






REVIEW

Behaviour change theories and techniques used to inform nutrition interventions for adults undergoing bariatric surgery: A systematic review

Charlene Wright MNutDietPrac, APD¹  |
Amandine Barnett MNutDietPrac, APD²  | Katrina L. Campbell PhD, APD^{1,3}  |
Jaimon T. Kelly PhD, APD^{2,4}  | Kyra Hamilton PhD^{5,6} 

¹School of Medicine and Dentistry, Centre of Applied Health Economics and Menzies Health Institute Queensland, Griffith University, Southport, Queensland, Australia

²Centre for Online Health, Faculty of Medicine, The University of Queensland, Herston, Queensland, Australia

³Healthcare Excellence and Innovation, Metro North Hospital and Health Service, Herston, Queensland, Australia

⁴Centre for Health Services Research, The University of Queensland, Saint Lucia, Queensland, Australia

⁵School of Applied Psychology, Griffith University, Mount Gravatt, Queensland, Australia

⁶Health Sciences Research Institute, University of California, Merced, California, USA

Correspondence

Charlene Wright, School of Medicine and Dentistry, Centre of Applied Health Economics and Menzies Health Institute Queensland, Griffith University, 1 Parklands Drive, Southport, QLD 4215, Australia.
Email: charlene.wright@griffithuni.edu.au

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Abstract

Aim: This systematic review aimed to describe behaviour change theories and techniques used to inform nutrition interventions for adults undergoing bariatric surgery.

Methods: A systematic search was conducted across PubMed, PsycInfo, CENTRAL, EMBASE and CINAHL from inception until 09 March 2021. Eligible studies were randomised controlled trials involving nutrition interventions performed by a healthcare provider, to adults that were waitlisted or had undergone bariatric surgery and received a nutrition intervention explicitly informed by one or more behaviour change theories or behaviour change techniques. Screening was conducted independently by two authors. Behaviour change techniques were examined using the behaviour change technique taxonomy version one which includes 93 hierarchical techniques clustered into 16 groups. Quality of included studies was assessed using Cochrane risk of bias 2.0.

Results: Twenty-one publications were included, involving 15 studies and 14 interventions, with 1495 participants. Bias was low or had some concerns. Two interventions reported using behaviour change theories (transtheoretical model and self-determination theory). Thirteen behaviour change technique taxonomy groupings and 29 techniques were reported across 14 interventions. Common techniques included '1.2 Problem solving' ($n = 9$ studies), '3.1 Social support (unspecified)' ($n = 9$ studies), '1.1 Goal setting (behaviour)' ($n = 6$ studies) and '2.3 Self-monitoring of behaviour' ($n = 6$ studies).

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Conclusion: While behaviour change techniques have been included, behaviour change theory is not consistently reported and/or adopted to inform nutrition interventions for adults undergoing bariatric surgery. Integrating behaviour change theory and techniques in nutrition interventions is important for researchers and bariatric surgery teams, including dietitians, to effectively target behaviours for this population.

KEYWORDS

bariatric surgery, behavior change technique, behaviour change theory, behavioural research, nutrition intervention, systematic literature review

1 | INTRODUCTION

An increasing number of individuals are presenting for weight loss treatment, and bariatric surgery is recognised as an effective option.¹ In Australia, there has been a 2.4-fold increase with 9300 surgeries performed during the financial year 2005/2006 and 21043 in 2018/2019.^{2,3} In this field, the care team, including dietitians, work with patients to navigate post-operative nutritional recommendations, identify history or re-emergence of disordered eating with on-going dietary monitoring, recognise mental health factors and employ counselling and behaviour change.⁴ The National Health and Medical Research Council highlights the need for additional post-operative lifestyle management support and recommends behaviour change strategies as integral.⁵

There is a substantial proportion of bariatric surgery patients who experience weight regain or insufficient weight loss.¹ Behavioural predictors of weight regain include increased food urges, decreased well-being and concerns over alcohol or drug use.⁶ Additional risk factors include anxiety, binge eating, emotional eating, portion size and sugary food and drink consumption.⁷ Willingness to change habits, self-esteem, social support and quality of life are negatively associated with post-operative weight regain.⁷

Behaviour change theories help to identify potentially effective content for interventions and the processes by which that content is thought to change behaviour.⁸ It is important to consider the link between intervention content and the theoretical constructs through which the content is proposed to exert effects. Intervention content is commonly based on a set of behaviour change techniques.⁸ Understanding the mechanisms through which these techniques can modify behaviour is important for the development and evaluation of effective behavioural interventions.

Behaviour change interventions can be complex and interacting components can make it difficult to replicate

in research and practically apply.⁹ There have been efforts to standardise the reporting of behaviour change interventions and their theoretical underpinnings,⁹ which may facilitate communication across disciplines, and strengthen intervention replication and implementation. The behaviour change technique taxonomy, for example, provides a standardised classification system of intervention techniques.⁹ Furthermore, frameworks such as intervention mapping,¹⁰ the PRECEDE-PROCEED model,¹¹ and the behaviour change wheel,¹² further support the transition from theory to intervention. Understanding the active components of interventions is essential for translating evidence-based interventions into practice; however, this depends on the available body of evidence.⁹ This systematic review aimed to describe behaviour change theories and techniques used to inform nutrition interventions for adults undergoing bariatric surgery.

2 | METHODS

This systematic literature review was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement,¹³ and was prospectively registered with PROSPERO (CRD42021240813).

Studies were searched across five electronic databases: PubMed (including MEDLINE), PsycInfo (via Ovid), CENTRAL, EMBASE and CINAHL (via EBSCOhost) from database inception up until 09 March 2021. The search strategy used a combination of keywords and translated to the other databases using CREBP-SRA Polyglot Search Translator (Table S1).¹⁴ Translated search terms were checked for accuracy and modified after assessment for each database. An experienced systematic review search librarian was consulted throughout the search execution. There were no language restrictions applied. Reference lists of all included articles and relevant systematic reviews were screened to identify any additional studies.

To be eligible for inclusion, each study had to satisfy the inclusion criteria regarding population, intervention, comparison, outcome and study design. Eligible studies were randomised controlled trials involving nutrition interventions performed by a bariatric surgery healthcare provider, to adults (≥ 18 years) that were waitlisted or had undergone bariatric surgery, and received a nutrition intervention explicitly informed by one or more behaviour change theories or behaviour change techniques. Bariatric procedures considered were any open, laparoscopic or endoscopic procedure used to manage obesity. Behaviour change theories include ecological model, health action process approach, health belief model, integrated theories, model of action phases, protection motivation theory, self-determination theory, social cognitive theory, theory of planned behaviour, and trans-theoretical model. Comparison needed to be usual care or minimal care (nutrition-related print materials, information booklets or information regarding the individual's health status) without the use of behaviour change theory or no intervention delivered. In addition, at least one of the following outcomes needed to be included; eating behaviours, dietary intake (measured with a validated assessment tool), anthropometric measures, clinical measures, or psychological outcomes. Conference papers, dissertations, abstracts without full text and protocol papers where it was not possible to identify a published result paper were excluded.

Duplicate records were removed using Endnote (version 9.3.3). Records were screened for potentially eligible studies based on title and abstract by two independent investigators. Full texts were reviewed to confirm eligibility by two independent investigators; disagreements were managed by consensus or a third reviewer when required.

Data were extracted by one researcher, checked for accuracy by a second researcher and any discrepancies were corrected through discussion. Data extracted included author, publication date, country, study design, setting, participant characteristics (age, gender and pre-operative body mass index), intervention characteristics (detail, duration, delivery personnel), control characteristics (detail, duration, delivery personnel), behaviour change theory and techniques, study aim, primary outcomes as listed in the published papers and associated measures of effectiveness. Data were extracted, tabulated and synthesised narratively.

Behaviour change techniques applied in the interventions were examined using the behaviour change technique taxonomy version one.^{9,15} The behaviour change technique taxonomy is considered the standard for reporting on techniques in health behaviour change literature,¹⁶ and includes 93 hierarchical techniques clustered into 16 groups.^{9,15} The behaviour change technique

taxonomy includes a descriptions table which denotes a number, label, definition and examples for each technique; demonstrated in Table S2. The groups within the behaviour change technique taxonomy do not have definitions or examples associated with them.

The full text of the included reports and additional relevant supplementary material or protocols were uploaded into NVivo.¹⁷ Intervention details within the manuscripts, tabulated results and supplementary material were analysed and coded. If the intervention was reported to be described in a prior publication, this publication was sourced and coded. One researcher initially coded behaviour change techniques according to exact phrases and specific terminology included in the behaviour change technique taxonomy description table (demonstrated in Table S2); herein referred to as 'objective' coding. The consistency of the coding was checked by a second researcher (a behavioural scientist). If techniques could not be coded according to exact phrases and specific terminology; yet, subjectively were able to be interpreted as being consistent with the behaviour change technique taxonomy, a 'subjective' code was applied by one researcher. This was checked by the second researcher, and any disagreements were resolved through discussion.

When studies explicitly reported a group rather than individual behaviour change techniques, for example, '1.0 Goals and planning', an objective code was applied to that group. Some studies described intervention components that could not be mapped to individual behaviour change techniques yet were subjectively determined to fit within a group. For example, an intervention providing psychoeducation on body image would be subjectively coded to the group '4.0 Shaping knowledge' as it did not meet the exact criteria to be coded as any of the behaviour change techniques under this group. Criteria were formed to provide some systematic approach to the subjective coding to groupings (Table 1). The frequency and total number of behaviour change techniques used in each study only include techniques that were determined through objective coding and do not include those coded subjectively. Techniques that were ambiguous and could not be mapped to the behaviour change technique taxonomy were coded as 'unspecified'.

Studies were assessed for risk of bias using the Cochrane risk of bias 2.0 tool,¹⁸ by two investigators independently, with disagreements managed by consensus. The risk of bias in the domain of 'bias in measurement of the outcome' depends on whether the method of measuring the outcome is appropriate, whether measurement or ascertainment of the outcome differs or could differ between intervention groups, who is the outcome

assessor, whether the outcome assessor is blinded to intervention assignment and whether the assessment of outcome is likely to be influenced by knowledge of intervention received. The primary outcomes as listed in the published papers were extracted and the risk of bias applies to these outcomes. Within the present study, our primary interest is the reported behaviour change theories and techniques.

3 | RESULTS

The flow of study identification and selection is detailed in Figure 1. The search identified 6474 publications. Twenty-one reports were included, involving 15 studies and 14 interventions. Two separate studies utilised the same intervention, one delivering the intervention pre-operatively and the other post-operatively.^{19,20}

TABLE 1 Taxonomy grouping and related criteria to allow intervention components to be coded despite not directly mapping to one of the behaviour change techniques under each grouping

No	Group label ^a	Criteria
4.0	Shaping knowledge	Related to knowledge, ⁵² and includes psychoeducation.
5.0	Natural consequences	May include the word consequences and includes implications.
7.0	Associations	Relating to cues and cue responses, ⁵² and includes triggers.
10.0	Reward and threat	Relating to the anticipation of a direct reward or punishment. ⁵²
15.0	Self-belief	Beliefs about capabilities and optimism. ⁵²

^aWhile there are 16 groupings in the behaviour change technique taxonomy,⁹ the establishment of criteria was only required for five groupings.

FIGURE 1 Preferred Reporting Items for Systematic Reviews and Meta-Analysis flowchart,¹³ of the literature search and filtering results for a systematic review of interventions delivered in bariatric health care that are informed by behaviour change theories or techniques

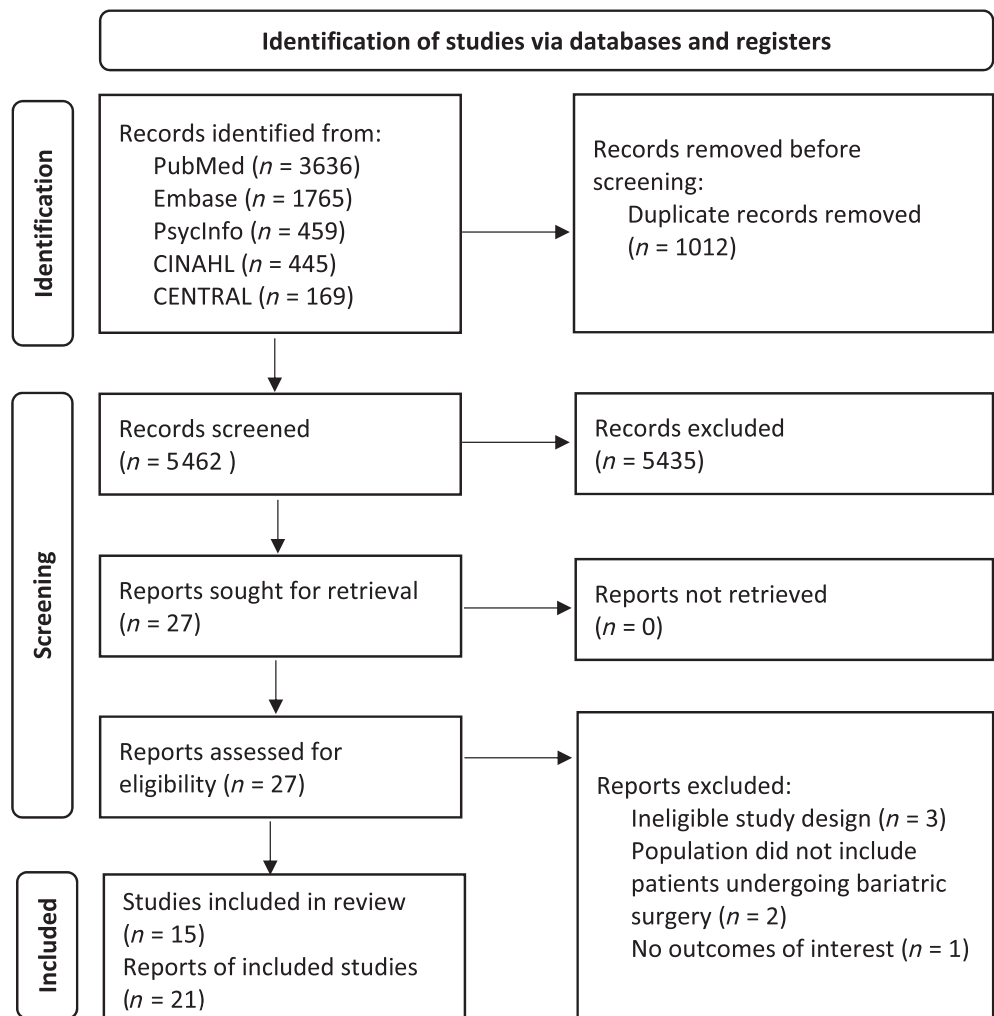


TABLE 2 Characteristics of studies with interventions delivered in bariatric health care and informed by behaviour change theories or techniques compared with controls underpinned by no theory, usual/minimal care or having received no contact

Author, year	Population: sample size; retention at longest follow up; age mean \pm SD; % female; pre-operative body mass index (BMI)	Intervention: detail; duration and intensity; delivery personnel	Control: detail; duration; delivery personnel	Behaviour change theory; total number of behaviour change techniques
<i>Pre-operative intervention (n = 3, 3 interventions)</i>				
Camolas et al., ³⁹ 2017	Sample size: N = 94 (Intervention n = 45, Control n = 49) Retention: 64% Age: Intervention 46.3 \pm 13.7 years, Control 43.5 \pm 13.9 years Gender: 81% female BMI: Intervention 42.8 \pm 5.0 kg/m ² , Control 43.5 \pm 7.0 kg/m ²	Pre-operative lifestyle focused nutritional intervention; 4 \times bimonthly consultations; nutritionist	Minimal care; 2 \times sessions; nutritionist	Trans-theoretical model and self-determination theory; behaviour change techniques n = 6
<i>Pre- and post-operative intervention (n = 3, 2 interventions)</i>				
Cassin et al., ¹⁹ 2016 ^a	Sample size: N = 47 (Intervention n = 23, Control n = 24) Retention: 75% Age: 45.5 \pm 8.9 years Gender: 83% female BMI: 53.1 \pm 12.0 kg/m ²	Pre-operative telephone-based cognitive behavioural therapy; 6 \times weekly sessions of 55 min; 2 \times Master-level psychometrists	Usual care; duration and delivery personnel not detailed	No theory; behaviour change techniques n = 24
Paul et al., ³⁰ 2021	Sample size: N = 130 (Intervention n = 65, Control n = 65) Retention: 82% Age: 41.7 \pm 9.7 years Gender: 74% female BMI: Intervention 42.7 \pm 5.0 kg/m ² , Control 43.4 \pm 5.4 kg/m ²	Pre-operative cognitive behavioural therapy sessions; 10 \times weekly sessions of 45-min duration; delivery personnel not detailed	Usual care; duration and delivery personnel not detailed	No theory; behaviour change techniques n = 14
<i>Pre- and post-operative intervention (n = 3, 2 interventions)</i>				
Kalarchian et al., ²⁶ 2013 and Kalarchian et al., ²² 2016	Sample size: N = 240 (Intervention n = 121, Control n = 119) Retention: 60% Age: 44.9 \pm 11.0 years Gender: 90% female BMI: 45.5 \pm 6.3 kg/m ²	Pre-operative behavioural lifestyle intervention; 6 months, comprising 24 weekly contacts n = 12 face-to-face and n = 12 telephone and 3 \times monthly telephone contacts post-operatively; delivery personnel not detailed	Usual care; 6 months; delivery personnel not detailed	No theory; behaviour change techniques n = 20

TABLE 2 (Continued)

Author, year	Population: sample size; retention at longest follow up; age mean ± SD; % female; pre-operative body mass index (BMI)	Intervention: detail; duration and intensity; delivery personnel	Control: detail; duration; delivery personnel	Behaviour change theory; total number of behaviour change techniques
Ogden et al., ²⁹ 2015	Sample size: <i>N</i> = 162 (Intervention <i>n</i> = 82, Control <i>n</i> = 80) Retention: 90% Age: 45.2 ± 10.8 years Gender: 75% female BMI: 50.7 ± 7.8 kg/m ²	Pre- and post-operative usual care plus a health psychology led bariatric rehabilitation service; 3 × individual sessions of 50-min durations; health psychologist	Usual care; 12 months; dietitian or specialist nurse	No theory; behaviour change techniques <i>n</i> = 2
<i>Post-operative intervention (n = 15, 10 interventions)</i>				
Cassin et al., ²⁰ 2020 ^a	Sample size: <i>N</i> = 122 (Intervention <i>n</i> = 61, Control <i>n</i> = 61) Retention: 82% Age: 48.4 ± 8.5 years Gender: 82% female BMI: not specified	Post-operative telephone-based cognitive behavioural therapy; 6 × weekly sessions of 60 min and 1 × 60-min 'booster' session 1 month after the 6th session; 4 × clinical psychology graduate students	Usual care; duration and delivery personnel not detailed	No theory; behaviour change techniques <i>n</i> = 25
Chacko et al., ²¹ 2016	Sample size: <i>N</i> = 18 (Intervention <i>n</i> = 9, Control <i>n</i> = 9) Retention: 100% Age: Intervention 53.4 ± 5.6 years, Control 54.5 ± 7.8 years Gender: 84% female BMI: Intervention 32.3 ± 6.2 kg/m ² , Control 36.6 ± 8.0 kg/m ²	Post-operative mindfulness-based intervention; 10 × weekly sessions of 90 min; a qualified mindfulness instructor	Usual care; 60 min session; dietitian	No theory; behaviour change techniques <i>n</i> = 12
David et al., ²⁸ 2016	Sample size: <i>N</i> = 51 (Intervention <i>n</i> = 23, Control <i>n</i> = 28) Retention: 86% Age: 49.2 ± 9.1 years Gender: 87% female BMI: not specified	Post-operative adapted motivational interviewing session; 1 × session of 107.9 ± 26.3 min; Master's level clinical psychology student	Waitlist control group; 12 weeks; delivery personnel not detailed	Transftheoretical model; behaviour change techniques <i>n</i> = 11
Gade et al., ³⁷ 2014, Gade et al., ³⁸ 2015 and Hjelmæsæth et al., ³⁶ 2019	Sample size: <i>N</i> = 102 (Intervention <i>n</i> = 50, Control <i>n</i> = 52) Retention: 60% Age: 42.4 ± 10.1 years Gender: 70% female BMI: 43.5 ± 4.4 kg/m ²	Post-operative cognitive behavioural therapy intervention; 10 weeks <i>n</i> = 5 via face to face and <i>n</i> = 6 via telephone; delivery personnel not detailed	Usual care; duration not detailed; medical doctor, dietitian, nurse or physical therapist	No theory; behaviour change techniques <i>n</i> = 10

(Continues)

TABLE 2 (Continued)

Author, year	Population: sample size; retention at longest follow up; age mean \pm SD; % female; pre-operative body mass index (BMI)	Intervention: detail; duration and intensity; delivery personnel	Control: detail; duration; delivery personnel	Behaviour change theory; total number of behaviour change techniques
Lauti et al., ³⁵ 2018	Sample size: $N = 95$ (Intervention $n = 47$, Control $n = 48$) Retention: 89% Age: Intervention 47.0 ± 8.8 years, Control 45.6 ± 7.2 years Gender 74% female BMI: Intervention 42.4 ± 6.0 kg/m ² , Control 42.5 ± 7.9 kg/m ²	Post-operative text messages based on behaviour change techniques; daily for 12 months; delivery personnel not detailed	Usual care; 12 months; delivery personnel not detailed	No theory; behaviour change techniques $n = 12$
Lent et al., ²³ 2019	Sample size: $N = 50$ (Intervention $n = 24$, Control $n = 26$) Retention 82% Age: Intervention 47.6 ± 9.1 years, Control 46.2 ± 12.0 years Gender: 82% female BMI: Intervention 47.1 ± 6.7 kg/m ² , Control 50.4 ± 6.2 kg/m ²	Post-operative behavioural intervention based on cognitive behavioural therapy, 8 \times 60-min group sessions over 16 weeks; co-led by a licenced clinical psychologist or doctoral-level psychology trainee	Usual care; duration and delivery personnel not detailed	No theory; behaviour change techniques $n = 15$
Nijamkin et al., ²⁴ 2012 and Nijamkin et al., ²⁷ 2013	Sample size: $N = 144$ (Intervention $n = 72$, Control $n = 72$) Retention 92% Age: 44.5 ± 13.5 years Gender: 83% female BMI: Intervention 35.4 ± 5.3 kg/m ² , Control 36.5 ± 6.4 kg/m ²	Post-operative comprehensive nutrition education and behaviour modification intervention; 6 \times fortnightly group sessions of 90-min duration; registered dietitian and psychologist	Minimal care; 6 months; delivery personnel not detailed	No theory; behaviour change techniques $n = 13$
Sarwer, ²⁵ 2012	Sample size: $N = 84$ (Intervention $n = 41$, Control $n = 43$) Retention: 46% Age: 42.0 ± 9.9 years Gender: 63% female BMI: 51.6 ± 9.2 kg/m ²	Post-operative in-person dietary counselling; 8 \times fortnightly sessions of 15-min duration (face to face or telephone—participant preference); registered dietitian	Usual care; duration not detailed; dietitian	No theory; behaviour change techniques $n = 2$

TABLE 2 (Continued)

Author, year	Population: sample size; retention at longest follow up; age mean \pm SD; % female; pre-operative body mass index (BMI)	Intervention: detail; duration and intensity; delivery personnel	Control: detail; duration; delivery personnel	Behaviour change theory; total number of behaviour change techniques
Weineland et al., ³² 2012 and Weineland et al., ³¹ 2012	Sample size: $N = 39$ (Intervention $n = 19$, Control $n = 20$) Retention: 74% Age: Not described Gender: 90% female BMI: Mean 37 (range 31–47) kg/m ²	Post-operative acceptance and commitment therapy; 2 \times face to face sessions, plus a 6-week treatment via the internet, plus 6 \times weekly telephone session of a 30-min duration; nurse and a nutritionist	Usual care; duration not detailed; operating-surgeon, bariatric nurse and specialised dietitian.	No theory; behaviour change techniques $n = 7$
Wild et al., ³⁴ 2015 and Wild et al., ³³ 2017	Sample size: $N = 117$ (Intervention $n = 59$, Control 58) Retention: 63% Age: Intervention 41.4 ± 8.8 years, Control 41.3 ± 9.8 years Gender: 69% female BMI: Intervention 35.2 ± 6.3 kg/m ² , Control 35.0 ± 6.3 kg/m ² (at baseline)	Post-operative psychoeducational videoconferencing-based group intervention 5 \times face-to-face group interventions (≤ 6 patients, for 90 min each), 6 \times videoconferencing sessions in smaller groups (3 patients, 50 min each) and 3 \times face-to-face group sessions over 12 months; delivery personnel not detailed	Usual care; duration not detailed; surgeon	No theory; behaviour change techniques $n = 9$

Abbreviations: BMI, body mass index; SD, standard deviation; y, years.

^aWhile Cassin et al. (2016) and Cassin et al. (2020) are different in that one was delivered pre-operatively,¹⁹ and the other post-operatively,²⁰ they both used the same intervention.

TABLE 3 Setting, study aim, primary outcomes, measures and significant results for a systematic review on interventions delivered by one or more bariatric surgery healthcare provider in bariatric health care and informed by behaviour change theories compared with controls underpinned by no theory, usual/minimal care or having received no contact

Author, year	Setting	Study aim	Primary outcome(s) ^a and measure(s)	Intervention effect compared to control ^b
<i>Pre-operative intervention</i>				
Camolas et al., ³⁹ 2017	Obesity treatment unit of a hospital	'Evaluate the effect of a pre-operative life-style focused nutritional intervention on weight and metabolic control and the impact of the intervention on psychosocial variables associated with successful weight-control'.	Weight and metabolic control indicators via body mass index (BMI), total weight loss (TWL%), excess weight loss (EWL%), fasting insulin and glycaemia and HbA1c at the end of the intervention which was 6 months	↓ BMI ($p = 0.001$) ↑ TWL% ($p = 0.001$) ↑ EWL% ($p = 0.001$) ↓ fasting glycaemia ($p = 0.019$) ≠ fasting insulin ($p \geq 0.05$) ≠ HbA1c ($p \geq 0.05$)
Cassin et al., ¹⁹ 2016	Bariatric surgery programme	'Examine the efficacy of a pre-operative telephone-based CBT intervention versus standard pre-operative care for improving eating psychopathology and psychosocial functioning'.	Eating psychopathology via binge eating scale (BES) and emotional eating scale (EES) at the end of the intervention which was 6 weeks	↓ BES ($p = 0.01$) ↓ EES ($p = 0.002$)
Paul et al., ³⁰ 2021	A community mental health centre and two general hospitals.	'Investigate the added value of 10 sessions of CBT [cognitive behavioural therapy] prior to bariatric surgery compared to the standard preparation/treatment-usual procedure in the hospital for long-term maintenance of weight loss and psychological well-being'.	NR; BMI and weight change by TWL%, eating behaviour via Dutch eating behaviour questionnaire (DEBQ), eating disorders via eating disorder examination questionnaire (EDE-Q), depressive symptoms via the quick inventory of depressive symptomatology (QIDS-SR), quality of life via the World Health Organization quality of life assessment (WHOQoL-BREF), psychological distress via brief symptom inventory (BSI) and global severity index (GSI), at the end of the intervention which was 10 weeks and at 1-year follow-up	≠ BMI ($p \geq 0.05$) ≠ TWL% ($p \geq 0.05$) ≠ DEBQ ($p \geq 0.05$) ≠ EDE-Q ($p \geq 0.05$) ≠ QIDS-SR ($p \geq 0.05$) ≠ WHOQoL-BREF ($p \geq 0.05$) ≠ BSI and GSI ($p \geq 0.05$) For both 10 weeks and 1-year follow-up
<i>Pre- and post-operative intervention</i>				
Kalarchian et al., ²⁶ 2013 (initial study)	Bariatric Centre of Excellence at a large, urban medical centre	'Document pre-operative outcomes of a behavioural lifestyle intervention delivered to patients prior to bariatric surgery in comparison to treatment as usual'.	NR; TWL (kg), BMI, depression via Beck's depression inventory (BDI), binge eating via the overeating section on the eating disorder examination (EDE-Q), eating behaviours via eating behaviour inventory (EBI), at the end of the intervention which was 6 months	↑ TWL (kg) ($p < 0.0001$) ≠ BDI ($p = 0.54$) ≠ EDE-Q for subjective ($p = 0.47$) and objective ($p = 0.72$) bulimic episodes ↑ EBI ($p = 0.0004$)

TABLE 3 (Continued)

Author, year	Setting	Study aim	Primary outcome(s) ^a and measure(s)	Intervention effect compared to control ^b
Kalarchian et al., ²² 2016 (follow up study)	Bariatric Centre of Excellence at a large, urban medical centre	'Evaluate whether a pre-surgery behavioural lifestyle intervention improves weight loss through 24 months post-surgery'.	NR; TWL (kg) at 6, 12 and 24 months post-operatively	≠ TWL (kg) at 6 months ($p = 0.12$) and 12 months ($p = 0.12$) ≠ TWL (kg) at 24 months ($p = 0.02$) ^c
Ogden et al., ²⁹ 2015	Hospital	'Evaluate the impact of a health psychology-led bariatric rehabilitation service (BRS) on patient weight loss following bariatric surgery at 1 year'.	BMI and change in BMI at the end of the intervention which was 12 months	≠ BMI ($p = 0.5$)
<i>Post-operative intervention</i>				
Cassin et al., ²⁰ 2020	Health network and hospital bariatric surgery programmes	'Examine correlates of food addiction among post-operative bariatric surgery patients; compare the clinical characteristics of patients who meet "diagnosis" for food addiction at 1-year post-surgery to those who do not; and examine whether Tele-CBT improves food addiction symptomatology among the subset of individuals who meet "diagnosis" for food addiction at 1-year post-surgery'.	NR; food addiction symptomatology via modified Yale Food Addiction Scale 2.0 (mYFAS 2.0) at post-intervention (3 months duration which equated to 15 months post-operative) and 18 months post-operatively (3 months post-intervention)	↓ mYFAS 2.0 symptom scores ($p = 0.027$) post-intervention ≠ mYFAS 2.0 symptom scores at follow-up ($p = 0.772$).
Chacko et al., ²¹ 2016	Weight loss surgery centre at a medical centre	'Develop and test a novel mindfulness-based intervention designed to control weight after bariatric surgery'.	Feasibility and acceptability via recruitment goals, willingness to participate, adherence rate, retention, at the end of the intervention which was 10 weeks	Recruitment numbers ($n = 18$) were just below target of 20 58% willing to participate Adherence and retention were reported as excellent
David et al., ²⁸ 2016	Hospital bariatric surgery programme	'Examine the acceptability, feasibility and preliminary efficacy of adapted motivational interviewing for improving self-efficacy and eating behaviours in post-operative bariatric surgery patients'.	NR; Self-efficacy via Ontario bariatric eating self-efficacy (OBESE scale), readiness for change via change ratings, guideline adherence via a checklist and visual analogue scale (VAS), binge eating via BES at 12 weeks follow-up	≠ OBESE scale ≠ change rating for importance of change ≠ change rating for readiness for change ↑ change rating for confidence for change ($p < 0.05$) ≠ dietary adherence via checklist ↑ dietary adherence via VAS ($p < 0.05$) ↓ BES ($p < 0.01$)

(Continues)

TABLE 3 (Continued)

Author, year	Setting	Study aim	Primary outcome(s) ^a and measure(s)	Intervention effect compared to control ^b
Gade et al., ³⁷ 2014 (initial study)	Tertiary care centre	'Examine whether CBT alleviates dysfunctional eating patterns and symptoms of anxiety and depression in morbidly obese patients planned for bariatric surgery.'	Dysfunctional eating via three-factor eating questionnaire (TFEQ-R21) at the end of the intervention which was 10 weeks	↓ TFEQ-R21 ($p \leq 0.001$)
Gade et al., ³⁸ 2015 (follow up study 1)	Tertiary care centre	'Examine whether a pre-operative CBT intervention exceeds usual care in the improvements of dysfunctional eating behaviours, mood, affective symptoms and body weight 1 year after bariatric surgery.'	NR; Body weight, dysfunctional eating behaviours via TFEQ-R21 and anxiety and depression via the hospital anxiety and depression scale (HADS) at 1-year follow-up	≠ weight at 1-year follow-up ($p > 0.05$) ≠ TFEQ-R21 at 1-year follow-up ($p > 0.05$) ≠ HADS at 1-year follow-up ($p > 0.05$)
Hjeltnes et al., ³⁶ 2019 (follow up study 2)	Tertiary care centre	'Assess the 4-year effects of CBT before bariatric surgery on weight loss, eating behaviours, affective symptoms and health-related quality of life.'	Dysfunctional eating behaviours via TFEQR-21 at 4-year follow-up	≠ TFEQ-R21 at 4-year follow-up ($p > 0.05$)
Lauti et al., ³⁵ 2018	Public tertiary level hospital outpatient clinic	'Determine the effectiveness of text message support in reducing weight regain following sleeve gastrectomy.'	EWL% at mid intervention (6 months) and at the end of the intervention period (12 months).	≠ EWL% at 6 months ($p = 0.273$) and 12 months ($p = 0.456$)
Lent et al., ²³ 2019	A large, integrated rural health system	'Evaluate the feasibility of a post-operative behavioural intervention programme.'	Feasibility and health-related quality via 36-item short-form survey (SF-36) at the end of the intervention which was 16 weeks	↑ SF-36 social functioning domain only (Cohen's $d = 0.69$)
Nijamkin et al., ²⁴ 2012	Bariatric laparoscopic institution	'Examine whether a comprehensive nutrition education and behaviour modification intervention improves weight loss and physical activity in Hispanic Americans with obesity following Roux-en-Y gastric bypass surgery.'	EWL% and physical activity involvement via a self-reported questionnaire based on the Short Health Enhancing Physical Activity (SQUASH) at 6 months follow-up (12 months post-operatively)	↑ EWL ($p < 0.001$). ↑ involvement in physical activity ($p < 0.001$)
Nijamkin et al., ²⁷ 2013	Bariatric laparoscopic institution	'Evaluate the effect of 2 post-bariatric support interventions on depressive symptoms of Hispanic Americans treated with gastric bypass for morbid or severe obesity.'	Depressive symptoms via BDI-II, and weight change via EWL% at 6 months follow-up (12 months post-operatively)	↓ BDI-II ($p < 0.001$) ↑ EWL% loss ($p < 0.001$)

TABLE 3 (Continued)

Author, year	Setting	Study aim	Primary outcome(s) ^a and measure(s)	Intervention effect compared to control ^b
Sarwer, ²⁵ 2012	Academic medical centre	'Investigate the hypothesis that the provision of post-operative dietary counselling, delivered by a registered dietitian, would lead to greater weight loss and more positive improvements in dietary intake and eating behaviour compared with standard post-operative care.'	TWL% at 2, 4, 6, 12, 18 and 24 months after surgery.	≠ TWL% ($p = 0.08$) at all timepoints
Weinland et al., ³² 2012 (initial study)	A local centre for minimally invasive surgery	'Evaluate the effects of ACT [acceptance and commitment therapy] for patients who underwent bariatric surgery, with regard to emotional eating, body dissatisfaction and quality of life.'	NR; Eating disordered behaviour via eating disorder examination questionnaire (EDE-Q), binge eating via subjective binge eating questionnaire (SBEQ), pre-occupation with body shape via body shape questionnaire (BSQ), quality of life via WHOQoL-BREF, acceptance of weight related thoughts and feelings via acceptance and action questionnaire for weight-related difficulties (AAQ-W) at the end of the intervention which was 6-8 weeks	↓ EDE-Q ($p = 0.047$) ↓ SBEQ ($p = 0.006$) ↓ BSQ ($p = 0.023$) ↑ WHOQoL-BREF ($p = 0.022$) ↓ AAQ-W ($p = 0.006$)
Weinland et al., ³¹ 2012 (follow up study)	A local centre for minimally invasive surgery	'Examine both the maintenance of behavioural change at a 6-month follow-up for the original study and the processes that may be involved in the outcomes.'	NR; Eating disordered behaviour via EDE-Q, binge eating via SBEQ, pre-occupation with body shape via BSQ, quality of life via WHOQoL-BREF, acceptance of weight related thoughts and feelings via AAQ-W at 6-month follow-up	↓ EDE-Q ($p = 0.067$). ≠ SBEQ ($p = 0.29$) ↓ BSQ ($p = 0.024$) ↑ WHOQoL-BREF ($p = 0.007$) ↓ AAQ-W ($p = 0.013$)
Wild et al., ³⁴ 2015 (initial study)	Three hospitals of which two were university hospitals	'The Bariatric Surgery and Education (BaSE) study aimed to assess the efficacy of a videoconferencing-based psychoeducational group intervention in patients after bariatric surgery.'	TWL (kg), health-related quality of life via SF-36 and self-efficacy via general self-efficacy scale (GSE) at 6 months and 12 months post-operatively.	≠ TWL (kg) at 6 months ($p = 0.92$) and 12 months ($p = 0.78$) ≠ SF-36 at 6 months ($p = 0.84$) and 12 months ($p = 0.39$) ≠ GSE at 6 months ($p = 0.66$) and 12 months ($p = 0.19$)

(Continues)

TABLE 3 (Continued)

Author, year	Setting	Study aim	Primary outcome(s) ^a and measure(s)	Intervention effect compared to control ^b
Wild et al., ³³ 2017 (follow up study)	Three hospitals of which two were university hospitals	'Evaluate the effects of the BaSE programme at longer-term follow-up.'	TWL (kg), health related quality of life via SF-36 and self-efficacy via GSE. The range of follow-up time was 23–61 months after surgery. This corresponds to a follow-up time of 11–49 months after the end of the intervention programme.	≠ TWL (kg) ($p = 0.82$) ≠ SF-36 ($p = 0.65$) ↑ GSE ($p = 0.03$)

Abbreviations: AAQ-W, action questionnaire for weight-related difficulties; BDI, Beck's depression inventory; BES, binge eating scale; BMI, body mass index; BSI, brief symptom inventory; BSQ, body shape questionnaire; DEBQ, Dutch eating behaviour questionnaire; EBI, eating behaviour inventory; EDE-Q, eating disorder examination questionnaire; EES, excess weight loss; GSE, general self-efficacy scale; GSI, global severity index; HADS, hospital anxiety and depression scale; mYFAS 2.0, modified Yale Food Addiction Scale 2.0; NR, not reported; OBESE scale, Ontario bariatric eating self-efficacy; QIDS-SR, quick inventory of depressive symptomatology; SBEQ, subjective binge eating questionnaire; SF-36, 36-item short-form survey; SQUASH, short questionnaire to assess health-enhancing physical activity; TFEQ-R21, three-factor eating questionnaire; TWL, total weight loss; VAS, visual analogue scale; WHOQoL-BREF, World Health Organization quality of life assessment.

^aPrimary outcome(s) as stated in the study. If the study did not indicate the primary outcomes, they were based off the study aim.

^b↑ or ↓ indicates the intervention significantly improved outcomes compared to control and ≠ indicates no significant change between the intervention and control.

^cThe control significantly improved weight loss at 24 months compared to intervention.

The 15 studies published across 21 reports were conducted in the USA ($n = 5$ studies),^{21–27} Canada ($n = 3$ studies),^{19,20,28} United Kingdom ($n = 1$ study),²⁹ Netherlands ($n = 1$ study),³⁰ Sweden ($n = 1$ study),^{31,32} Germany ($n = 1$ study),^{33,34} New Zealand ($n = 1$ study),³⁵ Norway ($n = 1$ study)^{36–38} and Portugal ($n = 1$ study).³⁹ Samples comprised mostly mixed bariatric surgeries ($n = 7$ samples),^{20,21,23,25,31–34,36–38} followed by Roux-en-Y gastric bypass ($n = 3$ samples),^{22,24,26,27,29} waitlisted ($n = 2$ samples)^{19,39} and gastric sleeve ($n = 1$ sample).³⁵ Two studies did not report surgery type.^{28,30} The setting for most of the studies was a hospital ($n = 7$ studies).^{20,28,29,33–39} Most interventions were delivered post-operatively ($n = 10$ interventions),^{20,21,23–25,27,28,31–38} followed by pre-operatively ($n = 4$ interventions),^{19,22,26,30,39} and both pre- and post-operatively ($n = 1$ intervention).²⁹ Interventions were delivered in-person ($n = 7$ interventions),^{21,23,24,27–30,39} via telephone ($n = 1$ intervention),^{19,20} text messages ($n = 1$ intervention)³⁵ or a combination of modalities ($n = 5$ interventions).^{22,25,26,31–34,36–38} Additional characteristics can be seen in Table 2. The intervention and report aim varied in focus, some with multiple components (Table 3). This included aiming to achieve a change in weight ($n = 10$ reports),^{21,22,24,25,29,30,35,36,38,39} eating behaviours and psychopathology ($n = 7$ reports),^{19,20,25,28,32,36,38} psychosocial variables ($n = 3$ reports),^{19,30,39} anxiety and depression screening ($n = 2$ reports),^{27,37} quality of life ($n = 2$ reports),^{32,36} self-efficacy ($n = 1$ report)²⁸ and diet ($n = 1$ report).²⁵ Of the 21 included reports, over one third did not describe the primary outcome(s) of the study ($n = 8$ reports, 38%; Table 3).^{20,22,26,28,30–32,38} Of those that did, weight status and metabolic control indicators were the most common ($n = 9$ reports),^{24,25,27,29,33–35,38,39} followed by changes in eating psychopathology ($n = 4$ reports),^{19,36–38} quality of life ($n = 3$ reports)^{23,33,34} and anxiety and depression screening ($n = 2$ reports).^{27,38}

Comparison groups included usual care ($n = 12$ studies),^{19–23,25,26,29–38} minimal care ($n = 2$ studies)^{24,27,39} and waitlist control ($n = 1$ study; Table 2).²⁸ Usual care was provided by a surgeon ($n = 1$ study),^{33,34} dietitian ($n = 2$ studies),^{21,25} surgeon, dietitian, nurse, doctor or physical therapist ($n = 3$ studies)^{29,31,32,36–38} or was not detailed ($n = 6$ studies).^{19,20,22,23,26,30,35}

Overall bias was low ($n = 8$ studies),^{19,22,26,28–30,35–38} or had some concerns ($n = 7$ studies; Figure S1).^{20,23–25,27,31–34,39}

The risk of bias for 'selection of reported results', 'measurement of the outcome', 'missing outcome data' and 'deviations from intended interventions' were generally low. For the randomisation process, 47% of reports had some concerns ($n = 7$ studies).

Of the 14 interventions, the majority did not report using any behaviour change theories to inform the nutrition intervention ($n = 12$ interventions, 86%; Table 2).^{19–27,29–38}

TABLE 4 Reported behaviour change theories and behaviour change techniques according to the behaviour change technique taxonomy (version one),⁹ in intervention arms of the included interventions

Behaviour change theory or technique	Interventions ^a														Total ^d
	1	2	3	4	5	6 ^b	7	8	9	10 ^c	11	12	13	14	
Behaviour change theory															
Transtheoretical model	●			●											2
Self-determination theory	●														1
Behaviour change technique (no. Label)															
1.0 Goals and planning	●	●	●	●	●	●	●	●	●	●	●	○	●	12	
1.1 Goal setting (behaviour)		●	●	●		●		●			●			6	
1.2 Problem solving		●	●	○	●	●		●	●	●	●		○	9	
1.4 Action planning		●	○					●					○	3	
1.6 Discrepancy between current behaviour and goal	●								○					1	
1.9 Commitment													●	1	
2.0 Feedback and monitoring		●	●		○	●	●	●	●		●	●		9	
2.1 Monitoring of behaviour by others without feedback					○				○			○		0	
2.2 Feedback on behaviour					○	●								1	
2.3 Self-monitoring of behaviour		●				●			●		●	●		6	
2.4 Self-monitoring of outcomes of behaviour		●	●			●		●						4	
3.0 Social support	○	●	●	●	●	●	●	●	●		●		●	10	
3.1 Social support (unspecified)	○	●	●	●	●	●		●	●		●		●	9	
3.2 Social support (practical)		●	●			●		●					●	5	
3.3 Social support (emotional)		●						●	●					3	
4.0 Shaping knowledge	○	●			○	●	●	●	●	○	●		○	6	
4.1 Instruction on how to perform the behaviour		●				●			●					3	
5.0 Natural consequences		○		●			●	●			○		○	3	
5.1 Information about health consequences		○		●				●						2	
7.0 Associations		●	○		●	●	●	○	●		○		●	6	
7.1 Prompts and cues		●			●				●				●	4	
7.5 Remove aversive stimulus		●				●								2	
7.6 Satiation		○												0	
8.0 Repetition and substitution	●	●	●		●	●	●	●	●		●		●	10	
8.1 Behavioural practise and rehearsal			●		●	●		●			○		○	4	
8.2 Behaviour substitution	●	●				●					●			4	
8.3 Habit formation									○					0	
8.7 Graded tasks						●			●				●	3	
9.0 Comparison of outcomes		●		●							●			3	
9.2 Pros and cons		●		●							●			3	
10.0 Reward and threat							●							1	
11.0 Regulation		●				●	●						●	5	
11.2 Reduce negative emotions		●				●							●	4	

(Continues)

TABLE 4 (Continued)

Behaviour change theory or technique	Interventions ^a														Total ^d
	1	2	3	4	5	6 ^b	7	8	9	10 ^c	11	12	13	14	
12.0 Antecedents					●		○	○							1
12.3 Avoidance/reducing exposure to cues for the behaviour					●										1
13.0 Identity		●		○		○	●				●		○		3
13.2 Framing/reframing		●				○					●		○		2
13.3 Incompatible beliefs				○											0
15.0 Self belief	●		●	●	○		●				○				4
15.2 Mental rehearsal of successful performance				●											1
15.3 Focus on past success	●		●	●	○										3
15.4 Self talk	○			○											0
Total no. of techniques used in each study ^d	6	24	12	11	10	20	12	15	13	2	14	2	7	9	

Note: Key = ● Objective coding ○ Subjective coding.

^aStudies are numbered in alphabetical order: 1 = Camolas et al.,³⁹ 2 = Cassin et al., 2016 and Cassin et al., 2020,^{19,20} 3 = Chacko et al.,²¹ 4 = David et al.,²⁸ 5 = Gade et al., 2014, Gade et al., 2015 and Hjelmessaeth,^{36–38} 6 = Kalarchian et al., 2013, and Kalarchian 2016,^{22,26} 7 = Lauti et al.,³⁵ 8 = Lent et al.,²³ 9 = Nijamkin et al., 2012 and Nijamkin et al., 2013,^{24,27} 10 = Ogden et al.,²⁹ 11 = Paul et al.,³⁰ 12 = Sarwer et al.,²⁵ 13 = Weineland et al., 2012(A) and Weineland et al., 2012(B),^{31,32} 14 = Wild et al., 2015 and Wild et al., 2017,^{33,34} (Note: While Cassin et al., 2016 and Cassin et al., 2020 are different in that one was delivered pre-operatively,¹⁹ and the other post-operatively,²⁰ they both used the same intervention hence have been combined in this table).

^bObtained from a published book chapter,⁵³ as the intervention was only briefly described within the manuscript.

^cObtained from published protocol,⁵⁴ as behaviour change techniques were not detailed in the intervention within the manuscript.

^dTotal only include techniques that were determined through objective coding and does not include those coded subjectively.

Two interventions used the transtheoretical model^{28,39} and self-determination theory.³⁹ Three interventions were based on cognitive behavioural therapy,^{19,20,23,36–38} one on acceptance and commitment therapy^{31,32} and one on motivational interviewing.³⁹

Thirteen behaviour change technique taxonomy groupings and 29 techniques were reported across the 14 interventions (Table 4). The mean number of techniques was 11 and ranged from 2 to 24. The most common behaviour change technique taxonomy groupings were '1.0 Goals and planning' ($n = 12$ interventions), '3.0 Social support' ($n = 10$ interventions), '8.0 Repetition and substitution' ($n = 10$ interventions) and '2.0 Feedback and monitoring' ($n = 9$ interventions). The most common techniques were '1.2 Problem solving' ($n = 9$ interventions), '3.1 Social support (unspecified)' ($n = 9$ interventions), '1.1 Goal setting (behaviour)' ($n = 6$ interventions) and '2.3 Self-monitoring of behaviour' ($n = 6$ interventions; Table 4). Seven techniques were ambiguous and coded as 'unspecified'.

Three studies found significant improvements in the intervention group for weight loss (Table 3).^{22,24,26,27,39} All three used techniques from the following behaviour change technique taxonomy groupings '1.0 Goals and planning', '4.0 Shaping knowledge' and '8.0 Repetition and substitution'; however, no technique was commonly used across all three studies. Three studies found significant

improvement in the intervention group for binge eating.^{19,28,32} The common behaviour change technique taxonomy grouping was '1.0 Goals and planning'; however, likewise, there were no common techniques used across all three studies.

Two studies were categorised as having both the intervention and control delivered by a credentialed nutrition or dietetics practitioner.^{25,39} Camolas et al.³⁹ reported a significant intervention effect over the minimal care control (Table 3), including significant improvements in body mass index ($p = 0.001$), total weight loss percentage ($p = 0.001$), excess weight loss ($p = 0.001$) and fasting glycaemia ($p = 0.019$).³⁹ Sarwer et al.²⁵ reported no significant difference in total weight loss percentage ($p = 0.08$) compared to usual care. Intervention effect was observed in studies where the intervention implemented cognitive behavioural therapy,^{19,20,23,38} motivational interviewing,²⁸ acceptance and commitment therapy^{31,32} and psychoeducation (Table 3).^{33,34}

4 | DISCUSSION

The findings from this review suggest behaviour change theory is not consistently reported and/or adopted to inform nutrition interventions for adults undergoing

bariatric surgery. The use of theory was limited to two studies using the transtheoretical model and self-determination theory. Behaviour change techniques were more widely incorporated with the most common including '1.2 Problem solving', '3.1 Social support (unspecified)', '1.1 Goal setting (behaviour)' and '2.3 Self-monitoring of behaviour'. The impact of integrating behaviour change theory and techniques in interventions, on patient outcomes, was not determined.

The absence of behaviour change theory reported and/or adopted to inform nutrition interventions for adults undergoing bariatric surgery highlights a potential disparity between intervention settings and populations. A recent review by Rigby et al.⁴⁰ found all of the dietary interventions delivered by qualified dietitians in various primary health care settings were underpinned by behaviour change theories. The intervention aims of included studies reported by Rigby et al.⁴⁰ included achieving change in weight, diet or clinical conditions. Comparatively, in the current review, aims varied including achieving change in weight, eating behaviours and psychopathology, psychosocial variables, anxiety and depression screening, quality of life, self-efficacy and diet. Applying behaviour change theories to interventions for adults undergoing bariatric surgery may be particularly challenging due to the need to target multiple behaviours. It may be necessary to integrate hypotheses from multiple behaviour change theories to overcome this challenge; referred to as an 'integrated behaviour change model'.⁴¹ Literature regarding the application of integrated behaviour change models on dietary behaviours is limited yet emerging,⁴²⁻⁴⁵ and exploration of the applicability to adults undergoing bariatric surgery is warranted. This is particularly important given Rigby et al.⁴⁰ found dietary interventions based on behaviour change theory and techniques were potentially more effective at improving patient health outcomes than interventions without theoretical underpinnings. While behaviour change science is valued by the dietetic profession,⁴⁶ we encourage embedding and documenting behaviour change theory in dietetic practice to improve patient-centred care.

The most commonly reported behaviour change techniques identified were '1.2 Problem solving', '3.1 Social support (unspecified)', '1.1 Goal setting (behaviour)' and '2.3 Self-monitoring of behaviour'. Results are consistent with other reviews exploring diet and physical activity interventions,^{16,40} weight loss and weight maintenance eHealth interventions⁴⁷ and eHealth interventions for adults undergoing bariatric surgery.⁴⁸ However, knowing the common behaviour change techniques does not help to determine which techniques to select. Johnston et al. have hypothesised links between behaviour change techniques and mechanisms of action and subsequently created an online interactive tool.⁴⁹ This tool may assist clinicians and interventionalists to select techniques for

inclusion in intervention design based on evidence. The common behaviour change techniques identified in our review link to the following mechanisms of action: 'beliefs about capabilities', 'behaviour regulation', 'social influences', 'intention', 'goals' and 'feedback processes'. Through making an appraisal of these links, key techniques may become apparent. For example, the technique '11.2 Reduce negative emotions' links to the mechanism of action 'emotion' which may be beneficial for those displaying emotional eating. The authors encourage the bariatric surgery care team, including dietitians, to reflect on patients' modifiable determinants and the behavioural predictors of weight regain after bariatric surgery. In addition, the authors encourage codesigning interventions and taking a collaborative approach with patients after bariatric surgery to foster participatory practice.

Objective and subjective coding of techniques was a novel approach; previous reviews have only coded objectively with the limitation that techniques may be under-reported.^{40,48} This was required due to the complex and interacting components of interventions and to gain a robust insight regarding all techniques applied in the body of literature. The authors recommend researchers place their efforts on reporting intervention components as per the behaviour change technique taxonomy to assist in strengthening intervention replication and implementation.⁵⁰ In addition, this may also help with future synthesis to determine if certain behaviour change techniques are more effective than others. This extends to other emerging areas of nutrition intervention, such as eHealth⁵¹; as half of the interventions in the included studies utilised eHealth modalities.

This review has limitations worth noting. The authors cannot exclusively say nutrition interventions for adults scheduled for (waitlisted) or who have undergone bariatric surgery are not explicitly informed by one or more behaviour change theories; rather publications are not reporting the use of theory. While comparison groups that were informed by behaviour change theories were excluded, behaviour change theory and techniques may be implemented as part of usual nutrition care without being documented. While the inclusion of randomised control trials aimed to provide the most robust level of research, including other study designs may have provided greater insight into theory-informed interventions. With substantial heterogeneity, the authors were unable to evaluate the effectiveness of the inclusion of behaviour change theory or techniques on health behaviours or outcomes. Results do not indicate that common behaviour change techniques lead to effective outcomes. The risk of bias for outcome measures does not assess the methodology of coding behaviour change techniques, hence caution should be taken when

interpreting this risk of bias. While the objective and subjective coding of behaviour change techniques is a novel approach, subjective coding is subject to bias. Furthermore, authors subjectively coded to 'groupings' which required creating criteria, a process that is also subject to bias.

This systematic review highlights that while behaviour change techniques have been included, behaviour change theory is not consistently reported and/or adopted to inform nutrition interventions for adults undergoing bariatric surgery. Behaviour change theories used included the transtheoretical model and self-determination theory. Common behaviour change techniques included '1.2 Problem solving', '3.1 Social support (unspecified)', '1.1 Goal setting (behaviour)' and '2.3 Self-monitoring of behaviour'. Integrating behaviour change theory and techniques in nutrition interventions is important for researchers and bariatric surgery teams, including dietitians, to effectively target behaviours.

CONFLICT OF INTEREST

Katrina Campbell is a member of the Journal Strategic Planning Committee of Nutrition & Dietetics. They were excluded from the peer review process and all decision-making regarding this article. This manuscript has been managed throughout the review process by the Journal's Editor-in-Chief. The Journal operates a blinded peer review process and the peer reviewers for this manuscript were unaware of the authors of the manuscript. This process prevents authors who also hold an editorial role to influence the editorial decisions made.

AUTHOR CONTRIBUTIONS


CW is responsible for ensuring that the descriptions are accurate and agreed by all authors. Conceptualisation: CW; Methodology: CW, KH; Literature Search: CW; Literature Evaluation: CW, AB; Data Extraction: CW, AB, KH; Writing – first draft: CW, JK; Writing – review and editing: JK, KC, KH; Supervision: JK, KC, KH.

DATA AVAILABILITY STATEMENT

Data extracted from included studies is available in the manuscript or supplementary materials

ORCID

Charlene Wright  <https://orcid.org/0000-0003-2918-6032>

Amandine Barnett  <https://orcid.org/0000-0003-1509-1729>

Katrina L. Campbell  <https://orcid.org/0000-0002-4479-1284>

Jaimon T. Kelly  <https://orcid.org/0000-0003-0232-5848>

Kyra Hamilton  <https://orcid.org/0000-0001-9975-685X>

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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