social influences, such as family and peer pressure, played a significant role, sometimes acting as both a barrier and an enabler. On the positive side, patients highlighted the benefits of self-monitoring and habit formation as key enablers of dietary behaviour change. Consistent with the most common BCTs reported in the second paper, potential strategies for changing postoperative dietary behaviour include '3.1 Social support', '1.2 Problem-solving', '1.1 Goal setting', and '2.3 Self-monitoring of behaviour'. To build better interventions future efforts should focus on addressing key barriers and promoting enablers while integrating recommended BCTs.

This work lays the initial groundwork for the design and development of nutrition-focused behavioural interventions by exploring "basic behavioural science" within the field. The three studies conducted in this thesis examined various aspects of basic behavioural science in line with the IBTN-ORBIT model. The findings reveal that while there is substantial evidence of interventions with some positive impacts on post-operative health and weight outcomes, a significant gap remains in understanding the specific components delivered within these interventions. This gap hinders progress to the next phase of the IBTN-ORBIT model and underscores the need for a deeper understanding and application of the basic behavioural sciences in the development of interventions. Moving forward, the design of interventions should be anchored in a structured framework, aimed at addressing the underlying factors of health behaviours while enhancing the quality of reporting, both in terms of intervention methodology and the identification of BCTs.

There was an imbalance in the geographic distribution of studies included in the reviews. As observed in studies 1 and 2 approximately 89% of the interventions were conducted in high-income Western countries (the USA, European countries, England, Australia, New Zealand, and Canada), while only 11% took place in low- to middle-income Asian and North African countries (Iran, Egypt, India), according to World Bank's economic classification.[218] Study 3 revealed a similar trend, with 87.5% of studies conducted in the same list of high-income Western countries, and only 12.5% in Asia (China, Saudi Arabia, Taiwan) and South America (Brazil). This distribution may reflect variations in resource availability and healthcare

infrastructure, which in turn impact research priorities across different regions. These disparities raise significant concerns about the generalisability of the findings, especially in contexts where differences exist between countries, such as varying eligibility criteria for MBS between races,[144] the content of usual care in different health systems,[219] different socio-economic characteristics of target populations, and varied specific cultural dietary practices across nations.[220] This situation underscores the importance of diverse research and global collaboration to enhance the inclusivity and generalisability of research findings. Although we did not perform any formal analysis to compare the results for interventions from each dichotomy, there was a balance between the studies in terms of: 1) the quality of reporting according to TIDieR and CONSORT checklists as the underreported items of checklists were distributed between all studies regardless of interventions location; 2) the quantity and quality of BCT reporting had similar pattern among all interventions; and 3) the domain distribution of barriers/enablers reported in both groups of publications had overlap as there were studies from both categories in each domain. This highlights that despite the importance of considering the profile of the countries, our findings seem to be less impacted by this dichotomy. It is also crucial to emphasise that poor reporting quality remains a universal issue. Therefore, authors from both groups of countries can benefit from adopting reporting tools to improve transparency and facilitate the replication of findings in diverse settings, which enhances the transferability of research into clinical practice by ensuring findings are robust and adaptable across different healthcare settings.

One significant layer of discussion to the findings is the point that there is a predominance of females in the studies (an average of 76% and 72% of participants in Study 2 and 3, respectively) which raises the issue of sex differences for our findings in terms of the active BCT component of interventions and barriers/enablers to dietary change. This proportion is consistent with global demographics of the population undergoing MBS, showing an overall female proportion of patients of 73.7% (95% CI: 73.5–73.9%).[221] The prevalence of severe obesity varies between males and females across countries and races. However, in most countries, it is predominantly females who are living with severe obesity.[2] It's important to consider this disproportionate distribution in the context of sex-specific social, psychological, and physiological aspects of obesity, for example, different sexes are impacted differently by weight stigma, emotional eating, and adiposity distribution.[222-224] These insights underscore the importance of sex-specific interventions, or considering how different sex categories might be influenced by interventions,

which could potentially enhance the effectiveness of obesity treatments.[225] For example, women are often more affected by the social and psychological aspects of obesity. They might benefit more from interventions that include emotional and social support, as they are more likely to experience weight-related stigma and psychological challenges that can impact treatment adherence. Men, on the other hand, may respond better to interventions focusing on metabolic health improvements and lean body mass retention, as they typically carry more visceral fat, which is closely linked to metabolic health risks.[222,226] However, in the context of our findings, a significant gap remains in how the authors of the included studies report results based on sex. Though the majority of the target population of the studies is composed of females, the lack of results reported separately for different sexes hinders our ability to fully understand the differential impacts of interventions across sex groups. In such a context, our findings in terms of the active BCT components and barriers and enablers of dietary change after MBS would be more generalisable among a predominantly female group of patients. Future studies should aim to report findings disaggregated by sex to better assess the effectiveness of tailored interventions and identify specific barriers faced by different groups.

Another important aspect to consider when interpreting the findings is that MBS creates a complex and unique situation in which patients rapidly undergo profound changes in physiological and psychological aspects of weight management and dietary behaviours, necessitating tailored intervention strategies.[40] MBS significantly alters gut hormones and satiety signals, impacting eating behaviours and dietary adherence.[227] Furthermore, the psychological shifts experienced by patients undergoing MBS, including changes in their relationships with food and body image, require interventions that explicitly address these issues to ensure effectiveness and sustainability.[228] Consequently, designing and developing a behavioural intervention for such a context must be specifically nuanced. In this work, we found that the most important domains for addressing barriers to post-operative dietary change refer to environmental context and resources, aspects of behavioural regulation, and emotions. The suggested BCTs to address these domains according to the overlapping results of Studies 2 and 3 include social support, problem-solving, and self-monitoring of behaviour. In the field of obesity management, previous analyses have investigated the most efficacious BCTs to improve weight-related behaviours (specifically for physical activity and eating behaviour),[69,165] finding that intervention strategies such as goal setting, self-monitoring of behaviour, providing information

on the consequences of behaviour, prompting practice, and general communication skills training provided the greatest benefits. These findings highlight the importance of BCTs like self-monitoring and goal setting, which are commonly used in behaviour change interventions and can be applied within the MBS context. They also indicate that additional, tailored elements may be necessary to address the specific challenges patients face following MBS. From a broader perspective, our findings – specifically regarding the issue of intervention reporting can still be applied to the design, development, and reporting of other health behaviour change contexts, underscoring the importance of improving the quality of reporting and utilising shared terminology (i.e., BCTO) to explain interventions.

Future Directions

Dietary modification is a complex behaviour influenced by a combination of individual, environmental, and psychosocial factors. Engaging patients in meaningful behaviour change interventions requires a deep understanding of the specific aspects of the target behaviour (i.e., identifying what needs to change) and determining the key functions of a potential intervention. Behavioural interventions often involve multiple interacting components, and a lack of detailed reporting on these components can hinder understanding of what drives their effectiveness. This thesis underscored the need for better engagement strategies in nutrition-focused behavioural interventions for patients undergoing MBS and provided both potential intervention materials for future testing and methodological guidance on designing and reporting interventions.

Building on these findings, future research should focus on the systematic development of nutrition-focused interventions tailored to patients' needs, following the IBTN-ORBIT model. The next phase will involve proof-of-concept studies to rigorously test core intervention components in real-world settings. These studies should validate key BCTs, such as goal setting, self-monitoring, and problem-solving, ensuring they effectively address the barriers and enablers identified in this research (e.g., environmental context and social influences) and lead to improved health outcomes. In addition, employing methodologies like the Multiphase Optimisation Strategy (MOST) could help optimise intervention components and facilitates the systematic testing of different combinations of BCTs to determine the most effective and feasible configurations before progressing to larger trials.[229,230]

After validating core components through proof-of-concept studies and optimising them using approaches like MOST, the next step would be to conduct larger-scale efficacy trials (Phase III of the IBTN-ORBIT model). These trials will test the fully developed intervention across multiple sites and patient populations, ensuring effectiveness and replicability. Beyond research, the findings from these rigorous trials should be used to influence and update clinical practice guidelines, ensuring that evidence-based, nutrition-focused behavioural interventions become a standard component of MBS care. By aligning clinical practice with research outputs, we can improve long-term dietary outcomes for patients undergoing MBS and contribute to more effective, sustainable healthcare practices.

Clinical Implications

The current clinical practice guidelines for dietary interventions in patients undergoing MBS provide specific recommendations regarding target dietary behaviours to improve postoperative health and weight outcomes. However, they lack precision on how to actively involve patients in the behaviour change process.[56] This missing piece in the current guidelines can be attributed to several factors. First is the inconsistent reporting of interventions. Many studies fail to report detailed descriptions of the interventions used, including the BCTs and other components and the rationale behind them. Without standardised reporting, it is difficult to compare interventions or replicate successful strategies, limiting the ability to generate clear recommendations for clinical practice.[231] Second factor is the variability in study design and intervention components. As presented in this thesis, the studies published on MBS often vary widely in terms of design, intervention components, and outcome measures. When there is a lack of clarity and poor intervention reporting this heterogeneity makes it difficult to synthesise evidence and draw clear, consistent conclusions. As a result, it becomes challenging to formulate standardised clinical guidelines that could be tailored to the specific needs of target populations.[231,232] The third factor is the limited focus on behavioural science infrastructure. Despite the significant increase in publications on MBS in the past decade,[233] research has not consistently integrated behavioural science frameworks, which are crucial for understanding and influencing health-related behaviours.[61] Without a solid theoretical foundation, interventions may lack the necessary depth and structure to be effective, further hindering the ability to translate research into practical guidelines.[231] Last is insufficient replication and validation. Research in this area is rarely driven

by scientific replication, which is essential for validating findings and ensuring their applicability in real-world settings. In such context, the reliability of the existing evidence remains in question, preventing the establishment of firm guidelines.[234]

Strengths and Limitations

The major strength of this thesis lies in its comprehensive and multifaceted approach to addressing nutrition-focused behavioural interventions adjunct to MBS, framed within an intervention development framework (IBTN-ORBIT model), ensuring that the development process is systematic rather than arbitrary. By systematically exploring intervention reporting quality, components, and patient perceptions, the thesis offers a holistic understanding that integrates both theoretical foundations and practical implications. The use of established behavioural science frameworks, such as the BCTTv1 and the TDF, adds rigour and credibility to the research, grounding it in recognised theories.[235] Additionally, the mixed-methods approach, combining quantitative and qualitative analyses, provides a richer, more nuanced understanding of the data. This methodological diversity allows for a balanced examination of both statistical outcomes and the lived experiences of patients. Furthermore, the focus on systematic reviews of randomised controlled trials (RCTs) ensures that the evidence base is robust, making significant contributions to future research and clinical practice by offering insights into the development of more effective and scalable interventions. [236]

In terms of limitations, the thesis does not include long-term follow-up data, which is crucial for understanding the sustainability of behaviour change post-MBS. Additionally, there is an underrepresentation of replication studies, which are essential for validating findings and ensuring their applicability across diverse clinical settings.

Concluding Remarks

This thesis provided critical insights into the complexities of nutritional management in bariatric care and lays the groundwork for advancing the design and development of future nutrition-focused interventions. Through a systematic exploration of the current literature and empirical analysis, this work identified significant gaps in the quality of intervention reporting, components, and implementation, highlighting the need for standardised frameworks like IBTN-

ORBIT, TIDieR, BCTO, and BCIO to ensure structured, transparent and replicable studies in future research.

The research not only emphasised the importance of BCTs tailored to individual patient needs but also demonstrated that addressing the barriers and enablers of dietary modification is key to improving post-surgical outcomes. By leveraging established behavioural science frameworks, this thesis advances our understanding of how to build effective and sustainable interventions to prevent weight regain and enhance the overall success of MBS.

Ultimately, this work contributes to bridging the gap between theory and practice in MBS care, providing a foundation for future research that aims to develop evidence-based, personalised nutrition interventions. The insights generated here have the potential to guide the creation of more targeted, effective strategies, ultimately improving the long-term health outcomes for individuals undergoing MBS and shaping clinical guidelines in the field.

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Appendices

Appendix 1a: Primary analysis performed on a longitudinal data set

Title: Who Gains the Most Quality-of-Life Benefits from Metabolic and Bariatric Surgery: Findings from The Prospective REBORN Cohort Study

Journal: Surgery for Obesity and Related Diseases

Publication status: Published

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Abstract

Background: Prioritizing patients for metabolic and bariatric surgery (MBS) based on their potential postoperative benefits is essential.

Objectives: To examine changes in quality of life (QoL) during the initial postoperative year among patients with diverse eligibility statuses and determine which group experiences greater benefits.

Setting: Centre intégré universitaire de santé et de services sociaux du Nord-de-l'Île-de-Montréal (CIUSSS-NIM), Canada.

Methods: We categorised patients into three groups based on obesity class and the presence of comorbidities: Group 1 (obesity class II without comorbidities, n=28); Group 2 (obesity class II with comorbidities, n=36); and Group 3 (obesity class III, n=460). QoL (Short-Form QoL questionnaire [SF-12]) and anthropometrics were measured at 6 months before, and 6 and 12 months after surgery.

Results: Repeated measures mixed models revealed a significant main effect of time (p<0.001) and an interaction between time and group for the physical component of QoL (p=0.007). These indicated consistent improvements across time in all groups, with the greatest benefits seen in Group 3 relative to Group 1. There were no interactions between time and group for the mental (MCS) components of QoL (p=0.402). There were significant interaction effects for weight and BMI (p's<0.001), with Group 3 loosing more weight than Groups 1 or 2.

Conclusion: All groups that underwent MBS had improvements in the physical aspects of QoL and weight over time, even those who have traditionally not be considered eligible for MBS (i.e., Group 1). This provides a starting point to explore the importance of not excluding patients due to their weight and comorbidity status and setting comprehensive eligibility criteria encompassing all patients who might benefit from MBS, beyond just weight loss.

Keywords: Obesity; metabolic and bariatric surgery; quality of life, postoperative outcomes; eligibility

1. Introduction

Obesity prevalence has steadily increased around the world.[1] In Canada, there has been a threefold rise in obesity rates over the past 3 decades, with a fourfold growth in severe obesity (Class III obesity), impacting nearly 2 million Canadian adults.[2] The most recent American Society of Metabolic and Bariatric Surgery (ASMBS) and International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) guidelines recommend metabolic and bariatric surgery (MBS) for individuals with a body mass index (BMI) >35 kg/m^2 (class II and III obesity), regardless of presence, absence, or severity of co-morbidities and state that MBS should be considered for individuals with metabolic disease and BMI of 30-34.9 kg/m2 (class I obesity).[3] The number of MBSs in Canada has increased roughly fourfold in the past decades, with continued outstanding growth during recent years.[4]

Recently, decisions regarding who should undergo MBS are increasingly guided by the ASMBS/IFSO 2022 guidelines.[3] However, clinical practice in Canada and insurance coverage in the US still primarily adheres to the criteria established during the National Institutes of Health (NIH) consensus conference in 1991.[5] The NIH criteria are less inclusive because patients who have obesity class II (BMI of 35-39.9 kg/m^2) without comorbidities or who have obesity class I are deemed ineligible for MBS. This might significantly impact the comprehensiveness of treatment for patients who could benefit from it, especially in countries where clinical decisions are mostly driven by public health policies like in Canada.[6] Recently, the inclusion criteria for MBS have been challenged as they are primarily based on the preoperative BMI, which is not an inclusive factor determining who might benefit from MBS.[7,8] For example, under certain clinical circumstances, such as where multiple attempts at non-surgical weight reduction interventions have proven unsuccessful or when there's a possibility of enhancing an individual's quality of life (QoL), some individuals who might conventionally be considered ineligible have undergone MBS. However, the outcomes of such cases have not been extensively documented.[9-12] The controversial literature leads to the continuing debate about what pre-surgical factors and/or outcomes should be considered when deciding who should have access to MBS.[13,14] Optimal interventions for obesity are expected to enhance not only clinical outcomes like body weight and biochemical measures, but also improve aspects related to physical and psychosocial health, i.e., QoL.[15]

Obesity negatively impacts several components of QoL, including poorer physical functioning, such as loss of vitality, physical pain, and poorer health perceptions, as well as reduced psychological functioning and social well-being, including greater levels of depression, stigmatisation, and discrimination, worse perceptions of body image, and diminished social interactions.[16] QoL reflects an individual's own assessment of well-being and generally reflects physical and mental health status, including social relationships, and environmental and economic factors.[17]

QoL is also suggested as one component of the core outcome set for MBS to inform clinical decision-making.[18] In such a context, drawing comparisons between individuals after MBS in terms of both weight and non-weight health-related outcomes (e.g., QoL) might clarify the question of who might benefit from the surgical procedure.

Previous studies have shown that all obesity classes, with and without metabolic conditions, impact physical and/or mental QoL, but to different extents.[19] However, it is unclear how MBS-induced changes in QoL vary across obesity classes and comorbidity status.[20] As such, the aim of this study was to explore MBS-induced changes in both QoL and weight over the first postoperative year across different obesity and comorbidity statuses.

1. Materials & Methods

1.1. Study design and participants

This study was a sub-analysis of an ongoing prospective cohort called the REsearch on Bariatric care for Obesity tReatmeNt (REBORN) study. The reporting of this paper follows the STROBE statement.[21] The REBORN study recruited adult individuals undergoing a first MBS at the Centre intégré universitaire de santé et de services sociaux du Nord-de-l'Île-de- Montréal (CIUSSS-NIM)) in Montréal, Canada. The Research Ethics Board Committee of the CIUSSS-NIM approved the study (REB#: 2015-1176) and informed consent was sought by a research assistant at the 6-month pre-operative visit. Consenting individuals provided baseline measures at the time of recruitment. Additional measures were captured on the day of surgery, where most participants underwent sleeve gastrectomy (SG) or roux-en-Y gastric bypass (RYGB), and 6 and 12 months after surgery (see **Figure 1**). For the current analyses, individuals with missing

baseline data for weight, height, and comorbidity status (required to generate the independent variable of eligibility status), and QoL measures (dependent variables) were excluded.

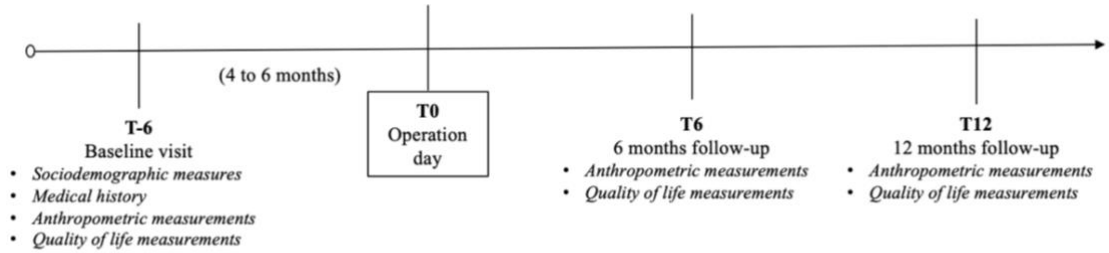


Figure 1. Timeline of the study

T-6; 6 months preoperative, T0; operation day, T6; 6 months postoperative, T12; 12 months postoperative

1.2.Measures

The full list of REBORN measures can be found on the project's website (mentioned above). For the current analysis, the following data was collected:

Demographics: We collected demographic information, including age, sex, ethnicity, marital status, socioeconomic status (years of education and income), and self-reported height and weight.

Medical History: Self-reported details of current and lifetime history of obesity-related comorbidities were collected. All self-reported clinical data was verified by hospital medical record review.

Quality of life: QoL was assessed using the Short-Form Quality of Life questionnaire (SF-12 health questionnaire), an abridged version of the 36-question SF-36 Health survey (SF-36). The SF-12 is a multipurpose generic measure of health status with sufficient evidence for its internal consistency, reliability and validity for use in large longitudinal surveys of general and specific populations.[22] It has also been utilised in previous studies of patients undergoing MBS.[23] The SF-12 includes eight domains measuring both functioning and well-being through 12 questions: physical functioning (PF); role limitations due to physical health problems (RP); bodily pain

(BP); general health (GH); vitality (VT - energy/fatigue); social functioning (SF); role limitations due to emotional problems (RE); and mental health (MH - psychological distress and psychological well-being). The eight domains can be further reduced to two subscales– a physical component summary score (PCS) (including PF, RP, BP, and GH) and a mental component summary score (MCS) (including VT, SF, RE, and MH). Factor analysis was used to accomplish this reduction, using factor scores derived from US general population survey data.

Anthropometric measures: Weight was measured on a digital medical scale, and height was measured with a stadiometer, as well as being self-reported before measurement. Measurements were taken at baseline and 6 months post-surgery, while only self-reported measurements were captured at 12 months. A sensitivity analysis conducted to validate the accuracy of these self-reported measurements in our cohort showed sufficient agreement between the self-reported and the measured anthropometric data.[24] Thus, for the purpose of this study, self-reported anthropometrics from all time points were used. Percent excess weight loss (EWL) was also calculated as follows: %EWL= [(pre-operation weight - post-operation weight)/ (pre-operation weight - ideal body weight)]×100. Ideal body weight was considered as the weight for a BMI of 25 kg/m^2.[25] Total body weight loss (TBWL%) was calculated by subtracting the pre-operative weight from the postoperative body weight at study time points.

1.3. Categorization of patients

Patients were categorized into three groups based on the class of obesity and co-existing comorbidities at baseline (**Table 1**). To receive a score of positive for comorbidities, patients had to report having at least one of the following conditions: cardiovascular disease (e.g. stroke/ transient ischemic attack (TIA), heart attack, heart failure, arrhythmias, coronary heart disease, myocardial ischemia, angina, etc.); Type II diabetes mellitus; hypertension; dyslipidemia; sleep apnea; gastroesophageal reflux diseases; non-alcoholic fatty liver diseases; polycystic ovarian syndrome; and arthro-skeletal disorders (e.g., arthritis, arthrosis). Since the eligible BMI range for receiving MBS encompasses a wide range starting from 30 kg/m^2 to above, the eligible patients might experience varied clinical and psychosocial conditions because of their baseline body weight, leading to different patterns of postoperative health and QoL outcomes.[26] Thus, to

homogeneously group the patients, we decided to add a further layer to the stratification and divide the eligible patients based on their class of obesity and comorbidity status.

Table 1. Groups eligible to undergo MBS.

Groups	Conditions	
	Class of Obesity	Comorbidity
Group 1	Class II (35≤BMI<40)	No
	Class I (30≤BMI<35)	Yes
Group 2	Class II (35≤BMI<40)	Yes
Group 3	Class III (BMI≥40)	Yes/No

BMI; body mass index

1.4. Statistical analysis

Descriptive statistical analyses were conducted for the overall sample and the three groups separately. Continuous variables were presented as means ± standard deviation (SD) and dichotomous/categorical variables as proportions. Where normality or homogeneity of variances was verified, we utilised a classical one-way ANOVA, otherwise, the results of non-parametric tests (Kruskal-Wallis) were reported. We used self-reported weight from baseline and 6 months post-operation, to impute self-report weight at 12 months post-surgery. Repeated measures linear mixed models were used for all outcomes, with the independent variables being the groups and time. The models were adjusted for a-priori-defined covariates (due to their potential to impact the outcomes of interest), including age, sex, type of surgery, ethnicity, marital status, education level, income, having undergone another MBS during the 1st year after the initial procedure (all models), baseline BMI and %EWL (for all QoL models). We also ran a variance inflation test between the covariates that had the potential of having collinearity (i.e., BMI and %EWL). Of note, there was no collinearity between the variables meaning that there is no linear relationship or dependency between the covariates (see the Appendix). Statistical analyses were carried out using the R program (4.2.1) with a significance level set for all the analyses was 5%.

1. Results

A total of 1,335 patients were screened for recruitment to the REBORN study, amongst which 613 were found eligible and consented to participate. A total of 99 participants had missing baseline data on their weight and comorbidity status. Thus, the data for 514 participants were included in our analyses (Group 1 n=25, Group 2 n=37, and Group 3 n=452). **Table 2** represents the baseline characteristics of the study sample demonstrating no statistical difference for the demographics between the groups (except weight, BMI, and comorbidities). Participants were predominantly women (78%) with a mean ± SD age of 44.39±11.32 years and a BMI of 48.7±8.4 kg/m^2 at baseline.

Table 2. Baseline characteristics of participants presented as Mean (SD) or n (%)

Variables	Total (n=514)	Group1 (n=25)	Group2 (n=37)	Group3 (n=452)
Age (years)	44.39 (11.32)	42.96 (10.51)	47.73(9.73)	44.2(11.4)
Weight (kg)	135(28.01)	102.22 (11.6) [1]	107.83(13.14) [2]	138.68(27.12) [1,2]
BMI (kg/m^2)	48.59(8.36)	36.38(4.2) [1]	38.21(1.16) [2]	49.98(7.64) [1,2]
Waist circumference (cm)	135(16.22)	116.17 (8.44) [1]	119.27 (11.49) [2]	137.19 (15.49) [1,2]
Proportion Female	401(78)	23(92)	29(78.4)	349(77.2)
Ethnicity				
White	20 (80%)	30 (81.1)	388 (85.8)	438 (85.2)
other	5 (20)	7 (18.9)	64 (14.2)	391(8)
Relationship status				
In relationship	323 (62.8)	14 (56.0)	23 (62.2)	286 (63.3)
Alone	191 (37.2)	11 (44.0)	14 (37.8)	166 (36.7)
Education level				
≤12th grade	191(37.2)	9(36)	17 (45.9)	197 (43.6)
>12th grade	323(62.8)	16(64)	20 (54.1)	255 (56.4)
Income [4]				
≤57,000 CAD	219(42.6)	13(52)	16(43.2)	190(42)
>57,000 CAD	211(41.1)	8(32)	18(48.6)	185(40.9)
Missing	84(16.3)	4(16)	3(8.1)	77(17)
Obesity class				
I	8(1.6)	8(32)	0	0
II	54(10.5)	17(68)	37(100)	0
III	452(87.9)	0(0)	0	425(100)
Comorbidity status				
Yes	374(72.8)	17(68)	0 (0)	123 (27.2)
No	140 (27.2)	8(32)	37(100)	329(72.8)
Surgery type [3]				
SG	461 (89.7)	20 (80)	29 (78.4)	412 (91.2)
RYGB	53 (10.3)	5 (20)	8 (21.6)	40 (8.8)

Values are reported as mean (SD) and n (%) for continuous and categorical variables, respectively. BMI; body mass index, SG; sleeves gastrectomy, RYGB; Roux-en-Y gastric bypass.

[1] *P*- value< 0.001 Group1 vs. Group3
[2] *P*- value< 0.001 Group2 vs. Group3
[3] *P*- value< 0.05, Chi-square test comparing categorical variable between groups
[4] The cut-off presents the average annual income for Canadians between 2017-2021, derived from "*Statistics Canada. Table 11-10-0239-01 Income of individuals by age group, sex and income source, Canada, provinces and selected census metropolitan areas. DOI: https://doi.org/10.25318/1110023901-eng."*

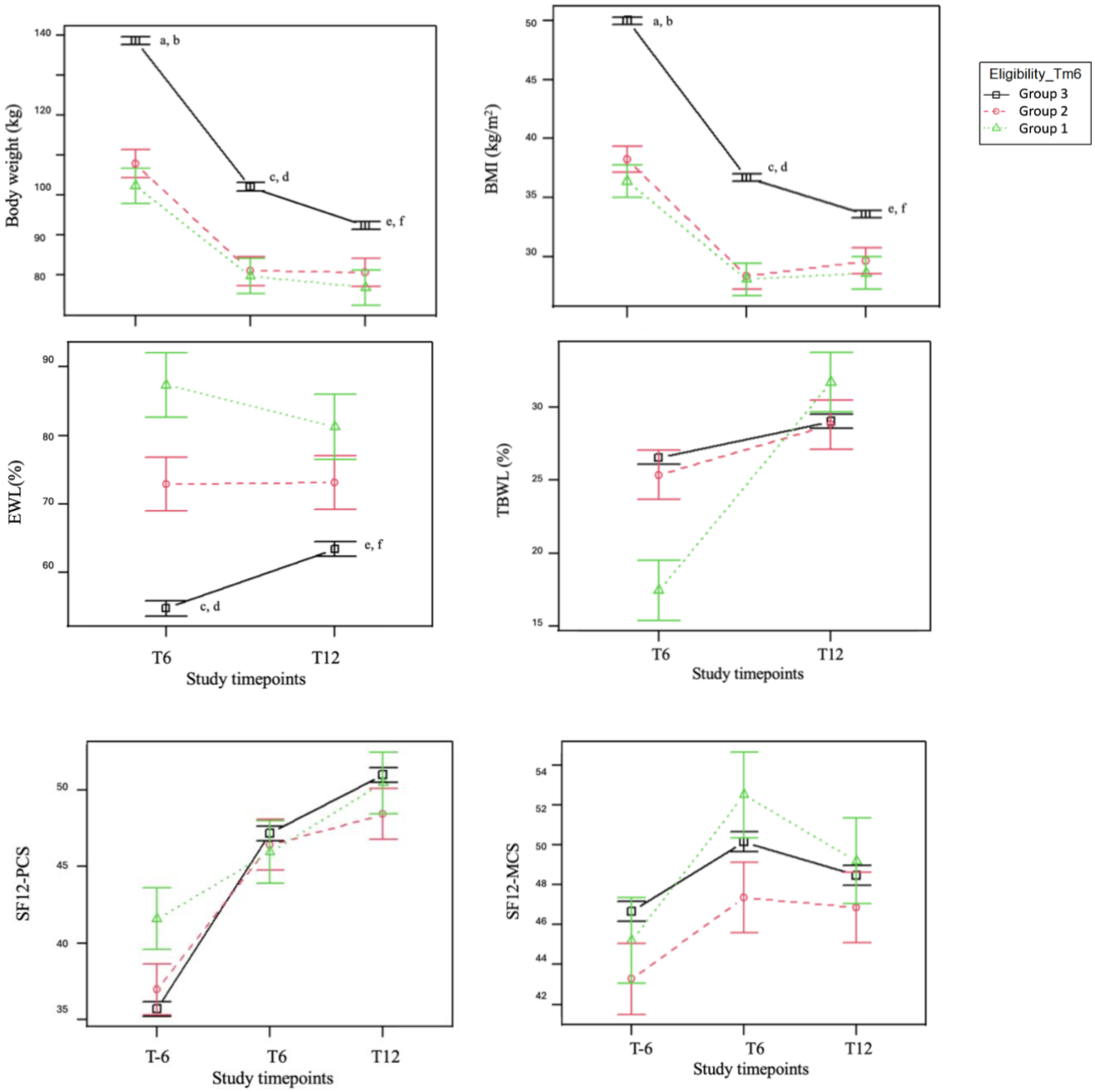
The main and interaction effects being explored are presented in **Table 3** and **Figure 2.** Changes in anthropometric measures and quality of life sub-scales according to the groups across each study time point, along with the post hoc analysis p-values for the main effects are presented in **Table 4**.

Table 3. Main & interaction effects of time and group for weight-related variables and QoL

Variables	Main effect of time		Main effect of group		Time * group interaction	
	Estimate [95%CI]	*P*-value	Estimate [95%CI]	*P*-value	Estimate [95%CI]	*P*-value
Weight (kg)	-9.66 [-14.49, -4.82]	**<0.0001**	26.26 [20.69, 31.84]	**<0.0001**	-6.55 [-9.11, -3.99]	**<0.0001**
BMI (kg/m^2)	-2.6 [-4.27, -0.93]	**0.0022**	10.77 [8.83, 12.7]	**<0.0001**	-2.71 [-3.59, -1.83]	**<0.0001**
EWL (%)	8.18 [2.57, 13.81]	**0.004**	2.54 [-4.6, 9.69]	0.476	-3.97 [-6.94, -0.99]	**0.009**
TBWL (%)	1.97 [-1.02, 4.97]	0.192	2.01 [-1.88, 5.89]	0.314	-64 [-2.28, 0.99]	0.442
SF-12 PCS	4.23 [1.89, 6.58]	**0.0004**	-2.42 [-5.15, 0.31]	0.081	1.69 [0.46, 2.93]	**0.007**
SF-12 MCS	1.99 [-0.55, 4.5]	0.124	0.56 [-2.41, 3.54]	0.721	-0.58 [-1.92, 0.77]	0.396

QoL quality of life, BMI body mass index, EWL excess weight loss, TBWL total body weight loss, PCS Physical component summary, MCS Mental component summary

Figure 2. The changing trajectory in variables and the time by group interactions



BMI body mass index, EWL excess weight loss, PCS Physical component summary, MCS Mental component summary, T-6; 6 months preoperative, T6; 6 months postoperative, T12; 12 months postoperative
a= Significantly different from group 1 at T-6, *p*-value <0.001
b= Significantly different from group 2 at T-6, *p*-value <0.001
c= Significantly different from group 1 at T6, *p*-value <0.001
d= Significantly different from group 2 at T6, *p*-value <0.001
e= Significantly different from group 1 at T12, *p*-value <0.001
f= Significantly different from group 2 at T12, *p*-value <0.001
g= Significantly different from group 1 at T12, *p*-value <0.001

Table 4. Weight-related variables and sub-scales of quality of life over the first postoperative year

Variables	Group	T-6	T6	T12	Post hoc p-values for main effect of time			Post hoc p-values for main effect of group		
					T-6_ T6	T-6_ T12	T6_ T12	G1_G2	G1_G3	G2_ G3
Weight (kg)	Group1	102.22(11.57)	79.65(9.62)	76.77(12.78)	**<0.001**	**<0.001**	0.642	0.762	**<0.001**	**<0.001**
	Group2	107.83(13.14)	80.91(11.54)	80.51(10.61)						
	Group3	138.68(27.12)	102.03(22.0)	92.35(18.29)						
BMI (kg/m^2)	Group1	36.38(4.2)	28.06(2.85)	28.6(4.21)	**<0.001**	**<0.001**	0.984	0.995	**<0.001**	**<0.001**
	Group2	38.21(1.16)	28.33(2.36)	29.62(6.08)						
	Group3	49.98(7.64)	36.69(6.57)	33.58(7.06)						
EWL (%)	Group1	NA	87.37(47.3)	81.23(23.22)	NA	NA	**0.044**	**0.015**	**<0.001**	**0.029**
	Group2	NA	72.89(17.26)	73.13(24.6)						
	Group3	NA	54.82(18.64)	63.44(26.46)						
TBWL(%)	Group1	NA	17.45(29.41)	31.69(9.84)	NA	NA	**0.012**	0.952	0.991	0.915
	Group2	NA	25.34(5.76)	28.79(9.56)						
	Group3	NA	26.53(7.42)	29.01(10.99)						
SF-12 PCS	Group1	41.59(13.33)	45.96(13.72)	50.48(6.58)	**<0.001**	**<0.001**	**0.049**	0.172	0.173	0.983
	Group2	36.97(13.58)	46.44(12.13)	48.44(8.73)						
	Group3	35.69(11.71)	47.19(10.17)	51.02(7.38)						
SF-12 MCS	Group1	45.21(11.43)	52.52(8.82)	49.19(9.54)	**0.035**	0.552	0.087	0.708	0.942	0.208
	Group2	43.27(13.64)	47.36(13.61)	46.86(11.18)						
	Group3	46.67(11.25)	50.16(10.1)	48.47(10.43)						

Values are reported as adjusted mean (SE). BMI body mass index, EWL excess weight loss, TBWL Total body weight loss, PCS Physical component summary, MCS Mental component summary, T-6; 6 months preoperative, T6; 6 months postoperative, T12; 12 months postoperative, NA not applicable, NS non-significant, G1 group1, G2 group2, G3 group3

There were a significant main effect of time and a significant interaction between time and group for SF12-PCS (see **Table 3**). Post hoc analyses revealed that the physical component of the SF-12 improved consistently for all groups overtime. However, the improvements were greatest in Group 3 compared to Group 1 (see **Table 4**). For the mental aspect of QoL of life, we observed no statistically significant differences in the impact of time, group, or their interaction. There was also a significant main effect of time for weight, BMI, and %EWL, with significant reductions in all measures of body weight from pre- to 12 months post-surgery. There were significant interactions between time and group for weight, BMI and %EWL, with those in Group 3 showing the greatest weight loss over time compared to the other two groups.

Discussion

In the present study, our focus was on assessing the change in QoL in a sample of adult patients undergoing MBS. Our approach involved categorising participants based on their obesity and comorbidity status. By doing so, we aimed to explore whether different groups experienced varying benefits from MBS in relation to both QoL and weight-related outcomes.

Our study revealed that the physical component of quality of life improved over time in all groups, from before to 6 and 12 months after the surgery. This suggests that MBS may enhance the physical aspect of quality of life across groups with different classes of obesity and comorbidity status, which was in line with changes in weight-related variables. In contrast, there were no changes in the mental aspect of quality of life. We also observed that the groups exhibited distinct patterns of change in the physical component of QoL, highlighting that the groups benefited differently from MBS which is in line with the weight-related findings. Our findings also indicated significant interactions between time and group for weight, BMI, and %EWL suggesting that the groups experienced different patterns of change in weight outcomes over the course of the study. Notably, Group 3 (class III obesity) demonstrated the most favourable physical QoL and weight outcomes a year after undergoing surgery. The weight effect is likely due to having more excess body weight to lose and the changes in physical QoL may also be related to the reduction in weight translating to a greater potential for mobility.[27] Previous studies demonstrated that in the short-term postoperative period (between 1-2 years), patients experience a meaningful level of weight loss and a feeling of being in control of their body weight. Accordingly, the highest mental health QoL scores approximately coincide with the

nadir weight change in this phase.[28] After this period, mental health QoL scores decline, probably associated with a slowing of weight loss. In our study, patients experienced significant improvements in the physical components of QoL kept increasing in all groups for up to one year, with the mental component having a non-statistically significant increase only in the first 6 months post-op. In agreement with our findings, previous studies also reported more consistent improvements in the physical, rather than mental aspects of QoL after surgery. The peak of improvement in the mental component scores usually occurs in the short term after the surgery (< 1 year), followed by a gradual decline in the medium term (1–5 years).[15]

We showed that all groups of patients benefitted from the surgery regardless of their baseline class of obesity and comorbidity status. This finding is in line with previous studies showing the benefits of MBS beyond just weight in patients defined as being ineligible for surgery. Sjöholm et al.[29] demonstrated that MBS is associated with improved cardiovascular risk factors and prevention of type 2 diabetes up to 15 years post-surgery in all patients regardless of their eligibility status. Ramírez et al. also studied the impacts of preoperative obesity class and demonstrated that all groups had similar improvement in their 12-month post-surgery metabolic profiles, as well as weight loss.[30] These results clearly show that patients who are categorised as ineligible according to the NIH eligibility criteria might also benefit from MBS. Previous studies suggest that higher preoperative BMI is not the only determinant for the consequences of MBS on postoperative obesity-related conditions and mortality.[7,13] In 2014, the International Federation of Surgery for Obesity (IFSO) declared that MBS should not be denied to historically ineligible patients, highlighting that the decision should be based on a comprehensive evaluation of the patient's global health and predicting future disease risk.[31] The most recent international ASMBS/IFSO 2022 guidelines also align with our findings. These guidelines recommend MBS for a significant proportion of individuals living with various levels of obesity and obesity-related comorbidities. This includes patients with obesity class II and higher, those with obesity class I and higher who have type 2 diabetes, and individuals with class I obesity who do not achieve substantial or durable weight loss or improvement in comorbidities using nonsurgical methods. The recommendation is primarily based on evidence indicating that obesity-related conditions can significantly improve, and in some cases, even remit, following the weight loss associated with MBS.[3] This is in line with what we propose which is to include all patients who might benefit from surgery.

The inclusion criteria for MBS need to emphasize factors like obesity burden and the likelihood of positive response to surgery for weight as well as non-weight outcomes and comorbidities.[7,13,29] Besides the cut-offs referring to the normal range for clinical, anthropometric, or biochemical measures and other quantitative health indicators, the current study suggests that health-related QoL could also be a determining criterion. QoL investigates quantitative health measures within the context of individuals' everyday life.[18] Currently, most healthcare professionals and patients are focused almost exclusively on getting as close as possible to patients' ideal body weight and resolution of comorbidities.[20,28] Nevertheless, more than half of the patients will be unable to maintain the weight loss over the longer term.[4] In such a context, QoL assessments would help normalise patients' expectations of the surgery and help them realise that they can significantly improve the quality of their lives without necessarily reaching some idealised body weight. Setting QoL as a critical outcome may also lead to enhanced motivation to make important behavioural changes (e.g., eating healthier foods, becoming more physically active) as a part of improved QoL and not body weight per se.

To our knowledge, this work is the first study on QoL outcomes across varying obesity classes and comorbidities. Where improving observable clinical or physical outcomes may not always reflect how the patients function or feel, QoL as a self-report measure reflects individuals' subjective evaluation and reaction to health or illness.[19] Thus, this assessment can provide a unique patient perspective on the impacts of MBS.[17] In spite of this, the findings of this study should be interpreted in light of some limitations. First, the number of patients was small in Groups 1 and 2, which might impact the power to detect any group by time interactions, increasing the possibility of a Type II error. However, the fact that we were able to detect interactions in the anthropometric measures slightly mitigates this concern. Secondly, our current sample was predominantly female (78%) limiting generalisation to other patient populations. However, this represents the global and national demographics of the MBS population.[6] Thirdly, the SF-12 was not originally designed to measure the QoL domains specific to obesity, as such, it might be relatively insensitive in our population. However, it has been used in other similar studies and, thus, provides us with some comparative capacity.[32] In contrast, in a recent review, Szmulewicz et al. demonstrated that QoL's mental aspect should be captured using specific validated measures of mental health functioning.[18] Thus, the mental subscale in SF-12 could only serve as a proxy for mental health conditions and may not be sensitive to capture impairments in

psychological health, such as body image and social stigma. Therefore, they may not be as sensitive to change in this population as measures developed for people living with obesity.[33] This gap suggests directions for future work to develop an assessment tool that can assess the psychological impact of MBS in a meaningful way and the interaction with weight loss, and weight regain over time. Lastly, our study's short follow-up duration does not allow us to explore the long-term impacts of MBS on QoL measures, such follow-ups in these cohorts is needed to validate our initial findings.

1. Conclusion

In summary, our data indicate that improvements in the physical component of quality of life (QoL) after MBS varies for patients with different preoperative weights and comorbidity statuses, but that all patients did see an improvement across the 1st year post-surgery. This can be a starting point to propose revisions on how to prioritise patients for MBS leading to the appropriate selection with a special focus on the health-related impacts of obesity beyond just weight.[7,13] Further longitudinal studies with longer follow-up duration and larger sample sizes are required.

Acknowledgements

Authors' contributions to manuscript: RY, SLB, KLL designed the study, its conceptualization and methodology. RY conducted research and analyzed data. RY, SLB, KLL, TBP, AMV contributed on writing the paper. SLB had primary responsibility for final content. All authors read and approved the final manuscript.

The REBORN Team includes: Bacon S.L. and Lavoie K.L. (principal investigators); Gautier, A. and Marion, P. (patient investigators); Alberga, A., Denis, R., Garneau, P., Lavigne, G., Pescarus, R., Raymond-Carrier, S., Santosa, S., and Studer, A.S. (co-investigators); and Ben-Porat, T., Delaney, K., Fortin, A., Julien, C., Mercier, L., Woods, R., and Yousef, R (mentees).

Source of support for the work: Funding for data collection was provided by operating grants from the Canadian Institutes of Health Research (CIHR) (PJT-153424 and UD1-170,148). The members of the Montreal Behavioural Medicine Centre are supported by a variety of career and scholarship awards. SLB is supported by the CIHR-Strategy for Patient-Oriented Research (SPOR) initiative through the Mentoring Chair program (SMC-151518) and by the Fonds de

recherche du Québec: Santé (FRQS) through the Chaire de recherche double en Intelligence Artificielle/Santé Numérique ET sciences de la vie program (309811). KLL is supported by a UQAM Research Chair and Canada Research Chair (CRC) in Behavioural Medicine (CRC-2019-00225). RY, TBP, and AMV are supported by FRQS scholarships. The supporting sources had no involvement in the study design, collection, analysis, interpretation of data, writing of the report, or any restrictions regarding the submission of the report for publication.

Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Competing Interests: RY, TBP, AMV have no conflicts of interest to report. Dr. Lavoie has served on the advisory board for ScheringPlough, Takeda, AbbVie, Almirall, Janssen, GSK, Astellas, Novartis, Boehringer Ingelheim (BI), Respiplus and Sojecci Inc. and received sponsorship for investigator-generated research grants from GSK and AbbVie; speaker fees from GSK, Astra-Zeneca, Astellas, Novartis, BI, Takeda, Janssen, AbbVie, Merck, Bayer, Pfzer, Respiplus, X-Facto, and Air Liquide; and support for educational materials from Merck, none of which are related to the current article. Dr. Bacon has received consultancy fees from Merck for the development of behavior change continuing education modules and speaker fees from Novartis and Janssen and has served on advisory boards for Bayer, Sanofi, and Sojecci Inc., none of which are related to the current article.

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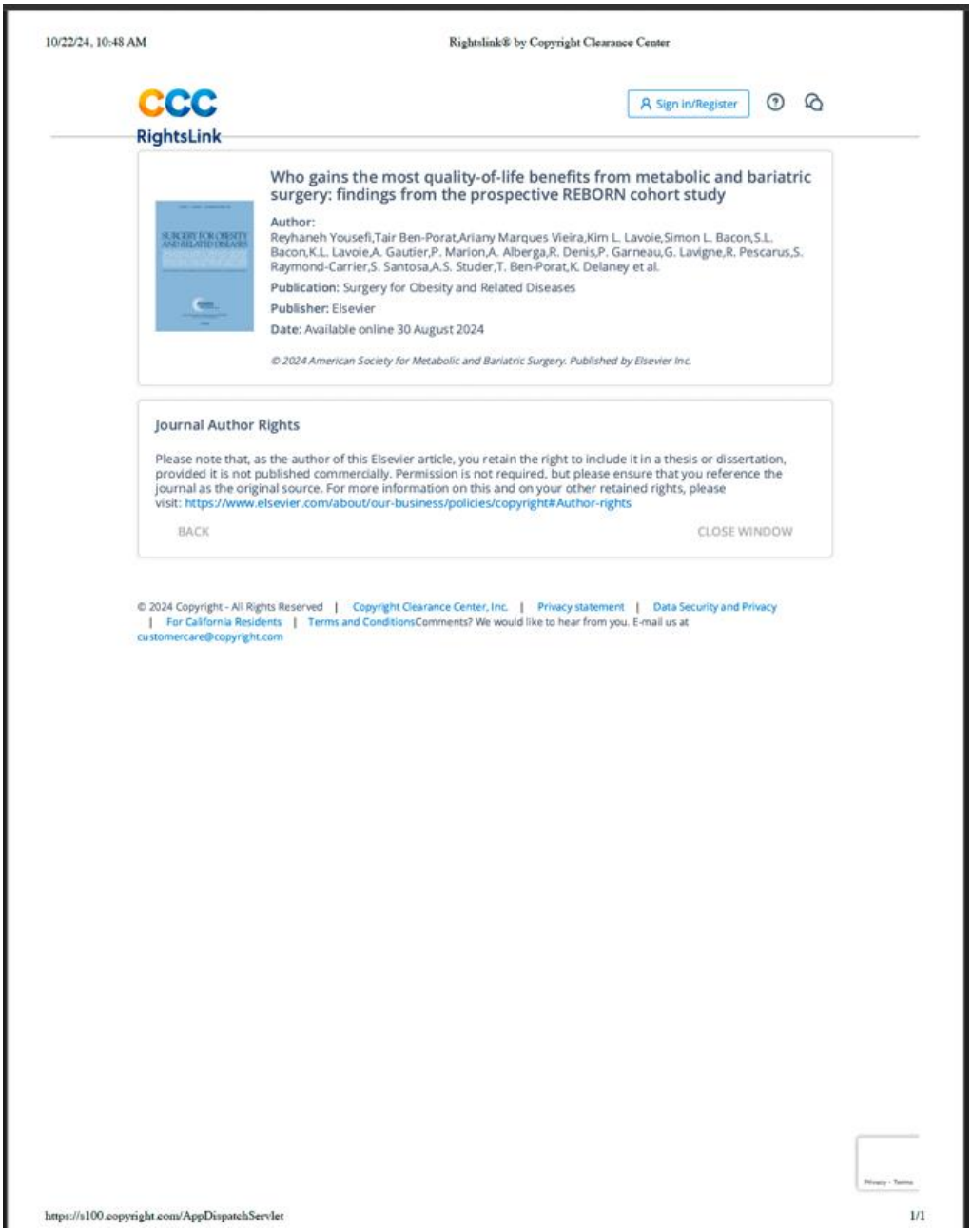

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Publication: Surgery for Obesity and Related Diseases

Publisher: Elsevier

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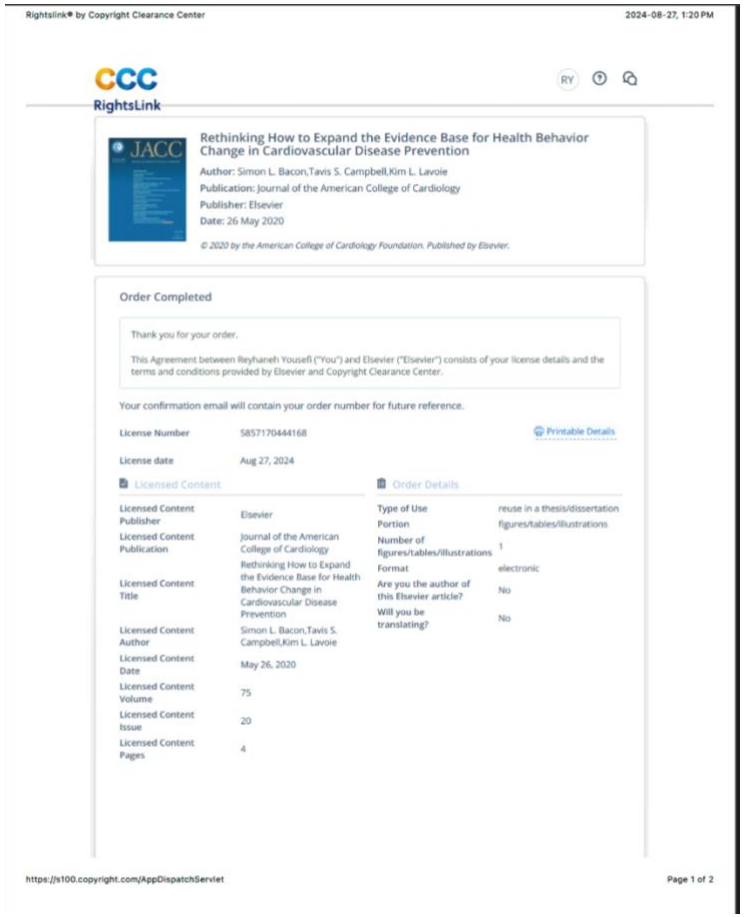

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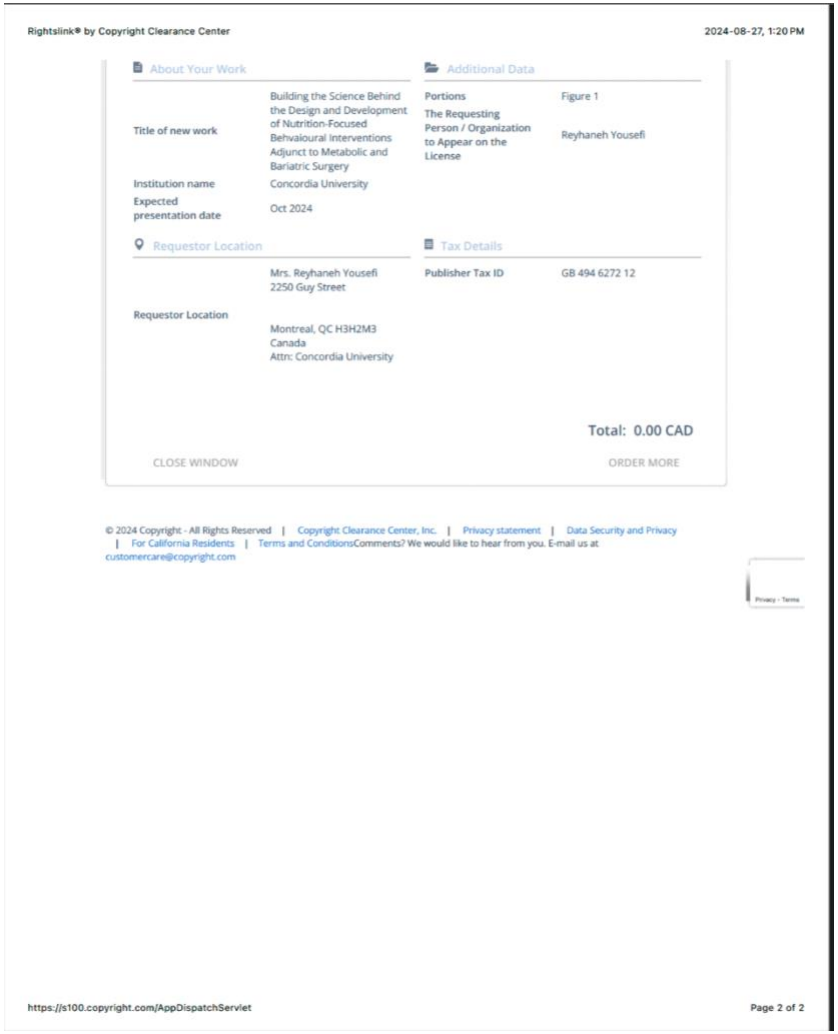

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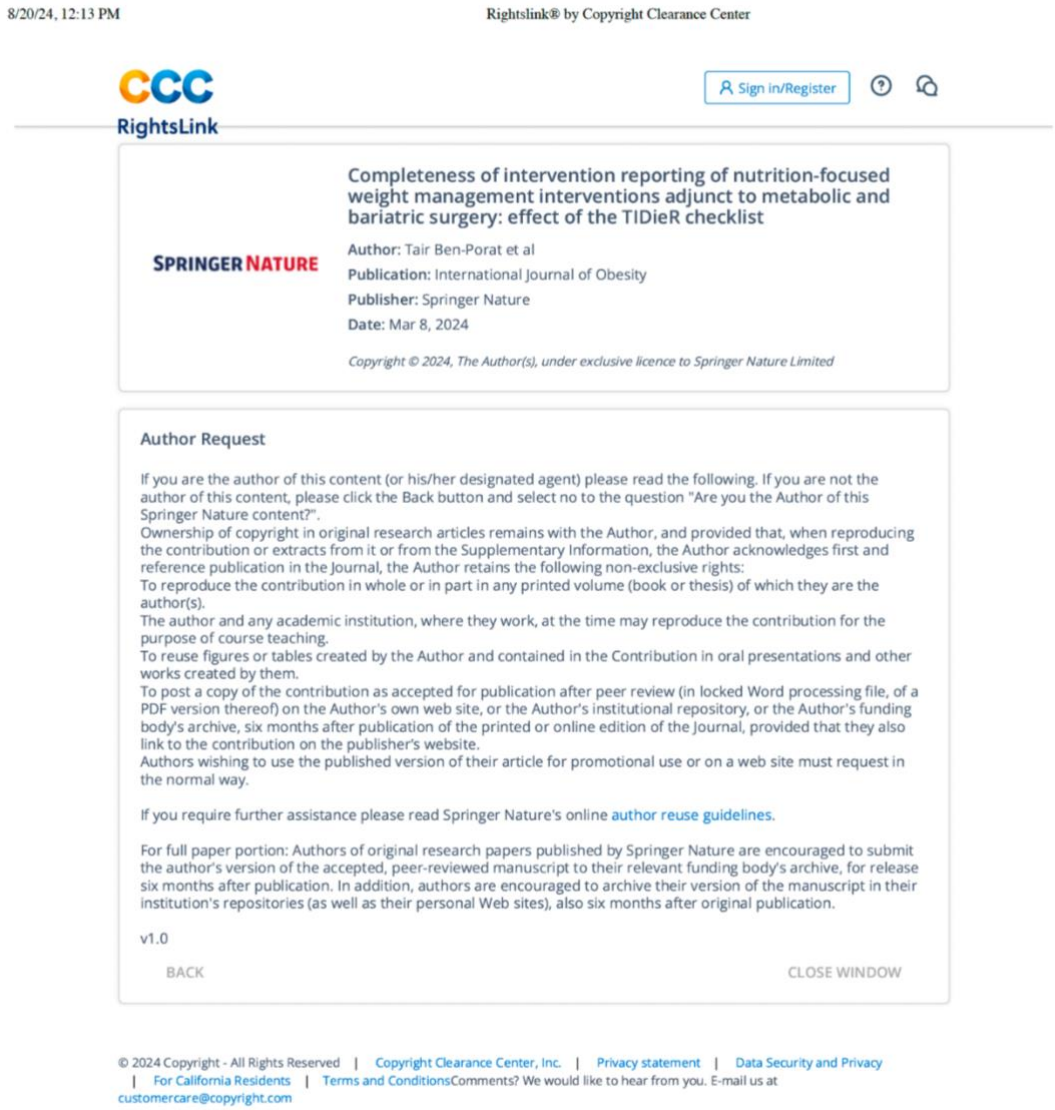

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Author: Tair Ben-Porat et al
Publication: International Journal of Obesity
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Appendix 4a. PubMed search strategy

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#1	bariatrics[mh] OR bariatric*[all] OR "bariatric surgery"[all] OR "bariatric surgeries"[all] OR "obesity surgery"[all] OR "obesity surgeries"[all] OR "weight loss surgery"[all] OR "weight loss surgeries"[all] OR "weight reduction surgery"[all] OR "weight reduction surgeries"[all] OR "gastric bypass"[all] OR "stomach bypass"[all] OR "gastric banding"[all] OR "gastric band"[all] OR "gastric balloon"[all] OR gastroplasty[all] OR "sleeve gastrectomy"[all] OR "gastric sleeve"[all] OR "biliopancreatic diversion"[all] OR "duodenal switch"[all] OR "laparoscopic band"[all] OR "lap band"[all]
AND	
#2	bahviour[mh] OR life style[mh] OR psychotherapy[mh] OR counseling[mh] OR weight reduction programs[mh] OR preoperative care[mh] OR postoperative care[mh] OR diet[mh] OR diet reducing[mh] OR nutrition therapy[mh] OR diet, food and nutrition[mh] OR exercise[mh] OR exercise therapy[mh] OR "bahvioural intervention*" [all] OR "behavioural intervention*"[all] OR "bahviour intervention*"[all] OR "behaviour intervention*"[all] OR "bahvioural treatment*" [all] OR "behavioural treatment*"[all] OR "bahviour treatment*"[all] OR "behaviour treatment*" [all] OR "bahvioural program*"[all] OR "behavioural program*"[all] OR "bahvioural therapy"[all] OR "behavioural therapy"[all] OR "bahviour therapy"[all] OR "behaviour therapy"[all] OR "bahvioural counseling"[all] OR "bahvioural counselling"[all] OR "behavioural counseling"[all] OR "behavioural counselling"[all] OR "bahvioural modification*"[all] OR "behavioural modification*"[all] OR "bahviour modification*"[all] OR "behaviour modification*"[all] OR "bahvioural change*"[all] OR "behavioural change*"[all] OR "bahviour change*" [all] OR "behaviour change*"[all] OR "bahvioural management"[all] OR "behavioural management"[all] OR "bahviour management"[all] OR "behaviour management"[all] OR "bahvioural control"[all] OR "behavioural control"[all] OR "bahviour control"[all] OR "behaviour control"[all] OR "lifestyle intervention*"[all] OR "lifestyle intervention*" [all] OR "lifestyle treatment*" [all] OR "lifestyle program*"[all] OR "lifestyle counseling"[all] OR "lifestyle counselling"[all] OR "lifestyle modification*" [all] OR "lifestyle change*"[all] OR "lifestyle management"[all] OR "comprehensive intervention*"[all] OR "comprehensive treatment*"[all] OR "comprehensive program*"[all] OR "multidisciplinary intervention*" [all] OR "multidisciplinary treatment*"[all] OR "multidisciplinary program*"[all] OR "cognitive-bahvioural intervention*" [all] OR "cognitive-behavioural intervention*" [all] OR "cognitive-bahvioural treatment*" [all] OR "cognitive-behavioural treatment*" [all] OR "cognitive-bahvioural program*"[all] OR "cognitive-behavioural program*"[all] OR "cognitive-bahvioural therapy"[all] OR "cognitive-behavioural therapy"[all] OR "cognitive-bahviour therapy"[all] OR "cognitive behaviour therapy"[all] OR CBT[all] OR "cognitive-bahvioural counseling"[all] OR "cognitive-behavioural counselling"[all] OR "cognitive therapy"[all] OR "psychological intervention*"[all] OR psychotherapy[all] OR "psychological treatment*"[all] OR "psychological management"[all] OR "psychological counseling"[all] OR "psychological counselling"[all] OR "psychological support"[all] OR "psychosocial intervention*"[all] OR "psychosocial treatment*"[all] OR "psychosocial management"[all] OR "psychosocial counseling"[all] OR "psychosocial counselling"[all] OR "psychosocial support"[all] OR "group therapy"[all] OR psychoeducation[all] OR "social support"[all] OR "diet therapy"[all] OR "diet counseling"[all] OR "diet counselling"[all] OR "dietary counseling"[all] OR "dietary counselling"[all] OR "nutrition therapy"[all] OR "nutritional therapy"[all] OR "nutrition counseling"[all] OR "nutrition counselling"[all] OR "nutritional counseling"[all] OR "nutritional counselling"[all] OR "calorie intake"[all] OR "caloric intake"[all] OR "calorie restriction"[all] OR "caloric restriction*"[all] OR "energy restriction"[all] OR "food bahviour*"[all] OR "food behaviour*"[all] OR "diet bahviour*"[all] OR "diet behaviour*"[all] OR "dietary bahviour*"[all] OR "dietary behaviour*" OR "nutrition bahviour*"[all] OR "nutrition behaviour*"[all] OR "nutritional bahviour*"[all] OR "nutritional behaviour*"[all] OR "physical activity"[all] OR "physical activities"[all] OR "motor activity"[all] OR "motor activities"[all] OR exercise*[all] OR "exercise training"[all] OR "exercise therapy"[all]

AND	
#3	treatment outcome[mh] OR body constitution[mh] OR overweight[mh] OR body weight changes[mh] OR body weight maintenance[mh] OR weight[all] OR "weight loss"[all] OR "weight reduction" [all] OR "weight control"[all] OR "weight management"[all] OR "weight maintenance"[all] OR "weight change*"[all] OR "weight modification*"[all] OR "weight loss maintenance"[all] OR "weight-loss maintenance"[all] OR "body composition"[all] OR "body constitution"[all] OR "body fat"[all] OR "body size"[all] OR adiposity[all] OR "body mass index"[all] OR BMI[all]

Appendix 4b. Scopus search strategy

Search	Query
#1	TITLE-ABS-KEY (bariatric* OR “bariatric surger*" OR "obesity surger*" OR "weight loss surger*" OR "weight reduction surger*" OR "gastric bypass" OR "stomach bypass" OR "gastric banding" OR "gastric band" OR "gastric balloon" OR gastroplasty OR "sleeve gastrectomy" OR "gastric sleeve" OR "biliopancreatic diversion" OR "duodenal switch" OR "laparoscopic band" OR "lap band")
AND	
#2	TITLE-ABS-KEY ("behavio* intervention" OR "behavio* treatment" OR "behavio* program*" OR "behavio* therapy" OR "behavio* counsel*" OR "behavio* modification*" OR "behavio* change*" OR "behavio* management" OR "behavio* control" OR "lifestyle intervention" OR "life style intervention" OR "lifestyle treatment" OR "lifestyle program*" OR "lifestyle counsel*" OR "lifestyle modification*" OR "lifestyle change*" OR "lifestyle management" OR "comprehensive intervention*" OR "comprehensive treatment*" OR "comprehensive program*" OR "multidisciplinary intervention*" OR "multidisciplinary treatment" OR "multidisciplinary program*" OR "cognitive-behavio* intervention" OR "cognitive-behavio* treatment" OR "cognitive-behavio* program*" OR "cognitive-behavio* therapy" OR cbt OR "cognitive-behavio* counsel*" OR "cognitive therapy" OR "psychological intervention" OR "psychological treatment" OR "psychological management" OR "psychological counsel*" OR "psychological support" OR "psychosocial intervention" OR "psychosocial treatment" OR "psychosocial management" OR "psychosocial counsel*" OR "psychosocial support" OR "group therapy" OR psychoeducation OR "social support" OR "diet therapy" OR "diet* counsel*" OR "nutrition* therapy" OR "nutrition* counsel*" OR "calori* intake" OR "calori* restriction*" OR "energy restriction*" OR "food behavio*" OR "diet behavio*" OR "nutrition* behavio*" OR "physical activit*" OR "motor activit*" OR exercise OR "exercise training" OR "exercise therapy")
AND	
#3	TITLE-ABS-KEY (weight OR "weight loss*" OR "weight reduction" OR "weight control" OR "weight management" OR "weight maintenance" OR "weight change*" OR "weight modification*" OR "weight loss* maintenance" OR "body composition" OR "body fat" OR adiposity OR "body mass index" OR bmi)
AND	
Filters	(LIMIT-TO (PUBSTAGE , "final") OR LIMIT-TO (PUBSTAGE , "aip")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (SUBJAREA , "MEDI") OR LIMIT-TO (SUBJAREA , "NURS") OR LIMIT-TO (SUBJAREA , "PSYC") OR LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "MULT") OR LIMIT-TO (SUBJAREA , "HEAL")) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "French")) AND (LIMIT-TO (SRCTYPE , "j"))

Appendix 4c. Cochrane search strategy

Search	Query
#1	MeSH descriptor: [Bariatrics] explode all trees
#2	(bariatric OR "bariatric surgery" OR "obesity surgery" OR "weight loss surgery" OR "weight reduction surgery" OR "gastric bypass" OR "stomach bypass" OR "gastric banding" OR "gastric band" OR "gastric balloon" OR gastroplasty OR "sleeve gastrectomy" OR "gastric sleeve" OR "biliopancreatic diversion" OR "duodenal switch" OR "laparoscopic band" OR "lap band") (Word variations have been searched)[all text]
#3	#1 OR #2
#4	MeSH descriptor: [Psychotherapy] explode all trees
#5	MeSH descriptor: [Life Style] explode all trees
#6	MeSH descriptor: [Counseling] explode all trees
#7	MeSH descriptor: [Weight Reduction Programs] explode all trees
#8	MeSH descriptor: [Perioperative Care] explode all trees
#9	MeSH descriptor: [Diet] explode all trees
#10	MeSH descriptor: [Nutrition Therapy] explode all trees
#11	MeSH descriptor: [Diet, Food, and Nutrition] explode all trees
#12	MeSH descriptor: [Exercise] explode all trees
#13	MeSH descriptor: [Exercise Therapy] explode all trees
#14	#4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13
#15	("bahviour intervention" OR "bahviour treatment" OR "bahviour program" OR "bahviour therapy" OR "bahviour counseling" OR "bahviour modification" OR "bahviour change" OR "bahviour management" OR "bahviour control" OR "lifestyle intervention" OR "life style intervention" OR "lifestyle treatment" OR "lifestyle program" OR "lifestyle counseling" OR "lifestyle modification" OR "lifestyle change" OR "lifestyle management" OR "comprehensive intervention" OR "comprehensive treatment" OR "comprehensive program" OR "multidisciplinary intervention" OR "multidisciplinary treatment" OR "multidisciplinary program" OR "cognitive-bahvioural intervention" OR "cognitive-bahvioural treatment" OR "cognitive-bahvioural program" OR "cognitive-bahvioural therapy" OR CBT OR "cognitive-bahvioural counseling" OR "cognitive therapy" OR "psychological intervention" OR "psychological treatment" OR "psychological management" OR "psychological counseling" OR "psychological support" OR "psychosocial intervention" OR "psychosocial treatment" OR "psychosocial management" OR "psychosocial counseling" OR "psychosocial support" OR "group therapy" OR psychoeducation OR "social support" OR "diet therapy" OR "diet counseling" OR "nutrition therapy" OR "nutritional counseling" OR "calorie intake" OR "calorie restriction" OR "energy restriction" OR "food bahviours" OR "diet bahviour" OR "nutrition bahviour" OR "physical activity" OR "motor activity" OR exercise OR "exercise training" OR "exercise therapy") (Word variations have been searched)[all text]
#16	#14 OR #15
#17	MeSH descriptor: [Treatment Outcome] explode all trees
#18	MeSH descriptor: [Body Constitution] explode all trees
#19	MeSH descriptor: [Overweight] explode all trees
#20	MeSH descriptor: [Body Weight Changes] explode all trees
#21	#17 OR #18 OR #19 OR #20
#22	(weight OR “weight loss” OR “weight reduction” OR “weight control” OR “weight management” OR “weight maintenance” OR “weight change” OR “weight modification” OR “weight loss maintenance” OR “body composition” OR “body constitution” OR “body fat” OR “body size” OR adiposity OR “body mass index” OR BMI) (Word variations have been searched)[all text]

#23	#21 OR #22
#24	#3 AND #16 AND #23

Appendix 4d. PsychNet search strategy

Search	Query		
	Index Terms		Any field
#1	bariatric*	OR	"bariatric surger*" OR "obesity surger*" OR "weight loss surger*" OR "weight reduction surger*" OR "gastric bypass" OR "stomach bypass" OR "gastric banding" OR "gastric band" OR "gastric balloon" OR gastroplasty OR "sleeve gastrectomy" OR "gastric sleeve" OR "biliopancreatic diversion" OR "duodenal switch" OR "laparoscopic band" OR "lap band"
#2	bahviour OR "bahviour change" OR "bahviour modification" OR "bahvioural therapy" OR lifestyle OR "lifestyle change*" OR psychotherapy OR "psychotherapeutic counselling" OR psychoeducation OR "dietary restraint" OR diets OR nutrition OR calories OR "food intake" OR "physical activit*" OR exercise	OR	"behavio* intervention*" OR "behavio* treatment*" OR "behavio* program*" OR "behavio* therapy" OR "behavio* counsel*" OR "behavio* modification*" OR "behavio* change*" OR "behavio* management" OR "behavio* control" OR "lifestyle intervention*" OR "life style intervention*" OR "lifestyle treatment*" OR "lifestyle program*" OR "lifestyle counsel*" OR "lifestyle modification*" OR "lifestyle management" OR "comprehensive intervention*" OR "comprehensive treatment*" OR "comprehensive program*" OR "multidisciplinary intervention*" OR "multidisciplinary treatment" OR "multidisciplinary program*" OR "cognitive-behavio* intervention*" OR "cognitive-behavio* treatment*" OR "cognitive-behavio* program*" OR "cognitive-behavio* therapy" OR CBT OR "cognitive-behavio* counsel*" OR "cognitive therapy" OR "psychological intervention*" OR "psychological treatment*" OR "psychological management" OR "psychological counsel*" OR "psychological support" OR "psychosocial intervention*" OR "psychosocial treatment*" OR "psychosocial management" OR "psychosocial counsel*" OR "psychosocial support" OR "group therapy" OR "social support" OR "diet therapy" OR "diet* counsel*" OR "nutrition* therapy" OR "nutrition* counsel*" OR "calori* intake" OR "calori* restriction*" OR "energy restriction*" OR "food behavio*" OR "diet behavio*" OR "nutrition* behavio*" OR "motor activit*" OR "exercise training" OR "exercise therapy"
#3	"body weight" OR "weight loss" OR "weight control" OR "body modification" OR "body fat" OR "body mass index"	OR	weight OR "weight reduction" OR "weight management" OR "weight maintenance" OR "weight change*" OR "weight modification*" OR "weight loss maintenance" OR "body composition" OR "body constitution" OR "body size" OR adiposity OR BMI
#4	#1 AND #2 AND #3		
Filters	AND Age Group: Adulthood (18 yrs & older) AND Peer-Reviewed Journals only		

Appendix 4e. Embase search strategy

Search	Emtree		Title, abstract, key Words
#1	bariatric surgery OR gastric bypass surgery OR gastric band OR gastric balloon OR gastroplasty OR gastric sleeve	OR	bariatric surger* OR bariatric* OR weight loss surger* OR obesity surger* OR weight reduction surger* OR gastric bypass OR stomach bypass OR gastric banding OR gastric band OR gastric balloon OR gastroplasty OR sleeve gastrectomy OR gastric sleeve OR biliopancreatic diversion OR duodenal switch OR laparoscopic band OR lap band
AND			
#2	bahviour therapy OR bahviour modification OR bahviour change OR bahviour control OR lifestyle intervention OR lifestyle counseling OR lifestyle modification OR multidisciplinary intervention OR cognitive bahvioural therapy OR psychological intervention OR psychotherapy OR psychological counseling OR psychological support OR psychosocial intervention OR psychosocial care OR psychoeducation OR social support OR diet therapy OR nutritional counseling OR caloric intake OR physical activity OR motor activity OR exercise OR kinesiotherapy OR bahviour change technique OR lifestyle counseling OR psychological therapy OR psychotherapy education	OR	behavio* intervention* OR behavio* treatment* OR behavio* program* OR behavio* therapy OR behavio* counsel* OR behavio* modification* OR behavio* change* OR behavio* management OR behavio* control OR lifestyle intervention* OR life style intervention* OR lifestyle treatment* OR lifestyle program* OR lifestyle counsel* OR lifestyle modification* OR lifestyle change* OR lifestyle management OR comprehensive intervention* OR comprehensive treatment* OR comprehensive program* OR multidisciplinary intervention* OR multidisciplinary treatment* OR multidisciplinary program* OR cognitive-behavio* intervention* OR cognitive-behavio* treatment* OR cognitive-behavio* program* OR cognitive-behavio* therapy OR CBT OR cognitive-behavio* counsel* OR psychological intervention* OR psychotherapy OR psychological treatment* OR psychological management OR psychological counsel* OR psychological support OR psychosocial intervention* OR psychosocial treatment* OR psychosocial management OR psychosocial counsel* OR psychosocial support OR group therapy OR psychoeducation OR social support OR diet therapy OR diet* counsel* OR nutrition* therapy OR nutrition* counsel* OR calori* intake OR calori* restriction* OR food behavio* OR diet* behavio* OR nutrition* behavio* OR physical activit* OR motor activit* OR exercise OR exercise training OR exercise therapy
AND			
#3	body weight OR body weight loss OR weight management OR body composition OR body fat mass	OR	body weight OR weight loss* OR weight reduction OR weight control OR weight management OR weight maintenance OR weight change* OR weight modification* OR weight los* maintenance OR body composition OR body fat OR body mass index OR BMI
Filters	Exclude animals		

Appendix 5. Table of screening decision guide

Appendix 5.a. Title & Abstract screening phase

Hierarchy of criteria	Inclusion criteria	Exclusion criteria	Reason for exclusion	Exclusion labels (Tags)	Comments
Duplicate publication			**duplicate** To be removed manually while screening in Rayyan		
Publication type			**wrong publication type** • Guidelines • Reports • Books Chapters • Theses editorials • Letters to editor • Conference abstracts • Review	• Review • Trial protocol	• Only tag it as "Review" if it is within the scope of our study (e.i. behavioural interventions for patients receiving BS) • Only tag it as "Trial protocol" if it is the protocol paper of a trial within the scope of our study.
Language		• No English • No French • No Italian • No Persian • No Hebrew • No Serbian • No Croatian	**foreign language**		

Participants	• Adult patients (18 years or older) • Undergoing all types of bariatric surgery • Both study arms should be in the bariatric program		**wrong population** • Non-adult • Non-bariatric • Animals	• Non-adult	• Only tag it as "Non-adult" if this a behavioural intervention in non-adult population receiving bariatric surgery
Study design	Any design including at least 2 arms: • Randomized controlled trials • Controlled trials • Parallel group trials	• No comparison group • Non-interventional study (e.g. cohorts) • Retrospective studies • Case reports	**wrong study design**	• Pre-post study	•Only tag it as "Pre-post study" if this a behavioural intervention in a single group of patients receiving BS (no comparison), with pre-post intervention measurements
Comparison	No intervention comparator group: • "Usual care" or "treatment as usual" defined as the treatment program, protocol or practices consisting of the routine clinical care provided to patients undergoing BS in a given clinical setting or institution (e.g., regular medical follow-ups with surgical or multidisciplinary team). • "Standard care" defined as the treatment program, protocol or practices officially recommended as part of bariatric care that would be considered as "best practice".	Comparator type: • Surgical wait list control group never receiving surgery • Any alternative behavioural (e.g., other type of diet or structured exercise program) or attention-placebo (e.g., support group meetings) intervention not referred to as the standard of care or usual care for patients undergoing bariatric surgery in a given setting. • Any comparison intervention that includes behavioural component(s) that are considered to be the critical hypothesised components that may be	**wrong comparison**		

		responsible for the intervention effects in the experimental group and was not also received by experimental participants.			
Intervention	Any pre and/or postoperative behavioural intervention designed explicitly to promote weight management through changes in physical activity, dietary behaviours, and/or psychological factors (e.g., emotional eating).	• Not designed for weight loss (to reduce weight and/or BMI and/or improve body composition) or weight management (e.g., CBT for depressive symptoms in patients undergoing bariatric surgery that also include weight outcomes) • Non-behavioural interventions (e.g. pharmacological)	**wrong intervention**		
Outcome	Change in at least one of the primary outcomes, including; • BMI • Absolute weight (kg; lbs) • Body fat (%/kg) • Lean body mass/ fat-free mass • WC • W/H **** The studies must have at least one post-surgical assessment of the target outcomes that is post intervention** Measurements must be taken before AND after behavioural treatment, otherwise the value of change must be reported	• Not an anthropometric and/or body composition outcome(s) • No pre- to post- behavioural intervention measure • Exclude any study that only reports post-intervention measures of the outcome variables (i.e., we need to be able to calculate BMI, weight, or %fat changes) → the paper should not be excluded at the title/abs screening → we need to contact authors	**wrong outcome**		

Appendix 5.b. Full-text screening phase

Hierarchy of criteria	Inclusion criteria	Exclusion criteria	Reason for exclusion	Exclusion labels (Tags)	Comments
Full-text not found			**inaccessible full-text**		
Publication type			**wrong publication type** • Guidelines • Reports • Books Chapters • Theses editorials • Letters to editor • Conference abstracts • Review	• Review • Trial protocols	• Only tag it as "Review" if it is within the scope of our study (e.i. behavioural interventions for patients receiving BS) • Only tag it as "Trial protocol" if it is the protocol paper of a trial within the scope of our study.
Participants	• Adult patients (18 years or older) • Undergoing all types of bariatric surgery • Both study arms should undergo bariatric surgery		**wrong population** • Non-adult • Non-bariatric • Animals	• Non-adult	• Only tag it as "Non-adult" if this a behavioural intervention in non-adult population receiving bariatric surgery
Study design	Any design including at least 2 arms: • Randomized controlled trials • Controlled trials • Parallel group trials	• No comparison group • Non-interventional study (e.g. cohorts) • Retrospective studies • Case reports	**wrong study design**	• Pre-post study	•Only tag it as "Pre-post study" if this a behavioural intervention in a single group of patients receiving BS

		• Interrupted time series design			(no comparison), with pre-post intervention measurements
Comparison	No intervention comparator group: • "Usual care" or "treatment as usual" defined as the treatment program, protocol or practices consisting of the routine clinical care provided to patients undergoing BS in a given clinical setting or institution (e.g., regular medical follow-ups with surgical or multidisciplinary team). • "Standard care" defined as the treatment program, protocol or practices officially recommended as part of bariatric care that would be considered as "best practice".	Comparator type: • Surgical wait list control group • Any alternative behavioural (e.g., other type of diet or structured exercise program) or attention-placebo (e.g., support group meetings) intervention not referred to as the standard of care or usual care for patients undergoing bariatric surgery in a given setting. • Any comparison intervention that includes behavioural component(s) that are considered to be the critical hypothesized components that may be responsible for the intervention effects in the experimental group and was not also received by experimental participants.	**wrong comparison**		
Intervention	Any pre and/or postoperative behavioural intervention designed explicitly to promote weight management through changes in physical activity, dietary behaviours, and/or psychological factors (e.g., emotional eating).	• Not designed for weight loss (to reduce weight and/or BMI and/or improve body composition) or weight management (e.g., CBT for depressive symptoms in patients undergoing bariatric surgery that also include weight outcomes) • Non-behavioural interventions (e.g. pharmacological)	**wrong intervention**		
Outcome	Change in at least one of the outcomes measures, including; • BMI	• Not an anthropometric and/or body composition outcome(s)	**wrong outcome**		

	• Absolute weight (kg; lbs) • Body fat (%/kg) • Lean body mass/ fat-free mass • WC • W/H **** The studies must have at least one post-surgical assessment of the target outcomes that is post intervention** Measurements must be taken before AND after behavioural treatment, otherwise the value of change must be reported	• No pre- to post- behavioural intervention measure • Exclude any study that only reports post-intervention measures of the outcome variables (i.e., we need to be able to calculate BMI, weight, or %fat changes) → the paper should not be excluded at the title/abs screening → we need to contact authors			

Appendix 6a. TIDieR scores for each of the included studies (n=22)

Author Year	Brief Name	Why	What		Who Provided	How	Where	When And How Much	Tailoring	Modifications	How Well	
			Materials	Procedure							Planned	Actual
Drakos 2022	2	2	0	1	1	1	2	1	0	0	2	2
Hany 2022	2	2	1	1	0	1	2	1	0	0	2	0
Grilo 2021	2	2	1	1	1	2	2	1	0	0	2	2
Paul 2020	2	2	1	1	2	2	2	1	0	0	2	0
Mangieri 2019	2	2	1	1	1	2	2	1	0	0	1	0
Lent 2019	2	2	2	2	2	2	2	2	2	0	2	2
Hanvold 2019	2	2	2	2	2	2	2	2	2	0	0	2
Lauti 2018	2	2	2	2	NA	1	2	1	0	0	2	2
Kalarchian 2016a	2	2	1	1	1	2	2	2	0	0	1	1
Kalarchian 2016b	2	2	1	1	0	2	0	2	2	0	2	0
Chacko 2016	2	2	1	1	2	2	2	2	0	0	2	1
Ogden 2015	2	2	1	1	2	2	2	2	1	0	0	0
Wild 2015,2017	2	2	1	1	1	2	2	2	0	0	0	0
Parikh 2012	2	2	0	1	1	2	2	1	0	0	0	2
Lier 2012	2	2	2	2	2	2	2	2	0	0	2	2
Nijamkin 2012	2	2	1	1	2	2	2	2	0	0	2	2
Kalarchian 2012	2	2	1	1	1	1	2	1	2	0	2	2
Sarwer 2012	2	2	1	1	2	2	2	1	0	2	2	2
Dodsworth 2012	2	2	2	2	2	2	0	0	0	0	2	2
Papalazarou 2010	2	2	2	2	1	2	2	2	2	0	0	0
Swenson 2007	2	2	1	1	2	2	2	1	0	0	0	0
Tucker 1991	2	2	1	1	1	2	0	2	0	0	2	2

Coding dictionary:
0= no (none of the criteria of the item meet in the report) or ambiguous (not enough information is provided to make a clear decision, e.g., the item is mentioned but no exact information is provided)
1= partial (some, but not all the criteria of the item are included)
2= yes (all criteria of the item were met in the report)
NA= non-applicable

Appendix 6b. CONSORT scores for each of the included studies (n=22)

CONSORT items		Drakos 2022	Hany 2022	Grilo 2021	Paul 2020	Mangieri 2019	Lent 2019	Hanvold 2019	Lauti 2018	Kalarchian 2016a	Kalarchian 2016b	Chacko 2016	Ogden 2015	Wild 2015, 2017	Parikh 2012	Lier 2012	Nijamkin 2012	Kalarchian 2012	Sarwer 2012	Dodsworth 2012	Papalazarou 2010	Swenson 2007	Tucker 1991
1a		2	1	2	2	0	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	2	0
1b		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2a		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2b		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3a		2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2
3b		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4a		1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	0	1
4b		2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	1	2	2	0
5		1	1	1	1	1	2	2	2	1	1	1	1	2	1	2	1	2	1	1	2	1	1
	Subitem#1	0	1	1	1	1	2	2	1	1	1	1	1	2	1	2	1	2	1	1	1	1	1
	Subitem#2	1	1	1	1	1	0	2	2	1	1	1	1	2	1	1	1	2	1	1	1	1	1
	Subitem#3	0	0	1	1	0	2	1	2	0	0	1	1	2	0	1	0	2	1	1	0	1	1
	Subitem#4	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Subitem#5	2	2	2	0	1	2	2	2	2	1	2	0	0	0	2	2	2	2	2	0	0	2
6a		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2
6b		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
7a		0	1	2	2	2	0	2	2	2	0	0	2	2	2	0	2	0	0	0	0	2	0
7b		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
8a		2	0	2	2	0	2	0	2	2	2	2	0	2	0	0	0	0	0	0	0	0	0
8b		0	0	2	2	1	0	2	2	2	2	2	0	2	0	0	0	0	0	0	0	0	0
9		1	0	2	2	0	0	0	2	2	0	2	0	2	0	0	0	0	0	0	0	0	0
10		2	0	2	1	0	2	2	2	2	0	1	1	2	0	0	2	0	0	0	0	0	0
11a		0	0	2	0	0	2	0	2	0	0	0	2	2	0	0	2	0	0	0	0	2	0
	Subitem#1	0	0	2	0	0	2	0	2	0	0	0	2	2	0	0	2	0	0	0	0	2	0
11b		1	0	1	2	1	2	2	2	1	2	2	2	2	1	2	2	2	1	1	2	1	1
11c		0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12a		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0
12b		0	0	2	2	2	2	2	2	2	2	2	0	2	0	0	0	2	2	2	0	0	0

CONSORT items		Drakos 2022	Hany 2022	Grilo 2021	Paul 2020	Mangieri 2019	Lent 2019	Hanvold 2019	Lauti 2018	Kalarchian 2016a	Kalarchian 2016b	Chacko 2016	Ogden 2015	Wild 2015, 2017	Parikh 2012	Lier 2012	Nijamkin 2012	Kalarchian 2012	Sarwer 2012	Dodsworth 2012	Papalazarou 2010	Swenson 2007	Tucker 1991
13a		2	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Subitem#1	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
13b		1	0	1	2	2	2	2	2	2	2	2	1	2	2	2	2	2	0	2	0	0	2
13c		0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
	Subitem#2	1	1	1	0	0	2	2	2	1	0	1	0	1	2	2	2	2	2	2	0	0	2
14a		1	0	2	1	0	2	2	2	1	2	2	2	1	0	0	0	0	2	2	2	0	0
14b		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15		0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	0	2	0
	Subitem#1	0	0	1	1	1	2	2	0	1	0	1	1	2	1	1	0	1	0	0	0	1	1
16		2	0	2	0	2	2	2	2	2	2	2	2	2	1	2	2	0	2	2	0	2	2
17a		1	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2
17b		0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18		2	0	2	2	2	2	2	2	2	2	2	0	2	0	0	0	2	2	2	0	0	0
19		0	0	0	0	0	0	0	2	2	0	2	0	2	0	0	0	0	0	0	0	2	0
20		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	0
	Subitem#1	0	1	1	1	0	2	1	1	1	0	1	0	1	0	1	1	0	0	0	0	0	0
21		0	2	2	1	2	2	2	2	2	2	2	0	2	2	2	2	2	0	2	2	0	0
	Subitem#1	0	1	1	1	1	2	1	1	1	1	1	0	1	1	1	1	1	0	1	1	0	0
22		2	2	2	2	2	2	2	2	2	1	2	0	2	2	2	1	1	1	1	1	2	2
23		0	0	2	2	0	2	2	2	2	0	2	2	2	0	2	0	0	0	2	0	0	0
24		0	0	0	2	0	2	0	0	0	0	1	2	2	0	0	0	0	0	0	0	0	0
25		2	0	2	0	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	0	0	0

Coding dictionary:

0= no (none of the criteria of the item meet in the report) or ambiguous (not enough information is provided to make a clear decision, e.g., the item is mentioned but no exact information is provided)

1= partial (some, but not all the criteria of the item are included)

2= yes (all criteria of the item were met in the report)

Appendix 7a. TIDieR scores for each of the included studies (n=22)

Author Year	Brief Name	Why	What		Who Provided	How	Where	When And How Much	Tailoring	Modifications	How Well	
			Materials	Procedure							Planned	Actual
Drakos 2022	2	2	0	1	1	1	2	1	0	0	2	2
Hany 2022	2	2	1	1	0	1	2	1	0	0	2	0
Grilo 2021	2	2	1	1	1	2	2	1	0	0	2	2
Paul 2020	2	2	1	1	2	2	2	1	0	0	2	0
Mangieri 2019	2	2	1	1	1	2	2	1	0	0	1	0
Lent 2019	2	2	2	2	2	2	2	2	2	0	2	2
Hanvold 2019	2	2	2	2	2	2	2	2	2	0	0	2
Lauti 2018	2	2	2	2	NA	1	2	1	0	0	2	2
Kalarchian 2016a	2	2	1	1	1	2	2	2	0	0	1	1
Kalarchian 2016b	2	2	1	1	0	2	0	2	2	0	2	0
Chacko 2016	2	2	1	1	2	2	2	2	0	0	2	1
Ogden 2015	2	2	1	1	2	2	2	2	1	0	0	0
Wild 2015,2017	2	2	1	1	1	2	2	2	0	0	0	0
Parikh 2012	2	2	0	1	1	2	2	1	0	0	0	2
Lier 2012	2	2	2	2	2	2	2	2	0	0	2	2
Nijamkin 2012	2	2	1	1	2	2	2	2	0	0	2	2
Kalarchian 2012	2	2	1	1	1	1	2	1	2	0	2	2
Sarwer 2012	2	2	1	1	2	2	2	1	0	2	2	2
Dodsworth 2012	2	2	2	2	2	2	0	0	0	0	2	2
Papalazarou 2010	2	2	2	2	1	2	2	2	2	0	0	0
Swenson 2007	2	2	1	1	2	2	2	1	0	0	0	0
Tucker 1991	2	2	1	1	1	2	0	2	0	0	2	2

Appendix 7b. CONSORT scores for each of the included studies (n=22)

CONSORT items		Drakos 2022	Hany 2022	Grilo 2021	Paul 2020	Mangieri 2019	Lent 2019	Hanvold 2019	Lauti 2018	Kalarchian 2016a	Kalarchian 2016b	Chacko 2016	Ogden 2015	Wild 2015, 2017	Parikh 2012	Lier 2012	Nijamkin 2012	Kalarchian 2012	Sarwer 2012	Dodsworth 2012	Papalazarou 2010	Swenson 2007	Tucker 1991
1a		2	1	2	2	0	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	2	0
1b		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2a		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2b		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3a		2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2
3b		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4a		1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	0	1
4b		2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	1	2	2	0
5		1	1	1	1	1	2	2	2	1	1	1	1	2	1	2	1	2	1	1	2	1	1
	Subitem#1	0	1	1	1	1	2	2	1	1	1	1	1	2	1	2	1	2	1	1	1	1	1
	Subitem#2	1	1	1	1	1	0	2	2	1	1	1	1	2	1	1	1	2	1	1	1	1	1
	Subitem#3	0	0	1	1	0	2	1	2	0	0	1	1	2	0	1	0	2	1	1	0	1	1
	Subitem#4	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Subitem#5	2	2	2	0	1	2	2	2	2	1	2	0	0	0	2	2	2	2	2	0	0	2
6a		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2
6b		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
7a		0	1	2	2	2	0	2	2	2	0	0	2	2	2	0	2	0	0	0	0	2	0
7b		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
8a		2	0	2	2	0	2	0	2	2	2	2	0	2	0	0	0	0	0	0	0	0	0
8b		0	0	2	2	1	0	2	2	2	2	2	0	2	0	0	0	0	0	0	0	0	0
9		1	0	2	2	0	0	0	2	2	0	2	0	2	0	0	0	0	0	0	0	0	0
10		2	0	2	1	0	2	2	2	2	0	1	1	2	0	0	2	0	0	0	0	0	0
11a		0	0	2	0	0	2	0	2	0	0	0	2	2	0	0	2	0	0	0	0	2	0
	Subitem#1	0	0	2	0	0	2	0	2	0	0	0	2	2	0	0	2	0	0	0	0	2	0
11b		1	0	1	2	1	2	2	2	1	2	2	2	2	1	2	2	2	1	1	2	1	1
11c		0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12a		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0
12b		0	0	2	2	2	2	2	2	2	2	2	0	2	0	0	0	2	2	2	0	0	0

CONSORT items		Drakos 2022	Hany 2022	Grilo 2021	Paul 2020	Mangieri 2019	Lent 2019	Hanvold 2019	Lauti 2018	Kalarchian 2016a	Kalarchian 2016b	Chacko 2016	Ogden 2015	Wild 2015, 2017	Parikh 2012	Lier 2012	Nijamkin 2012	Kalarchian 2012	Sarwer 2012	Dodsworth 2012	Papalazarou 2010	Swenson 2007	Tucker 1991
13a		2	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Subitem#1	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
13b		1	0	1	2	2	2	2	2	2	2	2	1	2	2	2	2	2	0	2	0	0	2
13c		0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
	Subitem#2	1	1	1	0	0	2	2	2	1	0	1	0	1	2	2	2	2	2	2	0	0	2
14a		1	0	2	1	0	2	2	2	1	2	2	2	1	0	0	0	0	2	2	2	0	0
14b		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15		0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	0	2	0
	Subitem#1	0	0	1	1	1	2	2	0	1	0	1	1	2	1	1	0	1	0	0	0	1	1
16		2	0	2	0	2	2	2	2	2	2	2	2	2	1	2	2	0	2	2	0	2	2
17a		1	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2
17b		0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18		2	0	2	2	2	2	2	2	2	2	2	0	2	0	0	0	2	2	2	0	0	0
19		0	0	0	0	0	0	0	2	2	0	2	0	2	0	0	0	0	0	0	0	2	0
20		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	0
	Subitem#1	0	1	1	1	0	2	1	1	1	0	1	0	1	0	1	1	0	0	0	0	0	0
21		0	2	2	1	2	2	2	2	2	2	2	0	2	2	2	2	2	0	2	2	0	0
	Subitem#1	0	1	1	1	1	2	1	1	1	1	1	0	1	1	1	1	1	0	1	1	0	0
22		2	2	2	2	2	2	2	2	2	1	2	0	2	2	2	1	1	1	1	1	2	2
23		0	0	2	2	0	2	2	2	2	0	2	2	2	0	2	0	0	0	2	0	0	0
24		0	0	0	2	0	2	0	0	0	0	1	2	2	0	0	0	0	0	0	0	0	0
25		2	0	2	0	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	0	0	0

Appendix 8. BCT Taxonomy Online Training

A deductive process of categorising interventions description is the core of identifying (coding) BCTs, which demands using an established coding framework (BCTTv1). This highly skilled process involves coders in making a series of complex interpretative judgments, thus requiring familiarity with the BCT labels and definitions.[1] In such a context, coders should receive specific training to be able to reliably recognize BCTs as defined by the taxonomy rather than relying on their own subjective judgement, which will maximise the reliability and confidence of using the taxonomy.[2] For the aim of this study, coders (RY, TBP) completed the online taxonomy tutorial training (www.bct-taxonomy.com) according to the recommended training time which is a minimum of 1 hour per session and 1 session per week. It includes practice coding tasks, feedback, structured discussion led by expert tutors, access to support networks and additional resources. The training program includes six sessions on technique descriptions, a new coding guideline and an interactive task. Coders are given a score and automated feedback after each session. The final two sessions are only available after scoring 70% on the first assessment. Completion of coder training programs has been reported to be effective in increasing coders' competence in coding techniques.[3,4] However, the effectiveness of the online taxonomy training program for teaching study-specific coders to code intervention materials still needs to be evaluated.[5]

[1] Hak T, Bernts T. Coder training: explicit instruction and implicit socialization? In: Krippendorff K, Bock A, eds. The content analysis reader. Thousand Oaks: Sage; 2009: 220-233.

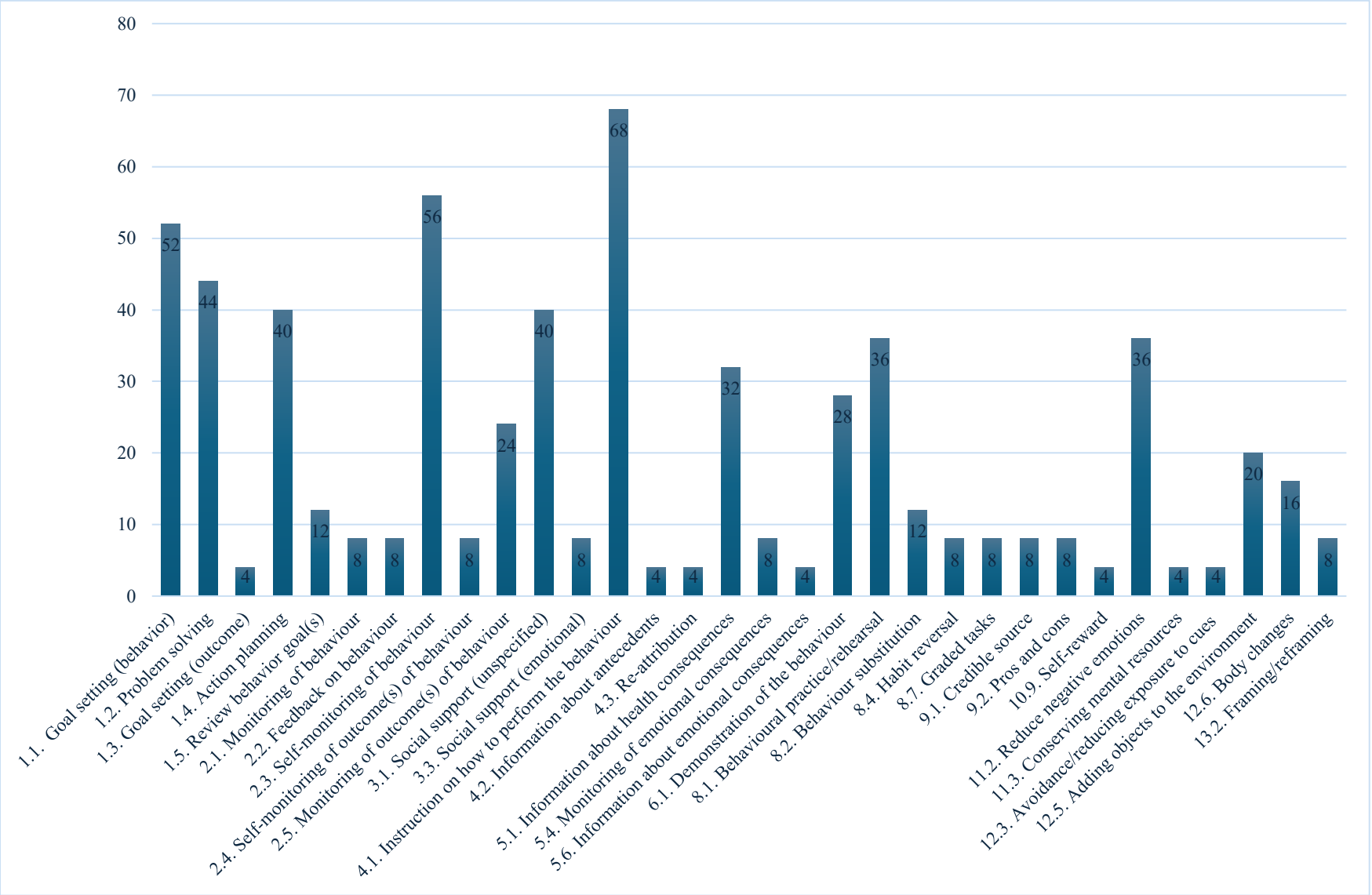
[2] Potter WJ, Levine-Donnerstein D. Rethinking validity and reliability in content analysis. J App Commun Res, 1999: 258–284.

[3] Abraham C, Wood CE, Johnston M, et al. Reliability of Identification of Bahviour Change Techniques in Intervention Descriptions. *Ann Behav Med.* 2015;49(6):885-900.

[4] Wood CE, Richardson M, Johnston M, et al. Applying the behaviour change technique (BCT) taxonomy v1: a study of coder training. *Transl Behav Med.* 2015;5(2):134-148.

[5] JaKa MM, Wood C, Veblen-Mortenson S, et al. Applying the Bahviour Change Technique Taxonomy to Four Multicomponent Childhood Obesity Interventions. *West J Nurs Res.* 2021;43(5):468-477.

Appendix 9. Percentage frequency of individual behaviour change techniques (BCTs) across all interventions



Appendix 10. Risk of bias assessment for 25 included studies

Appendix 10a. Risk of bias in randomised trials (ROB 2) [https://www.riskofbias.info]

			Studies																							
ROB domains	**Signaling Questions**	**Outcome**	**Rashidbeygi 2024**	**Nambiar 2023**	**Sockalingham 2023**	**Jassil 2023**	**Drakos 2022**	**Grilo 2021**	**Paul 2020, 2022**	**Mangieri 2019**	**Hanvold 2019**	**Lauti 2018**	**Kalarchian 2016a**	**Kalarchian 2016b**	**Chacko 2016**	**Ogden 2015**	**Wild 2015, 2017**	**Parikh 2012**	**Lier 2012**	**Nijamkin 2012**	**Kalarchian 2012**	**Sarwer 2012**	**Papalazarou 2010**	**Swenson 2007**	**Tucker 1991**
Domain 1: Risk of bias arising from the randomization process	1.1 Was the allocation sequence random?	Weight	Y	Y	Y	Y	Y	Y	---	PY	Y	---	Y	PY	Y	PY	Y	PY	Y	PY	PN	PY	PY	---	PY
		BMI	Y	Y	Y	Y	Y	Y	Y	PY	Y	PY	Y	PY	Y	PY	Y	PY	Y	PY	PN	PY	PY	PY	PY
	1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions?	Weight	NI	PN	Y	Y	Y	Y	---	N	Y	---	Y	NI	Y	Y	Y	PN	PY	Y	PN	PN	PN	---	PN
		BMI	NI	PN	Y	Y	Y	Y	PY	N	Y	NI	Y	NI	Y	Y	Y	PN	PY	Y	PN	PN	PN	PN	PN
	1.3 Did baseline differences between intervention groups suggest a problem with the randomization process?	Weight	N	Y	N	N	N	N	---	N	N	---	N	N	N	N	N	N	N	N	N	N	N	---	N
		BMI	N	Y	N	N	N	N	NI	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Risk-of-bias judgement			Low	Some concern	Low	Low	Low	Low	---	Some concern	Low	---	Low	Low	Low	Low	Low	Low	Low	Low	Some concern	Some concern	Some concern	---	Some concern
Domain 2a: Risk of bias due to deviations from the intended interventions (effect of assignment to intervention)	2a.1 Were participants aware of their assigned intervention during the trial?	Weight	PN	PY	PY	PY	PY	PY	---	PY	PY	---	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	---	PY
		BMI	PN	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY
	2a.2. [modified question] Were people delivering the interventions aware of differences across intervention arms during the trial?	Weight	PY	PY	PY	PY	PY	PY	---	PY	PY	---	PY	PY	PN	PN	PY	PY	PY	PY	PY	PY	PY	---	PY
		BMI	PY	PY	PY	PY	PY	PY	PY	PY	PY	PN	PY	PY	PN	PN	PY	PY	PY	PY	PY	PY	PY	PY	PY
	2a.3. [added by us] Were people delivering the intervention unique to a treatment arm (i.e., not working across treatment arms)?	Weight	PN	PN	PN	PN	PN	PN	---	PN	PN	---	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	---	PN
		BMI	PN	PN	PN	PN	PN	PN	PN	PN	PN	NA	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN
	2a.4. If Y/PY/NI to 2a.1 or 2a.2: Were there deviations from the intended intervention that arose because of the trial context?	Weight	NI	NI	PN	NI	NI	NI	---	NI	NI	---	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	---	NI
		BMI	NI	NI	PN	NI	NI	NI	NI	NI	NI	PN	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	2a.5 If Y/PY to 2a.4: Were these deviations likely to have affected the outcome?	Weight	NA	NA	NA	NA	NA	NA	---	NA	NA	---	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	---	NA
		BMI	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Weight	NA	NA	NA	NA	NA	NA	---	NA	NA	---	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	---	NA

	2a.6 If Y/PY/NI to 2a.5: Were these deviations from intended intervention balanced between groups?	BMI	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2a.7 Was an appropriate analysis used to estimate the effect of assignment to intervention?	Weight	N	PN	Y	Y	PN	Y	---	PN	N	---	N	PN	Y	Y	Y	N	N	Y	N	N	N	---	N
		BMI	N	PN	Y	Y	PN	Y	Y	PN	N	Y	N	PN	Y	Y	Y	N	N	Y	N	N	N	N	N
	2a.8 If N/PN/NI to 2a.7: Was there potential for a substantial impact (on the result) of the failure to analyse participants in the group to which they were randomised?	Weight	N	NI	PN	PN	PY	PN	---	NI	PN	---	PY	PN	PN	PN	PN	PY	PY	PN	PY	PY	PY	---	PY
		BMI	N	NI	PN	PN	PY	PN	PN	NI	PN	PN	PY	PN	PN	PN	PN	PY	PY	PN	PY	PY	PY	PY	PY
Risk-of-bias judgement			High	High	Some concern	Some concern	High	Some concern	Some concern	High	Some concern	Low	High	High	Some concern	Some concern	Some concern	High	High	Some concern	High	High	High	High	High
Domain 2b: Risk of bias due to deviations from the intended interventions (effect of adhering to intervention)	2b.1. Were participants aware of their assigned intervention during the trial?	Weight	PY	PY	PY	PY	PY	PY	---	PY	PY	---	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	---	PY
		BMI	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY
	2b.2. [modified question] Were people delivering the interventions aware of differences across intervention arms during the trial?	Weight	PY	PY	PY	PY	PY	PY	---	PY	PY	---	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	---	PY
		BMI	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY
	2b.3. [If applicable:] If Y/PY to 2b.1 or 2b.2: Were important non-protocol interventions balanced across intervention groups?	Weight	PN	NI	NA	NA	NA	NA	---	NI	NI	---	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	---	NI
		BMI	PN	NI	NA	NA	NA	NA	NI	NI	NI	NA	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	2b.4. [If applicable:] Were there failures in implementing the intervention that could have affected the outcome?	Weight	PN	PN	PN	PN	PN	PN	---	PN	PN	---	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	---	PN
		BMI	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN
	2b.5. [If applicable:] Was there non-adherence to the assigned intervention regimen that could have affected participants' outcomes?	Weight	PN	PN	PN	PN	PY	PN	---	PN	PN	---	PY	PN	PN	PN	PN	PY	PY	PN	PY	PY	PY	---	PY
		BMI	PN	PN	PN	PN	PY	PN	PN	PN	PN	PN	PY	PN	PN	PN	PN	PY	PY	PN	PY	PY	PY	PY	PY
	2b.6. If N/PN/NI to 2b.3, or Y/PY/NI to 2b.4 or 2b.5: Was an appropriate analysis used to estimate the effect of adhering to the intervention?	Weight	PN	PN	PN	PN	PN	PN	---	PN	PN	---	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	---	PN
		BMI	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN
Risk-of-bias judgement			High	High	Some concern	Some concern	High	Low	Some concern	High	Some concern	Low	High	High	Some concern	Some concern	Some concern	High	High	Some concern	High	High	High	High	High
Domain 3: Missing outcome data	3.1 Were data for this outcome available for all, or nearly all, participants randomised?	Weight	Y	PY	PY	N	N	Y	---	Y	N	---	N	N	Y	Y	Y	N	N	Y	N	N	N	---	N
		BMI	Y	PN	PY	N	N	Y	Y	Y	N	Y	N	N	Y	Y	Y	N	N	Y	N	N	N	N	N
	3.2 If N/PN/NI to 3.1: Is there evidence that the result was not biassed by missing outcome data?	Weight	PN	PN	PY	PY	PN	PY	---	PN	PY	---	PN	PN	PY	PY	PY	PN	PN	PY	PN	PN	PN	---	PN
		BMI	PN	PN	PY	PY	PN	PY	PY	PN	PY	PY	PN	PN	PY	PY	PY	PN	PN	PY	PN	PN	PN	PN	PN
		Weight	N	PY	PN	PN	PY	PN	---	PN	PN	---	PY	PN	PN	PN	PN	PY	PY	PN	PY	PY	PY	---	PY

	3.3 If N/PN to 3.2: Could missingness in the outcome depend on its true value?	BMI	N	PY	PN	PN	PY	PN	PN	PN	PN	PN	PY	PN	PN	PN	PN	PY	PY	PN	PY	PY	PY	PY	PY
	3.4 If Y/PY/NI to 3.3: Is it likely that missingness in the outcome depended on its true value?	Weight	NA	PY	PN	PN	PY	PN	---	PN	PN	---	PY	PN	PN	PN	PN	PY	PY	PN	PY	PY	PY	---	PY
		BMI	NA	PY	PN	PN	PY	PN	PN	PN	PN	PN	PY	PN	PN	PN	PN	PY	PY	PN	PY	PY	PY	PY	PY
Risk-of-bias judgement			Some concern	High	Low	Some concern	High	Low	Low	Some concern	Some concern	Low	High	Some concern	Low	Low	Low	High	High	Low	High	High	High	High	High
Domain 4: Risk of bias in measurement of the outcome	4.1 [added by us] Was the level of outcome at an acceptable level at baseline?	Weight	N	N	N	N	PN	N	---	N	N	---	N	N	N	N	N	N	N	N	N	N	N	---	N
		BMI	N	N	N	N	PN	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	4.2 Was the method of measuring the outcome inappropriate?	Weight	N	PN	N	N	PN	N	---	N	N	---	N	N	N	N	N	N	N	N	N	N	N	---	N
		BMI	N	PN	N	N	PN	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	4.3 Could measurement or ascertainment of the outcome have differed between intervention groups?	Weight	PN	PN	PN	PN	PN	PN	---	PN	PN	---	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	---	PN
		BMI	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN
	4.4 If N/PN/NI to 4.1 and 4.2: Were outcome assessors aware of the intervention received by study participants?	Weight	PY	PY	PY	N	PY	PY	---	PY	PY	---	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	---	PY
		BMI	PY	PY	PY	N	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY	PY
	4.5 If Y/PY/NI to 4.3: Could assessment of the outcome have been influenced by knowledge of intervention received?	Weight	PN	PN	PN	PN	PN	PN	---	PN	PN	---	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	---	PN
		BMI	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN
	4.6 If Y/PY/NI to 4.5: Is it likely that assessment of the outcome was influenced by knowledge of intervention received?	Weight	PN	PN	PN	PN	PN	PN	---	PN	PN	---	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	---	PN
		BMI	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN
Risk-of-bias judgement			Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Domain 5: Risk of bias in selection of the reported result	5.1 Were the data that produced this result analysed in accordance with a pre-specified analysis plan that was finalised before unblinded outcome data were available for analysis?	Weight	PN	PN	Y	Y	PN	Y	---	PN	PN	---	Y	PY	Y	Y	Y	Y	Y	Y	PN	PN	PN	---	PN
		BMI	PN	PN	Y	Y	PN	Y	Y	PN	PN	Y	Y	PY	Y	Y	Y	Y	Y	Y	PN	PN	PN	PN	PN
	5.2 Is the numerical result being assessed likely to have been selected, on the basis of the results, from...multiple eligible outcome measurements (e.g. scales, definitions, time points) within the outcome domain?	Weight	PN	PN	PN	PN	PN	PN	---	PN	PN	---	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	---	PN
		BMI	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN
	5.3 Is the numerical result being assessed likely to have been selected, based on the results, from... multiple eligible analyses of the data?	Weight	PN	PN	PN	PN	PN	PN	---	PN	PN	---	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	---	PN
		BMI	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN	PN

Risk-of-bias judgement	Some concern	Some concern	Low	Low	Some concern	Some concern	Low	Some concern	Some concern	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Some concern	Some concern	Some concern	Some concern	Some concern
Overall risk-of-bias judgement	High	High	Low	Low	Some concern	Low	Low	High	Some concern	Low	Some concern	Some concern	Low	Low	Low	High	High	Low	High	Some concern	Some concern	Some concern	High

*Appendix 10b. **R**isk **O**f **B**ias **I**n **N**on-randomized **S**tudies -of **I**nterventions (ROBINS-I)*
[https://www.riskofbias.info/welcome/home/current-version-of-robins-i]

			Studies	
ROBINS domains	**Signalling Questions**	**Outcome**	**Hany 2022**	**Dodsworth 2012**
Domain 1: Bias due to confounding	1.1 Did the authors use an appropriate analysis method that adjusted for all the important confounding domains?	Weight	Y	Y
		BMI	Y	Y
	1.2 Were confounding domains that were controlled for measured validly and reliably by the variables available in this study?	Weight	PN	PN
		BMI	PN	PN
Risk-of-bias judgement			Moderate	Moderate
Domain 2: Bias in selection of participants into the study	2.1 Was selection of participants into the analysis based on participant characteristics observed after the start of intervention?	Weight	PN	PN
		BMI	PN	PN
Risk-of-bias judgement			Low	Low
Domain 3: Bias in classification of interventions	3.1. Are there baseline differences between groups that might impact the outcome or risk of the outcome?	Weight	N	N
		BMI	N	N
Risk-of-bias judgement			Low	Low
Domain 4: Bias due to deviations from intended interventions	4.1. Were there deviations from the intended intervention that arose because of the trial context?	Weight	NI	NI
		BMI	NI	NI
	4.2. If Y/PY/NI to 4.1 Were important non-protocol interventions balanced across intervention groups?	Weight	PN	PN
		BMI	PN	PN
		Weight	N	N

	4.3. If N/PN/NI to 4.1, or Y/PY/NI to 4.2: Was an appropriate analysis used to estimate the effect of adhering to the intervention?	BMI	N	N
Risk-of-bias judgement			Critical	Critical
Domain 5: Risk of bias due to missing data	5.1. Were data for this outcome available for all, or nearly all, participants randomised?	Weight	Y	Y
		BMI	Y	Y
	5.2. If N/PN to 5.1: Could missingness in the outcome depend on its true value?	Weight	NA	NA
		BMI	NA	NA
Risk-of-bias judgement			Low	Serious
Domain 6: Risk of bias in measurement of outcomes	6.1. Could measurement or ascertainment of the outcome have differed between intervention groups?	Weight	NI	NI
		BMI	NI	NI
	6.2. If N/PN/NI to 6.1.: Were outcome assessors aware of the intervention received by study participants?	Weight	Y	Y
		BMI	Y	Y
	6.3. If Y/PY/NI to 6.2.: Could assessment of the outcome have been influenced by knowledge of intervention received?	Weight	N	N
		BMI	N	N
Risk-of-bias judgement			Moderate	Moderate
Domain 7: Bias in selection of the reported result	7.1. Is the numerical result being assessed likely to have been selected, on the basis of the results, from...multiple eligible outcome measurements (e.g. scales, definitions, time points) within the outcome domain?	Weight	PY	PY
		BMI	PY	PY
	7.2. Is the numerical result being assessed likely to have been selected, on the basis of the results, from... multiple eligible analyses of the data?	Weight	PY	PY
		BMI	PY	PY
Risk-of-bias judgement			Serious	Serious
Overall risk-of-bias judgement			Serious	Critical

Appendix 11. Inclusion/Exclusion criteria based on the review PECOs

Appendix 11a. Ti/Abs screening phase

Hierarchy of criteria	Inclusion criteria	Exclusion criteria	Reason for exclusion
Duplicate publication			**duplicate** To be removed manually while screening in Rayyan
Publication type	• Original research articles (primary sources)	Non original research • Guidelines • Reports • Books Chapters • Theses editorials • Letters to editor • Conference abstracts • Review • Protocol studies	**wrong publication type**
Language	• English • French	• Not English • Not French	**foreign language**
Participants	• Adult patients (18 years or older) • Undergoing all types of bariatric surgery - gastric bypass - stomach bypass - gastric banding/band - gastric balloon - Gastroplasty - sleeve gastrectomy - biliopancreatic diversion - duodenal switch laparoscopic band - lap band	• Non-adult • Non-bariatric • Animals	**wrong population**

Exposure	Any postoperative dietary follow-up (modification?) (referring to what people eat, how much they eat, and how they eat), e.g., • Changing the quantity/quality of consumption • Psychosocial aspects of eating behaviour		**wrong exposure**
Comparison	No formal control group/exposure		
Outcome	Any potential barriers and enablers to modifying dietary behaviours; factors influencing engagement with dietary behaviour change ● Knowledge ● Skills ● Beliefs and attitudes ● Emotion ● Environmental factors ● Resources ● Emotions ● Social influences		**wrong outcome**

Appendix 11b. Full-text screening phase

Hierarchy of criteria	Inclusion criteria	Exclusion criteria	Reason for exclusion	Labels
Publication type	• Original studies	• Guidelines • Reports • Books • Theses editorials • Letters to editor-commentary • Conf abstracts • Review	**wrong publication type**	• similar study
Participant	• Adult patients (18 years or older) • Undergoing all types of bariatric surgery	• Non-adult • Non-bariatric • Animals	**wrong population**	
Study design	• Qualitative studies: - Interview - Focus group - Survey with a qualitative component- i.e. free text responses - Case report- add a label [“case report”] • Quantitative studies- e.g. surveys that have items where people rate their agreement with different types of barriers or complete scales on certain types of barriers like motivation scales, social support scales: _ add label [“quantitative”] * If the focus of the study is broader than diet- e.g., weight management, or lifestyle change, or bariatric follow-up- as long as they report data specifically on barriers/enablers to diet, the study can be included.	• Studies without a component of assessing barrier/enabler to diet (Aarts 2015)	**wrong study design**	• case report • quantitative

	But we would only be extracting a subset of data from that paper (i.e. the barriers/enablers related to diet specifically) (see Wright 2022)- Add a label [“broader focus” vs. “diet focus”]			• broader focus • diet focus
Exposure	• Any postoperative dietary modification - Changing the quantity/quality of consumption - Psychosocial aspects of eating	• If the target behaviour in the study is not diet and nutrition (Conceição 2020)	**wrong exposure**	
Outcome	• Any potential barriers and enablers that can directly or indirectly impact dietary modifications *We would extract both raw data (i.e. participant quotes) but also author interpretations (i.e. generated themes, narrative summaries)- so if the studies only provide narrative summaries but no raw data, then it still meets the inclusion criteria. But it would be a lower quality study. (see Bocchieri 2002)	• If the study is not exploring the patients’ perspectives/ attitudes/ experiences	**wrong outcome**	

Appendix 12. Search strategy for database search

Appendix 12a. Pubmed

Search #	Query
1	bariatrics[mh] OR bariatric*[all] OR "bariatric surgery"[all] OR "bariatric surgeries"[all] OR "obesity surgery"[all] OR "obesity surgeries"[all] OR "weight loss surgery"[all] OR "weight loss surgeries"[all] OR "weight reduction surgery"[all] OR "weight reduction surgeries"[all] OR "gastric bypass"[all] OR "stomach bypass"[all] OR "gastric banding"[all] OR "gastric band"[all] OR "balloon"[all] OR gastroplasty[all] OR "sleeve gastrectomy"[all] OR "gastric sleeve"[all] OR "biliopancreatic diversion"[all] OR "duodenal switch"[all] OR "laparoscopic band"[all] OR "lap band"[all]
2	barrier*[all] OR facilitate*[all] OR challenge*[all] OR attitude*[all] OR perception*[all] OR perceive*[all] OR enabler*[all]
3	diet[mh] OR diet reducing[mh] OR eating[mh] OR diet, food and nutrition[mh] OR "calorie intake"[all] OR "caloric intake"[all] OR "calorie restriction"[all] OR "caloric restriction*"[all] OR "energy restriction"[all] OR "food bahviour*"[all] OR "food behaviour*"[all] OR "food consumption*"[all] OR "food intake*"[all] OR eating*[all] OR diet*[all] OR "diet bahviour*"[all] OR "diet behaviour*"[all] OR "dietary bahviour*"[all] OR "dietary behaviour*"[all] OR "nutrition bahviour*"[all] OR "nutrition behaviour*"[all] OR "nutritional bahviour*"[all] OR "nutritional behaviour*"[all] OR "eating behaviour*"[all]
4	#1 AND #2 AND #3
5	Animals[mh] NOT Human[mh]
6	#4 NOT #5

Appendix 12b. Scopus

Search #	
1	TITLE-ABS-KEY (bariatric* OR "bariatric surger*" OR "obesity surger*" OR "weight loss surger*" OR "weight reduction surger*" OR "gastric bypass" OR "stomach bypass" OR "gastric banding" OR "gastric band" OR "gastric balloon" OR gastroplasty OR "sleeve gastrectomy" OR "gastric sleeve" OR "biliopancreatic diversion" OR "duodenal switch" OR "laparoscopic band" OR "lap band")
2	TITLE-ABS-KEY (barrier* OR facilitate* OR challenge* OR attitude* OR perception* OR perceive* OR enabler*)
3	TITLE-ABS-KEY (diet* OR "diet* reducing*" OR eating* OR "calorie* intake*" OR "calorie* restriction*" OR "energy* restriction*" OR "food* behaviour*" OR "food* consumption*" OR "food* intake*" OR "dietary* behaviour*" OR "nutrition* behaviour*" OR "eating behaviour*")
4	(LIMIT-TO (PUBSTAGE , "final") OR LIMIT-TO (PUBSTAGE , "aip")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (SRCTYPE , "j")
5	#1 AND #2 AND #3 AND #4

Appendix 12c. Cochrane search strategy

Search #	Query
1	MeSH descriptor: [Bariatrics] explode all trees
2	(bariatric OR "bariatric surgery" OR "obesity surgery" OR "weight loss surgery" OR "weight reduction surgery" OR "gastric bypass" OR "stomach bypass" OR "gastric banding" OR "gastric band" OR "gastric balloon" OR gastroplasty OR "sleeve gastrectomy" OR "gastric sleeve" OR "biliopancreatic diversion" OR "duodenal switch" OR "laparoscopic band" OR "lap band") (Word variations have been searched)[all text]
3	#1 OR #2
4	MeSH descriptor: [Diet] explode all trees
5	MeSH descriptor: [Diet, Food, and Nutrition] explode all trees
6	#4 OR #5
7	(diet* OR "diet reducing" OR "calorie intake" OR "calorie restriction" OR "energy restriction" OR "food behaviours" OR "diet behaviour" OR "nutrition behaviour" OR "food consumption" OR "food intake" OR "eating behaviour" OR "dietary behaviour") (Word variations have been searched)[all text]
8	#7 OR #6

9	(barrier OR facilitate OR challenge OR attitude OR perception OR perceive OR enabler)(Word variations have been searched)[all text]
10	#3 AND #8 AND #9

Appendix 12d. PsychNet search strategy

Search #	Query		
	Index Terms		Any field
1	bariatric*	OR	"bariatric surger*" OR "obesity surger*" OR "weight loss surger*" OR "weight reduction surger*" OR "gastric bypass" OR "stomach bypass" OR "gastric banding" OR "gastric band" OR "gastric balloon" OR gastroplasty OR "sleeve gastrectomy" OR "gastric sleeve" OR "biliopancreatic diversion" OR "duodenal switch" OR "laparoscopic band" OR "lap band"
2	"dietary restraint" OR diets OR nutrition OR calories OR "food intake"	OR	"calori* intake" OR "calori* restriction*" OR "energy restriction*" OR "food behavio*" OR "diet behavio*" OR "nutrition* behavio*" OR "eating behavio*" OR "food behavio*" OR "food consumption*" OR "food intake*"
3	Attitudes OR "Treatment Barriers" OR "perceived control" OR "perceived social support"	OR	barrier* OR facilitate* OR challenge* OR attitude* OR perception* OR perceive* OR enabler*
4	#1 AND #2 AND #3		
Filters	AND Age Group: Adulthood (18 yrs & older) AND Peer-Reviewed Journals only		

Appendix 12e. EMBASE search strategy

Search #	Emtree		Title, abstract, key Words
1	bariatric surgery OR gastric bypass surgery OR gastric band OR gastric balloon OR gastroplasty OR gastric sleeve	OR	bariatric surger* OR bariatric* OR weight loss surger* OR obesity surger* OR weight reduction surger* OR gastric bypass OR stomach bypass OR gastric banding OR gastric band OR gastric balloon OR gastroplasty OR sleeve gastrectomy OR gastric sleeve OR biliopancreatic diversion OR duodenal switch OR laparoscopic band OR lap band

AND			
2	Diet OR nutrition OR caloric intake OR food intake	OR	diet*OR nutrition*OR calori* intake OR food* intake OR calori* restriction* OR food behavio* OR diet* behavio* OR nutrition* behavio* OR eating* behavio*
AND			
3	Attitude or perception or barrier	OR	barrier*[all] OR facilitate*[all] OR challenge*[all] OR attitude*[all] OR perception*[all] OR perceive*[all] OR enabler*[all]
Filters	Exclude animals		

Appendix 13. Risk of bias assessment of 35 included studies

Appendix 13a. Quality assessment of qualitative studies and the qualitative components of the mixed methods studies by applying Critical Appraisal Skills Programme Qualitative Checklist (http://www.casp-uk.net/casp-tools-checklists)

Authors/ year	Q1: Was there a clear statement of the aims of the research?	Q2: Is a qualitative methodology appropriate?	Q3: Was the research design appropriate to address the aims of the research?	Q4: Was the recruitment strategy appropriate to the aims of the research?	Q5: Was the data collected in a way that addressed the research issue?	Q6: Has the relationship between researcher and participants been adequately considered?	Q7: Have ethical issues been taken into consideration?	Q8: Was the data analysis sufficiently rigorous?	Q9: Is there a clear statement of findings?	Risk of bias (low/medium/ high)
Funk 2023	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Low
Tolvanen 2023/2022/ 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low
Wright 2022	Yes	Can't tell	Yes	Can't tell	Yes	Yes	Yes	Yes	Yes	Medium
Billing-Bullen 2022	Yes	Yes	Yes	No	Yes	Can't tell	Can't tell	Yes	Yes	Medium
Jarvholm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low

2021										
Coulman 2020	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low
Yates 2020	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes	Yes	Yes	Medium
Yu 2020	Yes	Yes	Can't tell	Yes	Yes	No	Can't tell	Can't tell	Yes	Unclear
Lin 2018	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Low
Opozda 2018	Yes	Yes	Can't tell	Yes	Can't tell	Yes	Can't tell	Yes	Yes	Unclear
Graham 2017	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Low
Moura de Oliveira 2016	No	Yes	Yes	No	Yes	Can't tell	Yes	No	Yes	High
Hillersdal 2016	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Low
Lauti 2016	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low
Lynch 2016	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Medium
Sharman 2015	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low
Geraci 2014	Yes	Yes	Yes	Can't tell	Yes	Yes	Can't tell	Yes	Yes	Medium

Lynch 2014	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Medium
Natvik 2014	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low
Benson-Davies 2013	Yes	Yes	Yes	No	Yes	Can't tell	Can't tell	No	Yes	High
Da silva 2012	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes	Yes	Yes	Medium
Knutsen 2012	Can't tell	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Medium
Stewart 2010	No	No	Can't tell	No	Yes	Yes	Can't tell	Yes	Yes	High
Zijlstra 2009	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes	Yes	Yes	Medium
Ogden 2006	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Medium
Bocchieri 2002	Yes	Yes	Yes	Can't tell	Can't tell	Yes	Can't tell	Can't tell	Yes	Unclear

Appendix 13b. Risk of bias assessment of quantitative studies by applying Mixed Methods Appraisal Tool (MMAT), version 2018

Authors/ year	Q1: Is the sampling strategy relevant to address the research question?	Q2: Is the sample representative of the target population?	Q3: Are the measurements appropriate?	Q4: Is the risk of nonresponse bias low?	Q5: Is the statistical analysis appropriate to answer the research question?	Risk of bias (low/medium/ high)
Athanasiadis 2021	Yes	Yes	No	Can't tell	Can't tell	High
Assakran 2020	Can't tell	Can't tell	Yes	No	Can't tell	Unclear
Liu 2017	Yes	Can't tell	Yes	Yes	Yes	Low
Schiavo 2017	Yes	No	Can't tell	Can't tell	Yes	High
Peacock 2016	Yes	Can't tell	Can't tell	No	Yes	High
Raves 2016	Yes	Yes	Can't tell	No	Can't tell	High
Benson-Davies 2008	Yes	No	No	NA	Can't tell	High

Appendix 14. Expressed importance

Author/year	Relevant topic(s) or factor(s) of investigation	Quotations indicating expressed importance	TDF domain
Funk 2023	Accessibility to health care services and travelling issues	Difficulties pertaining to household location and transportation were also described as important barriers.	Environmental context and resources
Funk 2023	Accessibility to health care services and travelling issues	Transportation difficulties and challenging patient household locations (both urban and rural) were reported by patients and providers to be important barriers to optimal weight loss after bariatric surgery.	Environmental context and resources
Tolvanen 2022	Negative emotions resulting from surgery or changes in eating behaviours	"It's my biggest feeling that I'm frustrated, that nothing happens and even if I eat right and exercise right, nothing happens. My weight is completely stable."	Emotion
Tolvanen 2022	Patients acquired new dietary and behavioural skills	"So keep your meal times, it's very important. Because it is the same thing there, no one told me that 'you should eat between 5 to 6 times / day' that is what I have heard. Now I think you should eat up to 6–7 times a day even. So, I have a 'food-and sleep-alarm' that goes off and reminds me when to eat, because otherwise I forget it."	Skills
Tolvanen 2021	Social support as an important factor for maintaining weight loss after bariatric surgery	.. it would be very important, for the first year, that you have enormous support at home. I would like to have practical tips, like you have to help each other with housework, with kids and everything so you can sit down and eat your meal in peace and quiet. There	Social influences

		needs to be time to prepare meals. That's why it is important that your partner also invest time.	
Wright 2022	Services Provided by the Healthcare System	Long-term psychological and dietary support is important to help individuals navigate the challenges and maintain positive changes achieved after bariatric surgery.	Environmental context and resources
Wright 2022	Support from social/group sessions	"it is important that new people going through it have that support"	Social influences
Billing-Bullen 2022	Support from social/group sessions	Support groups appear to be an integral component of weight-loss success following bariatric surgery. "That made you feel normal because you think it's only you that's scared of putting on the weight again or feels guilty and stuff like that. But to hear that everybody else did, it was just great".	Social influences
Athanasiadis 2021	Support from social/group sessions	Patient social support is very important and beneficial, especially for bariatric patients.	Social influences
Opozda 2018	Overestimating the role of surgery leading to unmet expectations from surgery	Our findings suggest that it is important that before deciding to undergo surgery, patients are educated that eating disorders, disordered eating behaviours and excessive hunger and appetite are not always cured or even improved by bariatric procedures, and that these difficulties may continue, worsen or even begin de novo after surgery.	Beliefs about consequences

Graham 2017	disciplined in their approach to post- surgical life (self-decipline)	It was important for Risk Acceptors to comply with the adjustments needed in order to be able to achieve their expectations of surgery.	Behavioural regulation
Graham 2017	Support from social/group sessions	Being able to continue their social activities was important to them	Social influences
Schiavo 2017	Lack of behavioural self-regulation/ impact of family and friends	Main reasons for patient non-adherence to diet were poor self-discipline and poor family support	Behavioural regulation/ social influences
Lauti 2016	Need for more psychological support services	Not enough support was one of the most predominant themes from the focus group discussions. In general, participants felt that the follow-up period was too short and that there was an unmet psychological need. "I think that emotional eating type psychological stuff was missing and I think that's what needs to kick in from twelve months onwards."	Environmental context and resources
Lauti 2016	Important emergent themes included the desire for more support, that is delivered within the overarching principles of providing individualised, specialised care by providers that maintain good rapport and assist in maintaining motivation.		Environmental context and resources
Lauti 2016	Another important aspect of follow-up care that emerged for some participants was the patient initiated support group.	NA	Social influences

Lauti 2016	A second important theme with regards to the negative aspects of follow-up care was poor rapport. This often resulted from participants feeling like they were not being listened to, a lack of consistency in dietician staff and the need to repeat one's story again.	"They didn't look in to the real problem which I'm having right now, and I'm reluctant to come back to them" "I anticipated that I would have the same dietician all the way through, and each visit I had a different dietician. So you were going through your history all over again. And I was like, 'can't you read the notes?' It just felt like you were repeating yourself, over and over."	Environmental context and resources/ Social influences
Lauti 2016	Despite this, participants 'taking responsibility for their own behaviours was an important emergent theme.	"It sort of switched the light on for me. I thought hey there's more to this as in actually it is about doing it for yourself, but it's knowing when you fall over or things go wrong that you've got somewhere to go to ask questions."	Behavioural regulation
Peacock 2016	In addition, it was evident that the ease and frequency of contact with these individuals was highly important to participants.	"Personal guidance from a dietitian. I know what I should eat, I know what healthy eating is, but making those choices on a continual basis is what is difficult."	Environmental context and resources
Peacock 2016	Given the previously discussed complexity of the barriers that patients experience, it seems paramount that facility staff, and in particular RDN's working with patients, be educated and trained on how to more effectively address postoperative dietary and	"I don't know that the dietician helped me much at all. I did not find her very knowledgeable about my particular problem."	Environmental context and resources

	nutritional issues.		
Sharman 2015	The main categories of support needs identified by participants were from health professionals, peers (recipients of bariatric surgery), significant others (family and close friends) and the general community.	NA	Social influences
Stewart 2010	Participants discussed why peer support was such an important part of this program. They felt that it was important that they be able to discuss their emotional struggle with food and their disappointment that these struggles seemed to return after a period of relative relief.	NA	Social influences

Appendix 15. Themes/sub themes within each of the 14 domains from the Theoretical Domains Frameworks.
Appendix 15a. Domain: Environmental context and resources (19 studies)

Global theme	Sub-theme	Barrier	Enabler	Sample quotes
Services provided by the healthcare system	Unmet need for more psychological support services 5 studies [Billing-Bullen 2022] [Coulman 2020] [Lauti 2016] [Tolvanen 2021] [Jarvholm 2021]	7	0	"…. maybe a little bit of advice of what we do and don't need to do before we go for the operation. Because I actually thought I was going to come out and look like Barbie"."[Billing-Bullen 2022] "Just the mental help…..but for me I really was just… I felt like I was just dropped." [Billing-Bullen 2022] "As I say I am most grateful and have no regrets or anything like that, but losing the weight is for me only a very small part of it and now I have flipped the page and now I have got other secondary problems that have come along with it, and they are not the best."[Billing-Bullen 2022] "There was no formal counselling…and that might be a good idea to find out why we eat so much, why we are addicted to food…" [Coulman 2020] "I think that emotional eating type psychological stuff was missing and I think that's what needs to kick in from twelve months onwards." [Lauti 2016] "I would have liked more follow up from someone on the team... I would prefer to have a bit more accountability to somebody as part of the team." [Lauti 2016] "I think definitely at eighteen months you shouldn't just be cast off. I think you need more support after that. And specialised support for the ones that are putting weight on." [Lauti 2016] "She's put on a multitude of weight. I kicked her butt. I turn up on her doorstep and say, right, put your running shoes on, we're going for a walk.That sort of thing is where I think you need the support." [Lauti 2016]

				"I think you need some other sort of support and I don't know whether it's group support or it might be motivational texts. "Are you eating too much?" "Are you still drinking your water?" I don't think coming here is the answer.' Other types of follow-up that emerged included using a buddy system and the internet." "Something internet-based that you could go on and they would also give you a list of bariatric nurses, or a list of dieticians, or a list of counsellors, or whoever, that if you need that extra specialised help, you can actually contact those people direct and set up an appointment." "Have a website that has forums on it as well, so that everybody can, at any stage, just go on and plonk their question in there. Someone with the knowledge, not necessarily the doctors, but someone else that's got access to it can give the advice. "You had this, I had that as well, I got over it doing this." Or, "If you can't eat meat, maybe try this." Just so that, not only have we got professionals looking at it, but we've got all the other people that have had the same experiences able to help out as well." [Lauti 2016] I would say the support were merely information about facts. In my opinion one needs a psychologist // Like once or twice a month to start with // because right now it has been nothing but follow-up of weight, BMI, fat percent [Tolvanen 2021] "It should, it's supposed to help you catch up, so you catch up with the change, 'cause it's kind of like the brain still thinks you are huge, even though the body changes, and you can't see the change itself, you really can't" [Jarvholm 2021]
	Need for nutritional support 7 studies [Peacock 2016] [Liu 2017]	6	2	"I mean I did see a dietitian for a short period before I had the surgery, but I had no advice on what or how to eat post-operatively and I really missed that. I can see it would have been most beneficial to have had that support. (male, public surgery) And it's only now that I've got a dietitian that's actually done work in the field [bariatric surgery], that she's seeing me, that I'm

	[Billing-Bullen 2022] [Sharman 2015] [Coulman 2020] [Da Silva 2012]			starting to come out the other end. (female, private surgery)" [Sharman 2015] "If I couldn't get hold of her (dietitian) straight away on the phone I'd send an email and it would either be answered the same day or the next day." [Coulman 2020] "Once she [the dietitian] seen me I started to lose weight, and she also gave me some advice on how to manage the eating with the lap-band. (male, public surgery)" [Sharman 2015] "I had no guidance of what food I could eat or how much." [Peacock 2016] "…. maybe a little bit of advice of what we do and don't need to do before we go for the operation. Because I actually thought I was going to come out and look like Barbie" [Billing-Bullen 2022] [It] really would have been better to do more with [the] dietician and meal planning, and understanding what eating would look like afterwards before having it done. We talked about no no's and amounts of food, but not really prepar[ing] recipes or foods that are well and not [well] tolerated, etc [Liu 2017] "A guide to eating post-op." "What to eat and what not to eat." "Consultations with the Dietitian."/ Medical "Reading literature provided by my doctor."Other "One on ones are important to stay on track and get new information and ideas for continued success." [Peacock 2016]
	Advice is infrequent, variable, inconsistent and generic 3 studies [Natvik 2014] [Tolvanen 2021] [Tolvanen 2023]	8	0	"It was [nurse's name] who was in charge of all these patients [undergoing bariatric surgery], but she was not a good person. She was completely uninterested. She didn't give advice, food lists, restrictions, or anything else that patients get nowadays." [Tolvanen 2023] "I need to hear what I am doing right, but also how I can do more right" [Tolvanen 2022] "I wish that there were follow-up visits every year to stop any

	[Tolvanen 2022] [Yu 2020]			weight regain as soon as you notice an increase in weight. Then you can maybe stop it at 120 or 130 kg and advise 'you have to do something', instead of allowing it to continue…" [Tolvanen 2021] "Maybe you [referring to herself] should also meet a counselor or psychologist because you still have a remaining [problematic] eating behaviour like mine. Couldn't eat any proper meals because I got dumping, I took a small piece of bread or something all the time, little things. So, more control [nutritional- and psychological support], not just, 'Manage this on your own' "[Tolvanen 2023]
Self-access internet based methods	No sub-theme 3 studies [Peacock 2016] [Wright 2022] [Athanasiadis 2021]	0	3	"motivational/success posts" , "healthy recipes", "do's and don'ts" [Athanasiadis 2021] "Online information. I could access at any time, and look up the topics that were relevant (sic) to my journey at that very time. Things like Daily Plate, or Fit Day were great, as they helped me identify things like sneaky carbs, and learn to be mindful of the little stuff that you can forget about." [Peacock 2016] "I also did a lot of reading and researching on the Internet." "Lots of books and info from my personal doctor and cardioligist. Also, talking with my doctor and nurse helps a lot. Mostly my personal doctor and pamplets or websites etc. he suggests." [Peacock 2016] "Boot camp. I got a lot of tips about food, measuring foods, and exercise." "…books on wls."/ [Peacock 2016] " Research on my own." [Peacock 2016]
The negative impacts of medical conditions or life circumstances	No sub-theme 4 studies [Lauti 2016] [Tolvanen 2023]	6	0	"I've gone wrong with my weight and not being able to go to the dentist. It's kind of like can't chew food so you go for the easy options, things you can chew, which is usually not the good things.", "I think other health issues have been my downfall." [Lauti 2016]

	[Lynch 2016] [Raves 2016]			Because if I'm stressed and…well, one is stressed and will eat, and we should hurry to eat lunch quickly. Then I can skip eating. Because as soon as I'm stressed, the body feels it, and then it blocks up. It feels like a blockage in the stomach. [Tolvanen 2023] …that they [the family] shouldn't have to eat the same thing that I eat and stuff like that, /…/ I knew about timing and that you must keep a meal structure, but I ate the same food as them. [Tolvanen 2023]
Financial stressors	No sub-theme 6 studies [Assakran 2020] [Billing-Bullen 2022] [Funk 2023] [Lauti 2016] [Peacock 2016] [Schiavo 2017]	6	0	"The prices of vegetables and that sort of thing. Everyone is telling you to eat healthy, but it is cheaper for us all to go and get a MacDonald's or a Burger King or something, whereas we would rather have cucumbers and tomatoes" [Billing-Bullen 2022] "Patients have to delay meals, skip meals or have very subpar nutritional intake, because they just don't have the income to buy more balanced meals, healthier options, or just are reliant on convenience food options that are cheaper," [Funk 2023] "They don't give you [healthy food] at the food pantry, and that's where we are at this point. We need to get food from the food pantry sometimes. It's high in sodium, processed meats, and processed foods." [Funk 2023] "I can afford a loaf of bread that lasts me three days." "It's so much easier to eat carbs than protein. And it's cheaper." "I can't afford to buy fifty dollars of veges and fruit." [Lauti 2016] "…expense of some proteins powders and variaties (sic) and some taste yuck!!" [Peacock 2016]
Accessibility and travelling issues	No sub-theme 2 studies [Funk 2023] [Peacock 2016]	3	0	"We definitely have patients who will have to cancel because they just don't have a ride or their ride didn't show up or things like that." "Sometimes it's transportation … Maybe they don't have a car. The bus line that comes [to the clinic] does not go to all the neighbourhoods where our patients come from." Patients

				who lived in rural areas also described having difficulty attending visits in the winter due to unsafe road conditions. [Funk 2023] "We're fairly rural here; Walmart is 30 miles away. Local grocery stores … There's only one in the county. There are dozens of convenience stores. So, being rural definitely makes it harder to get to a quality food source." [Funk 2023] "Finding good food choices when away from home, at a conference, etc" [Peacock 2016]
Employment situation/setting	No sub-theme 3 studies [Stewart 2010] [Tolvanen 2023] [Da Silva 2012]	5	0	"…it [shift work] slightly disturbs the balance, especially if you have worked in the evening and must get up early the next day. Then you're tired, and you don't feel like eating breakfast" [Tolvanen 2023] "you have to eat fruit with carbohydrates or eat every three hours but daily, when you have to work it is not possible" [Da Silva 2012]
Time limitation	No sub-theme 2 studies [Billing-Bullen 2022] [Peacock 2016]	2	0	"Cooking – still have very little time and need quick meal ideas…" [Peacock 2016]

Appendix 15b. Domain: Behavioural regulation (19 studies)

Global theme	**Sub-theme**	**Barrier**	**Enabler**	**Sample quotes**
Patient struggling with adapting to the new lifestyle	No sub-theme 7 studies [Coulman 2020] [Graham 2017]	8	0	"…all your insides are different but your brain…no different whatsoever…that for me was the hardest thing to adjust to, because my brain was still telling my stomach I was hungry but obviously I couldn't [eat]…" [Coulman 2020] "I rarely have a cup of tea now. I used to drink it like it was going

	[Peacock 2016] [Benson-Davis 2013] [Lynch 2016] [Opozda 2018] [Tolvanen 2021]			out of style….I don't know if I'm replacing the sugar hit now, but I drink more pop [carbonated drinks] than I did before and I still put sugar in my tea. I pick[graze], I used to pick all the time and still do, but now I pick sensibly. If I'd kept on drinking, eating and smoking I would have been dead by the time I was 50.I still do these things, but moderately." [Graham 2017] "They call it a lifestyle change but that is just another word for diet. I will be dieting for the rest of my life. But this is what my psychologist says thin women do." [Peacock 2016] ''Slipped back into same old type of habits" [Benson-Davis 2013] "The things that brought you to weight loss surgery could do it again. And we all fight this, we all fight. It's hard. You know, not going to old habits. And I'm three years out." [Lynch 2016] "I know a girl who does it [vomits]. It helps her" "I may have to try sometime if I am not feeling good. It may be much better to do that than to lay down" "Obviously, it's better to throw up than lay down and absorb calories" [Tolvanen 2021] "The first 6 months post-op I made all the right food choices and didn't want any of the foods I ate prior to surgery. It was like one morning I woke up and a switch was flicked and I started craving the crappy foods I ate previously like chocolate biscuits chips and deep fried foods. It is a mental struggle every day to try to stick to protein and veg three meals a day and low carb every day is so much harder almost 12 months since surgery. The constant worry of getting fat again enters my mind with every bite. I honestly didn't know the mental battle would be as hard as it is every day. I wish I had known that there would come a time after surgery where your mind would try to take you back to your old habits" [Opozda 2018]
Developing new strategies and	No sub-theme	0	29	"I'm not hungry, and if I am, I look at the clock and realize, Oh, it's time for dinner, which is what your stomach is telling you.

habits	13 studies [Knutsen 2012] [Jarvholm 2021] [Lynch 2014] [Ogden 2006] [Opozda 2018] [Natvik 2014] [Tolvanen 2022] [Graham 2017] [Lin 2018] [Stewart 2010] [Lynch 2016] [Wright 2022] [Peacock 2016]			But you can't eat everything—well, you can't eat the amount you did before. You're not able to. And it's nice that your stomach tells you when it's full." [Knutsen 2012] "But I've actually never, since I'm like this, and I'm really too old now, can't have a hangover day, but no, it's really like that, it's really tough, so I choose not to drink, and I don't really need it. I get cocky anyway [laughing]." [Jarvholm 2021] "But now I'm like this, I still like chips, but now it's enough with a handful." [Jarvholm 2021] "The three habits participants reported avoiding were grazing, eating craved foods, and emotional eating" [Lynch 2014] "I set so many good habits for myself that it's a lot easier for me to follow, 'the plan,' versus somebody that doesn't take that time and build in the good habits and try to push away the bad habits. Because eventually those, eventually some of those, if not all of those, bad habits will come back to haunt you." [Lynch 2014] "I eat 'selective eating' ... because I know my stomach can only take a little bit I have to choose very carefully what I'm going to eat because if I take pizza by the time I bite the base I cannot eat anything else so I have to not bother eating pizza" [Ogden 2006] "I now eat largely organic foods. I eat full fat but low sugar. I now rarely eat red meat but fish, chicken and a lot of legumes and veg. I drink a lot less alcohol. I am a lot more informed about what I eat and eat a wide range of food but small portions. I don't count calories or worry if I eat something unhealthy occasionally. I rarely get takeaway because it's a waste of food and money. […] I eat quality not quantity" [Opozda 2018] "Rhythm is a must . . . to eat less and more frequently. . . . It's not like before, when you come home from work feeling that you could eat an ox. Now you notice rumbling and noises when it's empty. And I feel dizzy if I don't eat. . . . I try to think about how I eat in general . . . I became intolerant to alcohol, so I don't drink. I'm careful with what I eat, avoiding fat and sugar; if not,

				I'm taken by the runs [diarrhea]. . . . I take the weekends off, without worrying about the consequences. . . . I eat the things which I shouldn't and become ill the next morning, but after a few hours I'm fine. I've chosen to live like this." [Natvik 2014] "So keep your meal times, it's very important. Because it is the same thing there, no one told me that 'you should eat between 5 to 6 times / day' that is what I have heard. Now I think you should eat up to 6–7 times a day even. So, I have a 'food-and-sleep-alarm' that goes off and reminds me when to eat, because otherwise I forget it." [Tolvanen 2022] "I pick[graze], I used to pick all the time and still do, but now I pick sensibly. If I'd kept on drinking, eating and smoking I would have been dead by the time I was 50.I still do these things, but moderately." [Graham 2017] "Definitely stopped bingeing because I can't. I have found other ways of coping. Crochet! Stopped emotional eating because I feel that I am not so emotional" [Opozda 2018] "I had a huge problem getting the amount of vegetables they say you need to have after the operation…it was difficult, but I make soup and you can get them all in there…because you boil them and blend it…they're all in there. Boy, you can get your five a day no problem… chewing was a problem, but not with soup…It's a habit my husband and I have got into with the soup, but the operation and how I feel now, has been absolutely life changing." [Graham 2017] "I'm doing what I'm supposed to." [Lynch 2016] "I don't eat out of a packet, I always put my food in a bowl." [Wright 2022] "Keeping a food log." [Peacock 2016]
Lack of self-regulation/ self-discipline	No sub-theme 6 studies	7	0	"I'm not going to do without, but I've got rules. It I do not eat cakes, I don't eat chocolate, sweets, fizzy drinks and I never touch alcohol I know people who eat them, they just water it

	[Assakran 2020] [Schiavo 2017] [Graham 2017] [Billing-Bullen 2022] [Opozda 2018] [Zijlstra 2009]			down with ice so it doesn't fizz up, but I just think I've had my surgery and up to now it has probably cost £25,000, maybe £30,000 by the time you think of the surgery, the doctors, the staff who looked after me.] I'm not prepared to waste that, because I would have stayed [obese], I wouldn't have had the operation, and I've had to make changes [to my life]" [Graham 2017] "I eat a wide range of food but small portions. I don't count calories" [Opozda 2018] "Binge now is like a little bag of chips and a biscuit because you can't get anything down. But, I mean, that mind-set is still there". [Billing-Bullen 2022] "I tend not to have a lot of self-control and I buy rubbish a lot" [Opozda 2018] She said that "she now accepted her weight and was no longer preoccupied with dieting." [Zijlstra 2009]

Appendix 15c. Domain: Emotions (18 studies)

Global theme	**Sub-theme**	**Barrier**	**Enabler**	**Sample quotes**
Negative emotions	No sub-theme 9 studies [Natvik 2014] [Assakran 2020] [Lauti 2016] [Da Silva 2012] [Tolvanen 2021] [Tolvanen 2023] [Tolvanen 2022] [Hillersdal 2016]	17	0	"When you remove half of your gastric pouch, you start a huge process in your body. In fact, you have your childhood in replay. I actually did. I've had a childhood which involved being molested, sexually molested. . . . I thought it was so hard the year I lost weight. I could barely visit them [family]. Because he [molester] followed me with his eyes, and said, "Yes, I'm proud of you, now you've turned stunning again." It was awful [with emphasis]. . . . We were, and we are no healthy family [laugh]. . . . It didn't work out. You could count my ribs both at the back and front of my chest. I felt that I couldn't be that weak. Because I've been molested, I need to

	[Billing-Bullen 2022] [Stewart 2010] [Opozda 2018]			feel that I have the power to defend myself, even if I'm no longer in a situation where I have to defend myself with my fists." [Natvik 2014] "Psychologically is where I feel you need help to work through whatever the issues are or what caused them in the first place to make us eat or do whatever we happened to do" [Lauti 2016] "Then comes a day when you cannot fight any more, when you quit and eat." [Da Silva 2012] "I [during the follow-up visit at the surgical clinic] was caught up with feeling ashamed about having to learn how to eat right. That was the main thing. So, I got no psychological [assessment/treatment]." [Tolvanen 2023] "you feel very bad . . . you know it is wrong but again and again you make the same mistakes . . . and then, then there is the guilt for being so. . . . so weak'). 'I cannot do anything' ('I cannot change it . . . it is stronger and bigger than me" [Da Silva 2012] "I am an emotional eater. I hoped it would stop that or curve [sic] the habit but I have realized I probably need counselling to explain why I do it and learn techniques to not get to that point" [Opozda 2018] "life is difficult, you are always making sacrifices, you cannot eat what you want or like. . . . you make a huge sacrifice . . . and then in a single moment . . . you lose everything" [Da Silva 2012] "I found that I obsess about food, and I obsess about my weight" [Billing-Bullen 2022]
Eating as a strategy to overcome negative emotions vs. eating in response to biological	No sub-theme 13 studies [Bocchieri 2002]	16	4	"I still have an awkward relationship with food…still have the same demons…I probably rely on food to deal with certain emotions" [Coulman 2020] "I know I have to keep staying on top of it, it's just that

triggers	[Coulman 2020] [Geraci 2014] [Knutsen 2012] [Natvik 2014] [Opozda 2018] [Tolvanen 2022] [Tolvanen 2023] [Peacock 2016] [Benson-Davies 2013] [Zijlstra 2009] [Ogden 2006] [Wright 2022] [Billing-Bullen 2022]			I'msick of protein, I'msick of water, I'm sick of working out, I'm just sick of it. I just want eat normal sometimes, but I know I just need to suck it up and deal with it. Finding that balance after the first year. . .it's so important." [Geraci 2014] "Food was coziness. Food was my friend. . . . There aren't great amounts of food here anymore, like there used to be. It was so cozy all the time. That is over. Well, we make dinner every day, but the portions are smaller." [Knutsen 2012] "I am an emotional eater. I hoped it would stop that or curve [sic] the habit but I have realized I probably need counselling to explain why I do it and learn techniques to not get to that point" [Opozda 2018] "Then [when feeling lonely] comfort eating starts again, because you think that, it's just no use. 'I can eat my chips, I can eat my chocolate, drink my soda'. [Tolvanen 2022] "Sometimes I eat for emotional reasons." [Peacock 2016] "I'll start thinking 'Oh I'm feeling full' and I actually listen to that whereas I didn't before, I mean I could just eat' 'The most incredible thing that has happened is lack of appetite ...the hunger pangs have gone, I'm sated when I eat .... I know that my stomach is smaller so I know in my head that if I have that food it will satisfy my hunger' 'You feel hungry in your head because you know you haven't eaten a lot ... it's just something to remember, that you might be hungry in your head but you're not hungry in your stomach" [Ogden 2006]

Appendix 15d. Domain: Beliefs about consequences (17 studies)

Global theme	**Sub-theme**	**Barrier**	**Enable r**	**Sample quotes**
Impact of surgery-	No sub-theme	10	14	"I can't eat some things, I get nauseous…... Since my surgery

induced food intolerance	13 studies [Billing-Bullen 2022] [Coulman 2020] [Moura de Oliveira] [Ogden 2006] [Knutsen 2012] [Sharman 2015] [Opozda 2018] [Lynch 2016] [Lin 2018] [Geraci 2014] [Jarvholm 2021] [Zijlstra 2009] [Yu 2020]			I haven't eaten anything that has come in a plastic packet……. It's just the same food every single day"; "You eat too fast because you have only got half an hour and then it comes back up"; "Water. I just sit there and burp the whole time and experience pain". "The only downfall is that I still throw up with some foods, there are some things that I can't really eat." [Billing-Bullen 2022] "I can't eat bread or meat…That's one of the small prices I have to pay…my intake of food is nowhere near balanced…" [Coulman 2020] "[...] Now I can eat, but I'm afraid of feeling sick, or for any complications to happen. Today, for me, food means limite" [Moura de Oliveira] "It's not logical; some days you can eat something and the next day you can't [Many agree]. One day you can drink a lot and the next day you can't. But it's not logical, you can't quite figure it out. (female, private surgery)" [Sharman 2015] "The unfortunate thing is the easy-to-eat foods are the ones that are bad for you like chocolate ice cream, because they dissolve in your mouth". [Biling-Bullen 2022] "Fried meat, like steak or pork chop, you know I can't eat that .... Occasionally I buy fresh fruit salad but I just find it so difficult to chew .... I find it too difficult to digest" [Ogden 2006] "The gastric band prevents bingeing, eating too fast, and guzzling. It stops you from going on and on with eating. You just cannot go on and on, that will not do. You will get sick and feel terrible" [Zijlstra 2009] "If I eat too much I start to feel sick and full up and uncomfortable so it's not worth it now" [Ogden 2006]
Impact of surgery-induced taste change	No sub-theme	1	0	"I had never thought but now it is different, food does have not the same taste, you can eat but it is not so nice, so

	1 study [Da Silva 2012]			pleasure as it was before" [Da Silva 2012]
Extent of realistic expectations from surgery	No sub-theme 3 studies [Tolvanen 2023] [Tolvanen 2021] [Knutsen 2012] [Zijlstra 2009]	4	0	"I expected that it would be easier to choose what to eat; that I would be able to choose the sandwich instead of the chocolate, cookie, crisps, etc. I thought I would manage this easily and that in the next year I would lose thirty kilograms. That it would work out that way. . ." [Zijlstra 2009] "I had hoped that the surgery would put a stop to my sweet tooth, that I would be unable to eat sweets and fat and able to stick to small meals. But that quickly became a letdown." [Tolvanen 2023] "I might have relied too much on the method itself and did not realise what I need to do myself. It's not just a quick fix" [Tolvanen 2021] "…so I am disappointed. I feel betrayed. I feel that health care has deceived me. Because when I came home from the hospital after having had the surgery, I was so happy." "I was crying, thinking 'finally, now I will be thin." [Tolvanen 2021]
Positive health benefits impacting dietary behaviour	No sub-theme 4 studies [Lin 2018] [Yu 2020] [Natvik 2014] [Hillersdal 2016]	0	6	"I know self-monitoring is very important, so I record my weight every day. Not to say I am over-concerned with my weight, but I just want to know what is happening to my body. I think the weight going up and down is not abnormal, it is just like the pattern of sunrise and sunset. But, it catches my attention if my weight increases continuously over a period of time. Then I would probably go to the gym more frequently and reduce my intake of sweetened beverages. That is my way to control weight, and I'm confident that I can do it well" [Yu 2020] "In the very beginning, I ate on the sly, but after each hospital visit, I knew that it would become worse if I didn't change. I started changing after returning home, and I am doing pretty

				good now…I don't breathe heavily when taking the stairs, holding children, or walking. I lost weight and I'm feeling better. In the past, when I went on a trip with the company, I used to walk behind everyone. Now I don't have to look at their backs anymore" [Lin 2018] "Everyone noticed that I've changed. My blood sugar levels and liver function are now normal. That's really wonderful" [Lin 2018] "I have to keep losing weight, but now it feels like my body is working with me. I feel I can be more relaxed because I can't eat very much. Before the operation, I would always go on some extreme diet to lose weight. Now I eat what I like, and in that sense it [the operation] doesn't feel extreme. It feels right" [Hillersdal 2016] "I feel hungry now. Since I'm no longer having large portion sizes and eat every three hours, like I should, then I feel hungry. Then I like to wait. I like feeling hungry, it gives me great satisfaction. Then I know that I'm the one controlling my hunger, and hunger is not controlling me" [Hillersdal 2016] "I do live more healthily. Now, I feel I can relax more and not be so strict with myself, the way I would at first. Now I allow myself a biscuit or an ice cream once in a while. Not every day—then it would go the wrong way" [Hillersdal 2016]
Avoiding surgery-induced nutritional side effect	No sub-theme 1 study [Lin 2018]	0	1	"Nutrition injections are expensive and painful. So I need to eat meat and get more protein" [Lin 2018]

Appendix 15e. Domain: Social influences (12 studies)

Global theme	Sub-theme	Barrier	Enabler	Sample quotes
Impact of family and friends	Support from family and friends 3 studies [Lin 2018] [Tolvanen 2021] [Liu 2017]	0	3	"Just after the surgery, I suffered a lot. Day and night, my family brought me water, towels, and tissues and helped clean my vomit whenever I felt bad. Sometimes it was too late and I vomited on my clothes or the floor and they cleaned up everything… My success is only thanks to them." [Lin 2018] "My husband, too, like, he says, 'Let's do it together.' Walk, or do something else. Or occasionally I have tried to cook, I have not fried or deep-fried, just more like boiled or made a salad or like lighter dishes and then he eats with me too." [Tolvanen 2021] "Family support is everything—they will be there and witness bariatric surgery 'weirdness'—things like being unable to eat more than an appetizer sized meal at a sitting, going out for dinner and ordering an entree with a 'to-go' box at the same time. it's stuff that I could not keep secret from my family if I tried! I needed their support and understanding.'' [Liu 2017]
	Pressure from family and friends 4 studies [Wright 2022] [Stewart 2010] [Tolvanen 2022] [Peacock 2016]	4	0	"it's good to catch up with people, but some people will put pressure on you to try and get you to eat things that you don't want to eat" [Wright 2022] "Some participants reported that they felt tempted or pressured to overeat when with their spouses or family members. Family members often unwittingly modelled permissive attitudes toward overeating in their attempts to be supportive, or even directly pressured participants to overindulge. [Stewart 2010]

				“And then he ordered a pizza slice or whatever it was, and then I said ‘Are you able to eat that? I´m not.’ Then he said ‘Oh, you are going to, and now I’ll show you how to drink a beer’. So, then I tried too. It’s very sad that I got that lesson.” [Tolvanen 2022] “Getting others to understand that I am not anorexic!” [Peacock 2016]
	Judgement and criticism from others 3 studies [Billing-Bullen 2022] [Tolvanen 2021] [Tolvanen 2023]	3	0	“Going out for dinner and people would say what's wrong with it? And I was like, there's nothing wrong. I just can't eat it all, sorry. And because I am still big, they look at me like - yeah right!”, “I don't like telling people because the minute you say to them that I have had weight loss surgery, they go-oh. Couldn't stick to a thing and then you have gone to a surgeon. But they don't know the aftermath of that, of what you have to go through.” [Billing-Bullen 2022] “She [mother in law] constantly comments on my weight, ‘you should lose weight’, and so I don’t feel like answering her anymore. Losing weight is the only thing I think about, still, she keeps commenting.” [Tolvanen 2021] “Family members would sometimes comfort them with sweets or, on the contrary, make negative comments about their eating behaviour that could lead to secret eating of “forbidden” foods.” [Tolvanen 2023]
	Lack of support from family and friends 4 studies [Assakran 2020] [Schiavo 2017] [Tolvanen 2021] [Peacock 2016]	4	0	“.. it would be very important, for the first year, that you have enormous support at home. I would like to have practical tips, like you have to help each other with housework, with kids and everything so you can sit down and eat your meal in peace and quiet. There needs to be time to prepare meals. That’s why it is important that your partner also invest time.” [Tolvanene 2021] “Participants also commented on the role that Others played

				in difficulties with nutrition, such as cooking separate meals for family members due to differences in diet." [Peacock 2016]
	Family members changing their own diet 1 study [Lin 2018]	0	1	This diet has also affected my family. My mother started eating the same way and her health improved. [Lin 2018]
Support from social/group sessions	No sub-theme 4 studies [Athanasiadis 2021] [Lauti 2016] [Billing-Bullen 2022] [Peacock 2016] [Stewart 2010]	0	5	"I am not alone as many are going through the same struggles" [Athanasiadis 2021] "I would have liked more follow up from someone on the team… I would prefer to have a bit more accountability to somebody as part of the team." [Lauti 2018] "I think definitely at eighteen months you shouldn't just be cast off. I think you need more support after that. And specialised support for the ones that are putting weight on", "She's put on a multitude of weight. I kick her butt. I turn up on her doorstep and say, "Right, put your running shoes on, we're going for a walk. That sort of thing is where I think you need the support" [Lauti 2016] "I thought it was really good that you heard that people were struggling the same as you. That made you feel normal because you think it's only you that's scared of putting on the weight again or feels guilty…". "It was nice to know that someone else was going through the same kind of thing and to get ideas off other people you know that's really valuable." [Billing-Bullen 2022] "I sought out nutritional counselling individually." "My boyfriend who is a chef." "I only had dietary services before the surgery. The only post surgery help I had was people I know at work that had the surgery and they helped me more

				than the professionals. It helps that I work in a hospital, too." [Peacock 2016] "Participants discussed why peer support was such an important part of this program. Participants were relieved to find that other participants had experienced similar challenges after losing weight with RYGBP. They felt that it was important that they be able to discuss their emotional struggle with food and their disappointment that these struggles seemed to return after a period of relative relief. They talked about how family and friends often had difficulty understanding their struggles with eating, and that sharing with others who did understand helped them to feel less alone in their struggle. They also felt encouraged by each other's successes, and supported each other through their challenges. Participants also modeled the cognitive-bahvioural strategies they were learning in group for one another. Participants frequently noted when another participant was thinking negatively about a ''setback'' situation. When a participant made a statement such as ''I was terrible this week,'' others provided more realistic and supportive statements such as ''You can't always be perfect'' or ''You'll do better next time,'' and encouraged her to think about what was learned from the ''setback.'' In their feed-back, participants rated peer support as the number one benefit to participating in group, and both groups decided to exchange e-mail addresses so that they could continue to meet informally after completing the group. This suggests that group format is highly desirable among this particular subset of RYBGP patients." [Stewart 2010] "I had no guidance of what food I could eat or how much." [Peacock 2016]

Eating in social events	No sub-theme 3 studies [Billing-Bullen 2022] [Tolvanen 2023] [Peacock 2016]	5	0	"Culturally we celebrate and socialise. At family gatherings, it is all around the food". "Everything we seemed to do was always around food or a meal or drinks. My mum struggles with that because she wants to go out for lunch and she is like I'll get a coffee and I'll get this and I'm like, I can only have one or the other. And she still can't get her head around that, you know? That I can't eat and drink at the same time." [Billing-Bullen 2022] "I think it's just society in general. Even in work meetings and things, it is almost rude not to eat something, even if you are not hungry or you don't feel like it. It is odd to have food in front of you and sit there and not have anything" "And when you have that relationship with food and it's a transition, but I wasn't prepared. At the start, I didn't realise that I was going to feel that way and because food was such a social thing for me and lots of my life revolved around consuming food and sharing food …all of a sudden, I felt isolated and so at the start I didn't expect that I didn't know that that was even going to be a thing." [Billing-Bullen 2022] Dining Out was the most frequently reported barrier "Eating out at restaurants." [Peacock 2016] "When I'm around people, I behave myself but as soon as that door shuts or I am on my own, it's like let me loose". [Billing-Bullen 2022] "Social eating was perceived as particularly challenging leading to consumption of high-energy-dense foods and drinks." [Tolvanen 2023]
Encouragement and support from HCPs	No sub-theme 2 studies [Lin 2018] [Liu 2017]	0	3	"I follow the diet rules, and I don't eat spicy food and or drink soft drinks. I only drink milk, yogurt, or water. I drink about 2 liters per day. I am grateful that the doctor gave me another chance to undergo surgery." "I believe there are more advantages than disadvantages because there are always ways

				to make changes. You should just eat well and do what the doctors and nurses tell you to do, then there will be no problem" [Lin 2018] "received a lot of post-care literature for after surgery care; including diet plans, post-care of surgical area, medicine prescriptions, medical appointment with family doctor, and a complete procedure [package] sent to [my] family doctor regarding surgical and post-procedures.'' [Liu 2017] ''[The] hospital staff was second to none. [They were] very knowledgeable about post-bypass procedures and diet and were emotionally supportive during the initial upheaval and fluid diet, etc.'' [Liu 2017]
Impact of media, e.g. marketing and advertising	No sub-theme 1 study [Billing-Bullen 2022]	1	0	"Being influenced by food product advertisements e.g., chocolates at Easter" [Billing-Bullen 2022]

Appendix 15f. Domain: Memory, attention and decision processes (7 studies)

Global theme	**Sub-theme**	**Barrier**	**Enabler**	**Sample quotes**
Being mindful and conscious of one's eating behaviour	No sub-theme 2 studies [Opozda 2018] [Benson-Davies 2013]	1	1	"I am now more mindful and aware of what goes in my mouth" [Opozda 2018] ''My food choices are my biggest problem.'' [Benson-Davies 2013] ''I don't eat that much food. It is what I'm eating that's the problem.'' [Benson-Davies 2013]
Restructuring thoughts about food	No sub-theme 2 studies	0	2	''Eating this cookie will make me feel better'' was replaced with ''Eating this cookie will distract me for a moment, but the feeling will still be there when I'm

	[Opozda 2018] [Stewart 2010]			done' [Stewart 2010] "I don't feel attracted to the same junk foods I was pre-surgery" [Opozda 2018]
Constantly thinking about food and being aware of what I eat	No sub-theme 4 studies [Lynch 2016] [Da Silva 2012] [Zijlstra 2009] [Opozda 2018]	4	3	"constantly think about food" or "be aware of everything I eat" [Lynch 2016] "I am always hungry, always thinking what I should eat or what I desire to eat. . . . and then I am very hungry, hungry, hungry." [Da Silva 2012] "I am still obsessed with food because I am still overweight" [Opozda 2018] "I still think about food all the time but because I physically can't eat the amounts that I did before, I don't let it dictate. It is actually secondary to the things I am doing with my life" [Opozda 2018] "I forget about food if I get busy – I don't have a constant, gnawing hunger whether I've already eaten or not" [Opozda 2018]

Appendix 15g. Domain: Knowledge (6 studies)

Global theme	Sub-theme	Barrier	Enabler	Sample quotes
Having knowledge about healthy eating, cooking, and the role of diet	No sub-theme 5 studies [Assakran 2020] [Billing-Bullen 2022] [Peacock 2016] [Tolvanen 2023] [Opozda 2018]	5	1	"I am a terrible cook…but have ordered wls cookbook for dummies…lol hopefully this helps." [Peacock 2016] "It might sound a bit stupid, but I don't know about calories, protein, or what they are or anything like that. So, when they talked about carbs, I understood zero. Because I didn't know what it was. And I wanted that information to understand what they were talking about" [Tolvanen 2023] "…. maybe a little bit of advice of what we do and don't need to do before we go for the operation. Because I actually thought I was going to come out and look like Barbie" [Billing-Bullen 2022] "I now eat largely organic foods. I eat full fat but low sugar. I now rarely eat red meat but fish, chicken and a lot of legumes and veg. I drink a lot less alcohol. I am a lot more informed about what I eat" [Opozda 2018]
Limited health literacy	No sub-theme 1 study [Funk 2023]	1	0	"I think there's a great degree based on educational status how patients understand exactly what is expected of them to make them achieve a great result." [Funk 2023]

Appendix 15h. Domain: Beliefs about capabilities (6 studies)

Global theme	Sub-theme	Barrier	Enabler	Sample quotes

Poor Self-efficacy/ self-confidence	No sub-theme 1 study [Peacock 2016]	1	0	“I am a terrible cook…but have ordered wls cookbook for dummies…lol hopefully this helps.” [Peacock 2016]
Perceived control on their behaviour	No sub-theme 6 studies [Peacock 2016] [Yates 2020] [Ogden 2006] [Geraci 2014] [Moura de Oliveira 2016] [Hillersdal 2016]	2	4	“I was brought up [thinking that] you eat everything on that plate or you don’t leave the table … But, if I look at a meal now and there is one mouthful left but because of the sleeve I do feel full, I just push it away.” [Yates 2020] “I can control the amount that I eat, the portions that I eat are small, they’re satisfying .... I don’t obsess about food anymore .... I think about what I’m putting in my mouth but not the point where it controls me. I feel that I am back in control of my body .... It’s about learning about how to eat from scratch and it’s a new start for me’ ‘I’ve had to work with the operation. I mean I am proud of myself in that I could have just sat down and ate hundreds and hundreds of bars of chocolate ...so I have worked at it as well” [Ogden 2006] “As far as eating. . .I can eat many more calories at one time than I used to be able to eat when recently post-op. You do have more hunger, though you still cannot eat like you used to. . .and I have a bitmore of a desire to eat than I did the first year. . .I’m still restricted in how much I can eat and eat about 3 ounces of dense protein and 1 ounce of vegetables and 1 ounce of starch for a meal.” [Geraci 2014] "My brain wants me to eat and my mouth wants me to eat, I’m still like that but my body doesn’t". "Now I feel that the control is taken out of my hands. I didn’t have that control over my body because my stomach controlled everything. If I eat too much I’m sick so I don’t have the control anymore ...that’s a good thing because I couldn’t

				control on my own" [Ogden 2006] "[...] I went through this whole process and I do not want to get fat again [...] the candy remains in my life. I had the surgery in the stomach, but the head still wants candy. [...] I feel I'm regressing [...] gained weight [...] continue with to believe I am fat" [Moura de Oliveira 2016]

Appendix 15i. Domain: Intentions (3 studies)

Global theme	**Sub-theme**	**Barrier**	**Enabler**	**Sample quotes**
Intention for adapting to the new life	No sub-theme 3 studies [Natvik 2014] [Zijlstra 2009] [Graham 2017]	2	2	"Rhythm is a must . . . to eat less and more frequently. . . . It's not like before, when you come home from work feeling that you could eat an ox. Now you notice rumbling and noises when it's empty. And I feel dizzy if I don't eat. . . . I try to think about how I eat in general . . . I became intolerant to alcohol, so I don't drink. I'm careful with what I eat, avoiding fat and sugar; if not, I'm taken by the runs [diarrhea]. . . . I take the weekends off, without worrying about the consequences. . . . I eat the things which I shouldn't and become ill the next morning, but after a few hours I'm fine. I've chosen to live like this" [Natvik 2014] "I am more aware of what I eat and how I eat. I know I have to eat quietly and chew well. (...) When one eats too fast or too carelessly, it gets stuck and one thinks 'I have the gastric band and that is not without reason!" [Zijlstra 2009] "I rarely have a cup of tea now. I used to drink it like it was going out of style….I don't know if I'm replacing the sugar hit now, but I drink more pop [carbonated drinks] than I did before and I still put sugar in my tea" [Graham 2017]

				"She said that she now accepted her weight and was no longer preoccupied with dieting" [Zijlstra 2009]

Appendix 15j. Domain: Skills (2 studies)

Global theme	**Sub-theme**	**Barrier**	**Enabler**	**Sample quotes**
Patients acquired new dietary and behavioural skills	No sub-theme 2 studies [Lynch 2016] [Tolvanen 2022]	2	1	"setting myself up for success," [Lynch 2016] "So keep your meal times, it's very important. Because it is the same thing there, no one told me that 'you should eat between 5 to 6 times / day' that is what I have heard. Now I think you should eat up to 6–7 times a day even. So, I have a "food-and sleep- alarm' that goes off and reminds me when to eat, because otherwise I forget it." [Tolvanen 2022]

Appendix 15k. Domain: Goals (1 study)

Global theme	**Sub-theme**	**Barrier**	**Enabler**	**Sample quotes**
Relative priorities and motivators	No sub-theme 1 study [Lin 2018]	0	1	"I want to live long for our newborn baby. I'm going to stay strong and cherish myself. I don't want to go back to the days when I was being laughed at" [Lin 2018]