Review article

Are eHealth interventions for adults who are scheduled for or have undergone bariatric surgery as effective as usual care? A systematic review.

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Abstract

This systematic review aimed to evaluate the effect of eHealth-delivered interventions for adults who undergo bariatric surgery on postoperative weight loss, weight loss maintenance, eating psychopathology, quality of life, depression screening, and self-efficacy. Six electronic databases were searched, with 14 studies (across 17 reports) included, involving 1633 participants. With substantial heterogeneity, qualitative descriptions have been provided. Interventions were delivered via an online program or internet modules (n = 2), telephone (n = 2), text messages (n = 2), videoconferencing (n = 3), mobile application (n = 1), and audiovisual media (n = 1). Three studies included a combination, including internet modules and telephone (n = 1), wireless fidelity scales, emails, and telephone (n = 1), and a combination of online treatment, weekly emails, and access to a private Facebook group (n = 1). All the eHealth interventions, except for one, implemented behavior change techniques, including self-monitoring, problem solving, social support, goal setting, and shaping knowledge. Both eHealth intervention and control groups lost weight across the included studies, and eHealth was found to be as effective as or more effective than the control for weight loss. Two studies measured weight loss maintenance; both eHealth and control groups regained weight in the longer term. The interventions showed significant improvement on assessment measures for eating psychopathology. In conclusion, when bariatric surgery patients have limited or no access to healthcare teams or require additional support, eHealth may be a suitable option. Future studies implementing eHealth interventions would benefit from reporting intervention components as per the behavior change techniques taxonomy and further consideration of delivering eHealth in a stepped care approach would be beneficial. (*Surg Obes Relat Dis* 2021; ■:1–16.) © 2021 American Society for Bariatric Surgery. Published by Elsevier Inc. All rights reserved.

Key words:

Bariatric surgery; Obesity; Weight loss; eHealth; Disordered eating; Weight maintenance

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The effectiveness of bariatric surgery for achieving weight loss and improvements in comorbidities is well established [1,2]. It results in superior improvement in glycemic-control metrics compared with various medical and lifestyle interventions [3], and greater excess weight loss with a lower chance of weight regain compared with non-surgical procedures [4]. Nevertheless, a substantial proportion of patients fail to meet clinically significant weight loss targets or experience weight regain [1,5]. The underlying causes leading to weight regain are multifactorial and relate to procedure- and patient-specific factors [6], such as poor adherence to postoperative dietary advice and disordered eating behaviors [7]. Considering the prevalence of weight regain postoperatively, efforts have been placed on determining treatment options. A systematic review and meta-analysis of randomized controlled trials by Stewart et al. [8], evaluated the effectiveness of lifestyle interventions delivered in-person, preoperatively, and/or postoperatively. The authors found that delivering behavioral interventions in addition to bariatric surgery resulted in improved postoperative weight loss outcomes, with the strongest evidence for postoperative interventions compared with preoperative. Rudolph et al. [9], conducted a review to determine the effects of behavioral management (delivered in-person and postoperatively) on weight loss and likewise found a positive effect [9]. Generally treatment was provided by dietitians trained and experienced in bariatric surgery or psychologists [9].

Continued follow-up between patients and their healthcare providers improves weight loss, weight loss maintenance, and mental health following bariatric surgery [10–13]. Bariatric practices are commonly based in large, urban centers, and access to routine follow-up is challenging for patients outside of the city [14]. Increased travel distance to bariatric surgery sites is associated with less follow-up and hence potentially poorer outcomes [15–17]. Behavioral and psychosocial interventions delivered by a bariatric surgery healthcare provider may contribute to successful weight maintenance postoperatively, yet, with fewer follow-up consultations, this also limits the ability of the bariatric surgery team to identify difficulties and intervene accordingly [18].

eHealth assists with the delivery of healthcare services to regional and remote patients [19,20]. The World Health Organization defines eHealth as “the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including healthcare services, health surveillance, health literature, and health education, knowledge, and research” [21]. Information communication technology examples include smartphone applications, text messaging, wearable devices, health information technology, telehealth, and videoconferencing [22]. A recent study by Maurice et al. [23] found bariatric surgical telehealth appointments were preferred by most patients residing in rural and remote locations. Consultation avoided

significant travel time and cost for both patients and the health service, and improved equity and access to specialist services for rural and remote patients [23]. In addition, patients who are scheduled for or have undergone bariatric surgery report willingness to use various technologies to enhance their care, including email, text messages, phone calls [24]. Furthermore, existing systematic reviews show that the delivery of obesity prevention and treatment via eHealth is cost-effective and scalable [25–27], which may also be the case in bariatric surgery healthcare. eHealth could be offered to bariatric surgery patients when they would normally have nothing, be it due to barriers such as distance and travel, or offered in addition to usual care. Health systems with adequate resources for all cannot be taken for granted, and as COVID-19 has shown, the uptake of eHealth is a rapid response.

COVID-19 is producing a “natural experiment” as eHealth has become a necessary alternative to traditional face-to-face consultation. In the wider context, it may enable widespread adoption as it has provoked rethinking traditional, face-to-face models and addressed new and old barriers to healthcare access including psychotherapy [28]. It is important that healthcare and organizations stay abreast of eHealth developments and understand how they can be used to support and improve practice. Furthermore, during the COVID-19 pandemic and associated isolation, adults who had undergone bariatric surgery experienced increased binge eating, depression, loneliness, loss of control when eating, nervousness, snacking [29], grazing behaviors, and negative urgency [30]. In addition, there were decreases in social support, eating healthy food, and physical activity [29], resulting in postoperative weight gain [29], less total weight loss, and larger weight regain [30]. More patients experienced excessive weight regain compared with patients before the pandemic (20% versus 4.5%) [30]. Given that a substantial proportion of patients fail to obtain clinically significant weight loss targets or experience weight regain postoperatively and are vulnerable in times of crises such as the COVID-19 pandemic, additional interventions to address behaviors that lead to weight regain are required; eHealth is possibly a viable option.

The literature regarding the delivery of services and support via eHealth in the bariatric surgery population is limited. Coldebella et al. assessed the evidence related to telemedicine finding interventions, and outcomes were not comparable owing to study design heterogeneity [31]. Similarly, Messiah et al. [32] examined eHealth intervention studies among bariatric surgery patients within the RE-AIM framework and likewise found study designs varied widely. Efficacy was rarely reported in studies, as the majority were not randomized controlled trials. Furthermore, the primary outcomes of the included studies were feasibility and acceptability.

The efficacy of eHealth remains unclear, and with the rapid adoption of eHealth during COVID-19, further

evaluation is warranted. In addition, considering weight regain is multifactorial, it is important to consider the effect of eHealth on eating psychopathology, quality of life, depression screening, and self-efficacy. Therefore, the aim of this review is to evaluate the effect of eHealth-delivered health service or support for adults who undergo bariatric surgery on postoperative weight loss, weight loss maintenance, eating psychopathology, quality of life, depression screening, and self-efficacy.

Methods

This systematic literature review was reported corresponding to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement [33,34] and followed a protocol registered prospectively with the International Prospective Register of Systematic Reviews (PROSPERO registration: CRD42020178489).

Search strategy

Six electronic databases were searched, including the Cochrane Central Register of Controlled Trials (CENTRAL), Cumulative Index to Nursing and Allied Health Literature (CINAHL via EBSCOhost), EMBASE, PubMed (includes citations for articles from MEDLINE), Scopus, and Web of Science (via Clarivate Analytics), from database inception up to April 30, 2021. A combination of keywords designed for PubMed was used and converted to the other databases using CREBP-SRA Polyglot Search Translator [35]. For each database, converted keywords were checked for accuracy and modified as required. An experienced systematic review search librarian was consulted throughout. There were no language restrictions applied. The entire search strategy can be seen in Table S1 and is dated April 30, 2021. To identify any additional articles, reference lists of all included articles and relevant systematic reviews were screened.

Eligibility criteria

To be eligible for inclusion, each study had to satisfy criteria including 1) randomized control trials (RCTs), Quasi-RCTs, or controlled before and after studies with a comparator group receiving usual care or any control group with no intervention; 2) adult participants (≥ 18 yr); and 3) conducted in a population that has undergone or has a confirmed, scheduled bariatric procedure (waitlisted). Any open, laparoscopic, or endoscopic bariatric surgery procedure for the management of obesity was considered. Excluded procedures were banded gastroplasty, biliopancreatic diversion without a duodenal switch, jejunoileal bypass, nonadjustable banded gastric bypass, vertical banded gastroplasty, and vertical gastroplasty (unbanded), owing to them no longer being in use [36]. The fourth and final criterion included the provision of an intervention that provided

healthcare support or services using eHealth including telephone, videoconferencing, smartphones, mobile devices, smartphone applications, online learning platforms, internet applications, email, or web-based techniques. This healthcare support or service could include those provided by a bariatric surgery healthcare provider, including a clinical nurse, dietitian, endocrinologist, exercise specialist, medical doctor, psychologist, or surgeon. If not described, the study was still included. The intervention could be delivered before and/or after the surgery. Requirements of the intervention were, if it was delivered preoperatively, a minimum duration of 2 weeks, and if delivered postoperatively a duration of ≥ 1 month, as guided by prior studies [37]. Single-session interventions were excluded.

Study screening

Duplicate records were identified and removed using Endnote (version 9.3.3). Title and abstract screening was conducted by 2 independent investigators (C.W. and R.M.) to identify potentially eligible studies. The full texts of these papers were then reviewed to confirm inclusion by 2 independent investigators (C.W. and R.M.); disagreements were managed by consensus or a third reviewer when required (J.K.). One publication in a language other than English was transcribed using Google Translate before the full-text screening [38].

Outcomes and data extraction

The primary outcomes of this review were weight loss and weight loss maintenance. Weight loss could be measured by the change in weight status, total weight loss in kilograms or percentages, body mass index (BMI), and Reinhold classification of excess weight loss. Weight loss maintenance was defined as weight loss at ≥ 6 months after final intervention contact. Secondary outcomes of this review included alternative forms of body composition measurement (i.e., muscle mass), quality of life, anxiety and depression screening, the incidence of comorbidity diagnoses, gastrointestinal symptoms, adverse events (mild, moderate, severe; including death and reversion/conversion rates), satisfaction, self-efficacy, physical activity outcomes, diet-related outcomes, disordered eating, cost-effectiveness, and interventions planned according to or informed by behavior change theories or techniques.

Data from the included studies were extracted into an electronic spreadsheet by the lead author (C.W.) and checked for accuracy by R.M. Where discrepancies were found, they were corrected through discussion. Items extracted included study characteristics (year, design, registration, location, duration and intervention timing, setting, funding, conflicts of interest, sample size, attrition), participant characteristics (age, sex, baseline preoperative BMI, comorbidities, type of bariatric surgery), intervention characteristics (delivery method, content, delivery personnel,

objective, tailoring, behavior change techniques), and control characteristics (delivery method, content, delivery personnel, objective). The study aim, primary outcome, and associated measures of effectiveness were extracted in addition to the outcomes mentioned previously. Missing data were requested from the study authors or sourced through additional articles of the same study. The interventions targeted bariatric surgery patients in general, and the outcomes in this review correspond to the results for the entire group. In addition, any specific subgroups (i.e., bariatric surgery patients experiencing a specific type of problem) have also been detailed.

Behavior change techniques

Behavior change techniques applied in the interventions were examined using the Behavior Change Technique Taxonomy (BCTT) [39]. The BCTT is considered the standard for reporting on techniques in health behavior change literature [40] and includes 93 hierarchical techniques clustered into 16 groups [39]. Behavior change techniques defined by the BCTT were coded by the lead author in NVivo and consistency checked by author K.H., a behavioral scientist. Any disagreements were resolved through discussion. Techniques were coded according to exact phrases and specific terminology included in the BCTT description table [39].

Quality assessment and evidence certainty

The Cochrane Risk of Bias tool [41] was used to assess for risk of bias. This tool evaluates 1) selection; 2) performance; 3) detection; 4) attrition; 5) reporting; and 6) overall bias. Two investigators independently completed the assessment of study quality (C.W. and R.M.). Disagreements were managed by consensus.

Statistical analysis

Mean differences and *P* values for statistical significance were extracted and analyzed for the primary outcomes of the review and the primary outcomes indicated by the study. Where possible, study interventions were compared with controls of usual care, minimal care, or no intervention. Statistically significant between-group comparisons over time were used to indicate intervention effectiveness for the stated primary outcomes or the overall intervention aim in the case that there was no primary outcome stated.

Results

The PRISMA flowchart can be seen in Fig. 1 identifying 4299 publications. After duplicates (*n* = 1747) and nonrelevant records (*n* = 2508) were excluded, 44 reports underwent full text review. After this, 27 reports were excluded, leaving 14 studies reported across 17 studies involving 1633 participants for inclusion.

Participant characteristics

Studies were conducted in Australia and New Zealand (*n* = 4) [42–45], Canada (*n* = 4) [46–49], Europe (*n* = 3 studies, reported across 5 publications) [50–54], the United States (*n* = 2 studies, reported across 3 publications) [55–57], and Korea (*n* = 1) [58]. Among the studies, 10 were conducted as RCTs (reported across 13 publications) [43–47,49,51–57], 3 were controlled before and after studies [42,48,50], and 1 was a quasi-experimental design [58]. The majority of the study settings were tertiary or public hospitals (*n* = 8 studies, reported across 9 publications) [42–44,48–50,52,53,58]. Two were conducted in a medical or local center (reported across 4 publications) [51,54–56], 1 in a public health service [47], 1 study was not site-specific and recruited via social media [45], and 2 studies did not report the setting [46,57]. In all but 2 studies (reported across 3 publications) [51,54,58], the predominant patient sex was female. The mean age ranged from 40 to 53 years. BMI at baseline (preoperative) ranged from 42 to 53 kg/m² and was not detailed in 3 studies [45,49,57]. Samples contained mostly mixed bariatric surgeries (*n* = 6 studies, reported across 8 publications) [49–55,58], or laparoscopic sleeve gastrectomy (*n* = 2) [44,57], along with waitlist samples in preoperative interventions (*n* = 5) [42,43,46,47,56], and 2 not reporting detail [45,48].

Intervention characteristics

Intervention characteristics are tabulated in Table S2. Six interventions were delivered preoperatively [42,43,46,47,56,58], and Kalarchian et al. [55] also delivered a postoperative intervention to the same sample. Four studies delivered the postoperative intervention without usual care [45,48,49,51,54], and 4 were in addition to usual care [44,50,52,53,57]. Across the interventions, modalities varied and included an online program or internet modules [42,47], telephone [46,49,55,56], text messages [43,44], videoconferencing [48,52,53], mobile application [57], and audiovisual media [58]. Three studies included a combination of modalities, with internet modules and telephone [51,54], wireless fidelity scales, emails, and telephone [50], and a combination of online treatment, weekly emails, and access to a private Facebook group [45]. Durations ranged from the minimum preoperative intervention of 2 weeks [58] to a maximum of 24 weeks [47]. Postoperatively, the minimum intervention was 8 weeks [45], and the maximum was 2 years [57].

The majority of interventions were delivered individually; only 1 study (reported across 2 publications) was carried out in a group setting [52,53], and another provided access to a private Facebook group [45]. Delivery personnel included a nurse manager [42], psychometrist [46], clinical and health psychologist [45], psychology graduate students [49], research coordinators [57], and the surgical team [50]. Six studies did not detail the delivery personnel involved [48,51,52,54–56,58]. For 3 studies delivery personnel

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analysis flowchart of the search results and the included studies.

were not applicable owing to the nature of the intervention (i.e., text messages [43,44] or an online program [47]).

Overall, timeframes of intervention commencement were described poorly, if at all. Studies implementing the intervention preoperatively were more likely to provide this detail, reporting commencement at 2 weeks [58], 4 weeks [43], and 4.7 months preoperatively [46]. With regard to postoperative interventions, only 2 provided this detail, with 1 commencing immediately after surgery [50] and another 18 months after surgery [44]. Two studies had inclusion criteria stating participants had to be ≥ 12 months postoperative [45,49], yet did not detail intervention commencement timeframes. For all other studies, the intervention commencement was not detailed [42,47–49,51–57].

Behavior change techniques

The content included in the intervention was generally well described and can be seen in Table S3. All studies except for 1 [48] used behavior change techniques in the eHealth interventions as seen in Table 1. Of the 93 techniques listed in the taxonomy [39], 39% were mentioned in the included studies ($n = 36$). The mean number of techniques per intervention was 6. The highest number used was 16 by Kalarchian et al. [55,56], and the intervention was described in great detail

within a book chapter [59]. The most commonly reported techniques, across the 13 interventions, were self-monitoring of behavior ($n = 6$ interventions, reported across 9 publications) [42,46,47,49,52,53,55–57], shaping knowledge ($n = 6$ interventions, reported across 9 publications) [42,44,46,47,49,51–54], problem solving ($n = 5$ interventions, reported across 8 publications) [43,46,47,49,52,53,55,56], social support (unspecified) ($n = 5$ interventions, reported across 11 publications) [42,45,46,49,51,54–56], goal setting (outcome) ($n = 5$ interventions, reported across 11 publications) [42,43,46,47,49,55,56], and self-monitoring of outcomes of behavior ($n = 5$ interventions, reported across 8 publications) [42,46,49,50,52,53,55,56]. Of the 36 techniques identified 22 (61%) were reported only once, with 12 originating from 1 study [44]. Lauti et al.'s [44] intervention design was guided by the behavior change wheel framework [60] and coded according to the taxonomy clusters rather than the individual techniques.

Control characteristics

Control characteristics are tabulated in Table S2. Control groups included routine clinic visits and assessments [46], supervised diet and activity programs [55,56], very-low-

Table 1

Reported behavior change techniques according to the Behavior Change Technique Taxonomy (v1) [39], in intervention arms of the included studies with eHealth interventions delivered to adults who are scheduled for or have undergone bariatric surgery

Behavior change technique no. Label	Interventions*													Total
	1	2	3 [†]	4	5	6 [‡]	7	8	9	10	11	12	13	
2.3 Self-monitoring of behavior	●	●	●				●	●					●	6
4.0 Shaping knowledge	●	●		●				●				●	●	6
1.2 Problem solving		●	●			●		●					●	5
3.1 Social support (unspecified)	●	●	●						●			●		5
1.3 Goal setting (outcome)	●	●	●			●		●						5
2.4 Self-monitoring of outcomes of behavior	●	●	●							●			●	5
8.2 Behavior substitution	●	●	●										●	4
4.1 Instruction on how to perform the behavior			●		●		●		●					4
2.1 Monitoring of behavior by others without feedback			●				●			●				3
13.2 Framing/reframing	●	●												2
1.1 Goal setting (behavior)			●										●	2
1.4 Action planning		●				●								2
5.1 Information about health consequences			●		●									2
8.1 Behavioral practice and rehearsal									●				●	2
9.2 Pros and cons					●									1
5.3 Information about social and environmental consequences			●											1
3.2 Social support (practical)			●											1
8.3 Habit formation			●											1
12.3 Avoidance/reducing exposure to cues for the behavior			●											1
5.6 Information about emotional consequence			●											1
2.2 Feedback on behavior			●											1
1.0 Goals and planning				●										1
2.0 Feedback and monitoring				●										1
3.0 Social support				●										1
5.0 Natural consequences				●										1
7.0 Associations				●										1
8.0 Repetition and substitution				●										1
10.0 Reward and threat				●										1
11.0 Regulation				●										1
12.0 Antecedents				●										1
13.0 Identity				●										1
15.0 Self belief				●										1
8.7 Graded task	●													1
12.1 Restructuring the physical environment	●													1
11.2 Reduce negative emotions													●	1
1.7 Review outcome goals		●												1
Total no. of techniques used in each study	9	10	16	12	3	3	3	4	3	2	0	2	8	

* Interventions are numbered in alphabetical order of author: 1=Brown et al. [42]; 2=Cassin et al. [46,49]; 3=Kalarchian et al. [55,56]; 4=Lauti et al. [44]; 5=Lee et al. [58]; 6=Lemanu et al. [43]; 7=Mangieri et al. [57]; 8=Padwal et al. [47]; 9=Stapleton et al. [45]; 10=Vilallonga et al. [50]; 11=Wang et al. [48]; 12=Weineland et al. [51,54]; 13=Wild et al. [52,53] (Note: While the Cassin et al. references are different in that one was delivered preoperatively [46] and the other postoperatively [49], they both used the same intervention and hence have been combined in this table).

[†] Obtained from published book chapter [59] as the intervention was only briefly described within the manuscript.

[‡] Obtained from a prior publication [82], as the intervention was modeled from this study.

calorie-diet [43], and printed education material [47] preoperatively. Postoperative control groups included routine clinic visits including psychosocial follow-up and a monthly support group option [49], discharge or follow-up as required [44], and structured follow-up [50,52,53,57]. Several studies did not describe what the control group was exposed to or what usual care entailed [42,45,48,51,58].

Study aims and primary outcomes

The study aim, primary outcome, and associated measures of effectiveness can be seen in Table 2. Primary outcomes of the studies included weight loss [42,44,45,49,50,52,53,55–57], eating psychopathology [46,49,51,54], quality of life [51–54], self-efficacy [52,53,58], preoccupation with body shape [51,54],

Table 2

The study aim, primary outcome, measures, and intervention effect compared with control of included studies with eHealth interventions delivered to adults who are scheduled for or have undergone bariatric surgery

Author, year	Study aim	Primary outcome(s)* and measure(s)	Intervention effect compared to control [†]	
			Primary outcome(s)	Additional measure(s)
Preoperative (intervention only)				
Brown et al., 2016 [42]	“To report on a prospective study of this pre-hospital program as well as the 12-month weight outcomes for the first cohort of patients treated though this new pathway comparing them to a control group of contemporaneous patients treated through the standard pathway.”	Weight loss via excess weight loss (% EWL) at 12 mo from the date of surgery.	↑ EWL% ($P = .012$)	Satisfaction; eHealth intervention rated 3.78 out of 4
Cassin et al., 2016 [46]	“To examine the efficacy of a pre-operative telephone-based cognitive behavioral therapy (Tele-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 7 wk.	↓ BES ($P = .01$) ↓ EES ($P = .002$)	≠ SF-36 ($P > .05$) ↓ PHQ-9 ($pP < .001$)
Lee et al., 2020 [58]	“Examine the effect of pre-operative information by audio-visual media on patients before bariatric surgery.”	NR; self-care knowledge via self-nursing knowledge measurement tool for presurgical education chairs for gastrectomy patients, self-efficacy via New General Self-Efficacy (NGSE), and anxiety via State Trait Anxiety Inventory (STAI) and the temperament standardized for Koreans-state anxiety at the end of the intervention which was 2 wk.	↑ Preoperative self-care knowledge ($P < .001$) ↑ NGSE ($P = .001$) ↓ STAI ($P = .036$)	Nil
Lemanu et al., 2018 [43]	“To investigate whether a text message intervention improves adherence to preoperative exercise advice prior to laparoscopic sleeve gastrectomy.”	Adherence to preoperative exercise advice via the number of participants partaking in ≥ 450 metabolic equivalent minutes (METmin–1) exercise activity per week preoperatively at the end of intervention period, which was 4–6 wk in duration.	↑ adherence to exercise ($P \leq .05$)	Nil
Padwal et al., 2017 [47] [§]	“Evaluate the clinical and economic outcomes of two self-management programs of varying intensity that are currently in use.”	Proportion of patients achieving 5% weight loss; weight loss (kg) and (%); and BMI change at 6 mo postintervention, which was 3 mo in duration (full study duration of 9 mo).	≠ 5% weight loss responders ($P = .28$) ≠ weight loss (kg) ($P = .96$) ≠ weight loss (%) ($P = .79$) ≠ BMI ($P = .88$)	≠ SF-12 for the mental component ($P = .24$) and the physical component ($P = .58$) ↓ EQ-5D VAS score ($P = .03$) ≠ EQ-5D index score ($P = .33$) ≠ PHQ-8 ($P = .58$) ≠ Readiness to change ($P = .58$) ↑ WEL ($P = .01$)

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Table 2 (continued)

Author, year	Study aim	Primary outcome(s)* and measure(s)	Intervention effect compared to control [†]	
			Primary outcome(s)	Additional measure(s)
Pre- and postoperative (intervention only)				
Kalarchian et al., 2013 [56] (initial study preoperative intervention)	“Document preoperative outcomes of a behavioral lifestyle intervention delivered to patients prior to bariatric surgery in comparison to treatment as usual.”	NR; weight loss (kg) at the end of the intervention, which was 6 mo in duration.	↑ weight loss ($P < .0001$)	≠ EDE-Q for subjective ($P = .47$) and objective ($P = .72$) bulimic episodes ↑ EBI ($P = .0004$) ≠ BDI ($P = .54$)
Kalarchian et al., 2016 [55] (follow-up with a postoperative intervention)	“Evaluate whether a pre-surgery behavioral lifestyle intervention improves weight loss through 24-months post-surgery.”	NR; weight loss (%) at follow up of 6, 12, and 24 mo postoperatively.	≠ weight loss at 6 mo ($P = .12$), 12 mo ($P = .12$) ≠ weight loss at 24 mo ($P = .02$) [‡]	Nil
Postoperative (intervention only)				
Wang et al., 2019 [48]	“Compare post bariatric surgery appointment adherence, psychosocial, and body mass index (BMI) outcomes in patients that did or did not use telemedicine.”	NR; appointment adherence via percentage of appointment attended and rate of dropout at 2 yr postsurgery	≠ appointment attendance ≠ rates of patients being lost to follow-up	Nil
Weineland et al., 2012a [51] (initial study)	“Evaluate the effects of acceptance and commitment therapy for patients who underwent bariatric surgery, with regard to emotional eating, body dissatisfaction and quality of life.”	NR; eating disorder behavior via eating disorders examination questionnaire (EDEQ), subjective binge eating via subjective binge eating questionnaire for bariatric surgery patients (SBEQ), preoccupation with body shape via body shape questionnaire short version (BSQ), quality of life (QOL) via World Health Organization Quality of Life (WHOQOL-BREF), acceptance of weight related thoughts and feelings via acceptance and action questionnaire for weight (AAQ-W) measured at the end of the intervention, which was 6-8 wk.	↓ EDE-Q ($P = .047$) ↓ SBEQ ($P = .006$) ↓ BSQ ($P = .023$) ↑ WHOQOL-BREF ($P = .022$) ↓ AAQ-W ($P = .006$)	Nil
Weineland et al., 2012b [54] (6-mo follow-up study)	“Examine both the maintenance of behavioral change at a 6-month follow-up for the original study and the processes that may be involved in the outcomes.”	NR; Eating disordered behavior via EDE-Q, binge eating via SBEQ, preoccupation with body shape via BSQ, QOL via WHOQOL-BREF, acceptance of weight related thoughts and feelings via AAQ-W, at 6 mo.	↓ EDE-Q ($P = .067$). ≠ SBEQ ($P = .29$) ↓ BSQ ($P = .024$) ↑ WHOQOL-BREF ($P = .007$) ↓ AAQ-W ($P = .013$)	Nil
Stapleton et al., 2020 [45]	“Assess whether post-surgery care comprising Emotional Freedom Techniques, an emerging energy psychology intervention, combined with a behavior-based nutrition and portion control eating plan in an online self-guided delivery would aid weight-loss and maintenance in bariatric patients.”	NR; weight loss via BMI at the end of the intervention which was 8 wk and at 6 mo postintervention.	≠ BMI at the end of the intervention and 6 mo postintervention ($P = .917$)	↓ TFEQ-18 ($P = .001$) ≠ FCI ($P = .328$) ≠ RSE ($P = .072$)

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Table 2 (continued)

Author, year	Study aim	Primary outcome(s)* and measure(s)	Intervention effect compared to control†	
			Primary outcome(s)	Additional measure(s)
Cassin et al., 2020 [49]	“Examine correlates of food addiction among postoperative 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 postintervention (3-mo duration, which equated to 15 mo postoperative) and 18 mo postoperatively (3 mo postintervention).	↓ mYFAS 2.0 symptom scores ($P = .027$) postintervention ≠ mYFAS 2.0 symptom scores at follow-up ($P = .772$).	Nil
Postoperative (intervention plus usual care)				
Lauti et al., 2018 [44]	“Determine the effectiveness of text message support in reducing weight regain following sleeve gastrectomy.”	Weight loss via EWL% at mid intervention (6 mo) and at the end of the intervention period (12 mo).	≠ EWL% at 6 mo ($P = .273$) and 12 mo ($P = .456$)	≠ BMI at 6 mo ($P = .106$) and 12 mo ($P = .452$) ≠ TBW% at 6 mo ($P = .148$) and 12 mo ($P = .339$) ≠ BAROS at 6 mo ($P = .650$) and 12 mo ($P = .092$)
Mangieri et al., 2019 [57]	“Examine the use of mHealth technology in a bariatric surgery population to evaluate effects on weight loss following surgery.”	Weight loss via EWL% and excess BMI loss (EBL%) at mid intervention (12 mo) and the end of the intervention (24 mo).	↑ EWL% at 12 mo ($P = .047$) and at 24 mo ($P = .0078$) ↑ EBL% at 12 mo ($P = .0007$) and at 24 mo ($P = .048$)	Nil
Vilallonga et al., 2013 [50]	“Evaluate the possibility of using Internet of Things technology in morbidly obese patients.”	NR; weight loss via EWL% at 9 mo postoperatively/end of study.	Between group analysis not performed	BMI; between group analysis not performed
Wild et al., 2015 [52] (initial study)	“The Bariatric Surgery and Education (BaSE) study aimed to assess the efficacy of a videoconferencing-based psychoeducational group intervention in patients after bariatric surgery.”	Weight loss in kg, health-related QOL via 36-Item Short Form Health Survey (SF-36) and self-efficacy via General Self-Efficacy (GSE) at 6 mo and 12 mo postoperatively.	≠ weight loss at 6 mo ($P = .92$) and 12 mo ($P = .78$) ≠ SF-36 at 6 mo ($P = .84$) and 12 mo ($P = .39$) ≠ GSE at 6 mo ($P = .66$) and 12 mo ($P = .19$)	≠ EWL% at 6 mo ($P = .65$) and at 12 mo ($P = .73$) ≠ TBW% at 6 mo ($P = .78$) and 12 mo ($P = .81$) ≠ BMI at 6 mo ($P = .86$) and at 12 mo ($P = .82$) ≠ PHQ-9 at 6 mo ($P = .32$) and 12 mo ($P = .18$) ≠ EDE-Q at 12 mo ($P = .59$) ≠ GSE at 6 mo ($P = .66$) and 12 mo ($P = .19$)

(continued on next page)

Table 2 (continued)

Author, year	Study aim	Primary outcome(s)* and measure(s)	Intervention effect compared to control†	Additional measure(s)
Wild et al., 2017 [53] (follow-up study)	“Evaluate the effects of the BaSE program at longer-term follow-up.”	NR; Weight loss in kg, health related QOL via SF-36 and self-efficacy via GSE. The range of follow-up time was 23–61 mo after surgery. This corresponds to a follow-up time of 11–49 mo after the end of the intervention program.	Primary outcome(s) ≠ weight loss ($P = .82$) ≠ SF-36 ($P = .65$) ↑ GSE ($P = .03$)	Additional measure(s) ≠ BMI ($P = .87$) ≠ EDE-Q ($P = .65$) ≠ EWL% ($P = .65$) ≠ TBW% ($P = .74$) ↓ PHQ-9 ($P = .03$)

EWL = excess weight loss; TELE-CBT = telephone-based cognitive behavioral therapy; BES = binge eating scale; SF-36 = 36-item short form survey; PHQ-9 = patient health questionnaire-9; NR = not reported; NGSE = new general self-efficacy scale; STAI = state trait anxiety inventory; BMI = body mass index; SF-12 = 12-item short form survey; EQ-5D = EuroQol-5 dimension instrument; VAS = visual analogue scale; PHQ-8 = patient health questionnaire-8; WEL = weight efficacy life-style questionnaire; EDE-Q = eating disorder examination questionnaire; EBI = eating behavior inventory score; BDI = Beck depression inventory score; SBEQ = subjective binge eating questionnaire; BSQ = body shape questionnaire short version; QOL = quality of life; WHOQOL-BREF = World Health Organization quality of life; AAQ-W = acceptance and action questionnaire for weight; TFEQ-18 = three factor eating questionnaire-18; FCI = food craving inventory; RSE = Rosenberg's self-esteem scale; mYFAS 2.0 = modified Yale food addiction scale 2.0; TWB = total body weight; BAROS = bariatric analysis and reporting outcome system; EBL = excess BMI loss; BaSE = bariatric surgery and education; GSE = general self-efficacy.

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

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

‡ The control significantly improved weight loss at 24 months compared to intervention.

§ Padwal et al. [47] had 2 intervention arms; however, only the eHealth intervention has been described.

|| Stapleton et al. [45] had 2 intervention arms; however, only the eHealth intervention has been described.

¶ Obtained from corresponding author as this data point was missing from the manuscript.

acceptance of weight-related thoughts and feelings [51,54], self-care knowledge [58], anxiety [58], adherence to preoperative exercise advice [43], appointment adherence [48], and rate of dropout [48]. No studies reported dietary intake-related outcomes as a primary outcome. The heterogeneity of assessment methods used between the included studies made quantitative comparisons difficult; thus, qualitative descriptions have been provided.

Effect of eHealth on weight loss

Both eHealth intervention and control groups lost weight across the included studies. Associated measures of effectiveness can be seen in Table 2. There was a high degree of variability in measures used to assess weight loss, including BMI [44,45,47,50,52,53,], excess BMI lost [57], total body weight percentage [44,48,52,53,55], excess weight loss percentage [42,44,52,53,57], and total body weight in kilograms [47,52,53,56]. The results for each outcome measure can be seen in Table S4. Overall, eHealth was found to be as effective as or more effective regarding weight loss compared with control groups, in all except 1 study where the control significantly improved weight loss percentage [55]. While some studies compared eHealth (without usual care) with usual or minimal care [42,43,45–49,51,54–56,58], few measured weight loss, and those that did showed an equal effect, except for 1 that improved weight loss at the end of a preoperative intervention [56]. Studies that delivered eHealth plus usual care, compared with usual care [44,50,52,53,57], similarly showed equal effect, except for 1 study by Mangieri et al. [57] that found the intervention significantly improved excess weight and BMI loss.

Weight loss maintenance

Two studies (reported across 4 publications) reported postintervention follow-up [52,53,55,56], which allowed weight loss maintenance to be determined (Table 3). In the study by Kalarchian et al. [55,56], participants maintained their weight loss at 12 months: 27.4% versus 29.4% for intervention and control respectively ($P = .12$). Between 12 and 24 months, participants in the intervention group had regained approximately 1%. Overall, the percentage weight loss of 26.5% remained higher than 22.8% at postintervention (3 months postoperatively). The control group maintained their weight, with 29.5% weight loss at 24 months. In the study by Wild et al. [52,53], all participants continued to lose weight between 6 and 12 months. Between 12 and 24 months, all participants regained weight, with the intervention group gaining a mean of 5.2 kg and the control group a mean of 3.8 kg. Overall, they remained below the weights recorded at 6 months.

Table 3

Weight maintenance results of included studies with eHealth interventions delivered to adults who are scheduled for or have undergone bariatric surgery

Time points postoperatively	Group	Weight (kg)	BMI (kg/m ²)	EWL%	TBW%
Kalarchian et al. 2013 [56] and Kalarchian et al., 2016 [57]					
6 mo*	Intervention	-	-	-	22.9
	Control	-	-	-	24.4
12 mo	Intervention	-	-	-	27.4
	Control	-	-	-	29.4
24 mo	Intervention	-	-	-	26.5
	Control	-	-	-	29.5
Wild et al., 2015 [52] and Wild et al., 2017 [53]					
6 mo†	Intervention	112.5	37.9	49.5	24.1
	Control	112.3	37.8	50.7	24.4
12 mo	Intervention	99.1	33.5	67.1	32.9
	Control	99.8	33.7	65.9	32.5
23–61 mo	Intervention	104.3	35.2	60.3	30.0
	Control	103.6	35.0	62.1	29.4

BMI = body mass index; EWL = excess weight loss; TBW = total body weight.

* The end of the intervention was at 3 months postoperatively. The second publication included follow-up at 12 and 24 months postoperatively, which is ≥ 6 months after final intervention contact. While there was no data for end of intervention at 3 months post operatively, data at 6 months was available.† The initial publication reported outcomes measured at at 6 month and 12 months post operatively [52]. The follow-up publication reported on outcomes measured 23–61 months after surgery; corresponding to a follow-up time of 11–49 months after the end of the intervention program. The duration of the intervention is unclear, and end of intervention data were not reported. However, data at 6 months postoperatively were available. It reasonable to suspect measurements at 12 and 23–61 months postoperatively would be ≥ 6 months after final intervention contact.*Effect of eHealth on eating psychopathology, quality of life, depression screening, and self-efficacy**Eating psychopathology*

Six studies (reported across 8 publications), involving 562 participants, measured eating psychopathology [45,46,49,51–54,56]. Associated measures of effectiveness can be seen in Table 2. There was large diversity regarding outcome measures used to assess eating psychopathology. The interventions showed significant improvement on eating disorder examination [51,54], subjective binge eating [51], modified Yale Food Addiction Scale (YFAS) [49], binge eating scale [46], emotional eating scale [46], eating behavior inventory [56], and Three-Factor Eating Questionnaire (TFEQ) [45]. Further details can be seen in Table S5.

Quality of life

Five studies (reported across 7 publications), involving 716 participants, measured quality of life [44,46,47,51–54]. Associated measures of effectiveness can be seen in Table 2. The interventions showed significant improvement on the World Health Organization Quality of Life assessment (WHOQOL) [51,54], and EuroQol-5 Dimension 9EQ-5D) on the visual analog scale (VAS) [47]. The intervention showed an equal effect to the control for all other measures. Further details can be seen in Table S5.

Depression screening

Four studies (reported across 5 publications), involving 768 participants, screened for depression [45,47,52,53,56]. Associated measures of effectiveness can be seen in Table 2. A significant effect for the intervention over the

control was seen for Patient Health Questionnaire Version 9 (PHQ-9) [46]. Further details can be seen in Table S5.

Self-efficacy

Three studies (reported across 4 publications), involving 574 participants, measured self-efficacy [47,52,53,58]. Associated measures of effectiveness can be seen in Table 2. A significant difference was seen for results on the weight efficacy life-style questionnaire [47], new general self-efficacy questionnaire [58], and general self-efficacy [52,53], showing intervention effect over control. Further details can be seen in Table S5.

Subgroups

Five studies, reported across 6 publications [42,46,48,52,55,56], conducted further analysis on subgroups including procedure type (i.e., laparoscopic adjustable gastric banding versus laparoscopic sleeve gastrectomy), those with and without food addiction, rurality index (i.e., urban versus non-urban), those with and without clinically significant depression symptoms, as well as gender, BMI, age, and preoperative weight loss. Results have been tabulated and can be seen in Table S6.

Study quality

Overall bias was low for 5 reports [43–46,52], had some concerns for 7 reports [47,49,51,53–56], and high risk for 5 reports [42,48,50,57,58]. The risk of bias for “selection of reported results,” “measurement of the outcome,” and “deviations from intended interventions” were generally low (Fig. 2). For the randomization process, 41% of studies

Fig. 2. Risk of bias graph: review authors' judgments about each risk of bias item presented as percentages across all included studies with eHealth interventions delivered to adults who are scheduled for or have undergone bariatric surgery.

($n = 7$) had some concerns or high risk; 47% had some concerns or high risk for missing outcome data ($n = 8$).

Discussion

This systematic review aimed to evaluate the effect of complementing or substituting care with eHealth interventions on postoperative weight loss, weight loss maintenance, eating psychopathology, quality of life, depression screening, and self-efficacy in patients who are scheduled for or have undergone bariatric surgery. Given the rapid adoption of eHealth owing to COVID-19, a better understanding of the impact of eHealth has the potential to significantly inform bariatric health services that facilitate pre- and postoperative consultation and interventions for patients. Results showed no significant difference between the intervention and control groups for weight loss and weight maintenance; however, eHealth significantly improved various assessments for eating psychopathology. When bariatric surgery patients have limited or no access to health care teams or require additional support, eHealth may be a suitable option.

Overall, there was generally an equal effect of the eHealth interventions on weight loss compared with control groups. Therefore, eHealth could be offered to patients when they have limited or no access to health care teams or require additional support. To a lesser extent, eHealth was found to be more effective, and in 1 study negative effect was observed where the control significantly improved weight loss percentage compared with the intervention [55]. Current literature, with nonsurgical patients, has shown strong evidence that weight loss occurs in the short term because of eHealth and moderate evidence for the medium term [25,61]. It is speculated that no difference was seen in weight loss outcomes owing to the considerable postoperative weight loss related to the procedure itself. The role of eHealth in supporting weight loss for adults who undergo

bariatric surgery remains unclear, and clarity is needed regarding whether eHealth is simply a delivery mechanism for interventions or whether it can change the nature of interventions [62].

Regarding weight loss maintenance, of the 2 studies (reported across 4 publications) available, participants demonstrated continued weight loss 6 months after the intervention (12 months postoperatively). This trend stopped 18 months after the intervention (24 months postoperatively) and weight regain was observed in both the intervention and control groups. Weight regain is a common occurrence associated with all weight loss modalities including bariatric surgery [6,63–65]. Underlying causes leading to weight regain are multifactorial [6], and given the prevalence of postoperative weight regain efforts have been focused on developing treatment options including lifestyle interventions [8], behavior management [9], and cognitive behavior therapy [63]. Of the included studies, none specifically targeted adults who had undergone bariatric surgery and regained weight. The eligibility criteria of the current review excluded studies without a control group, which excluded studies with interventions that targeted weight regain [66,67]. Studies that have investigated the efficacy of rescue interventions, such as Bradley et al. [67] and Kalarchian et al. [68], may also provide practical knowledge that can be transferred into interventions using eHealth modalities.

Successful weight loss and prevention of postoperative weight regain requires a behavioral change in combination with lifestyle modification. Behavior change interventions are typically complex, involving many interacting components [69], which can make it challenging to synthesize in reviews, replicate in research, and practically implement [39]. In the present review, techniques from the BCTT (v1) were only reported when explicitly stated by the authors. Findings may be limited by this coding decision and the lack of detailed reporting of BCTs within the included studies makes it difficult to draw concrete conclusions

regarding the use of specific strategies in this context. Of the 36 techniques identified in the eHealth interventions [39], the most common techniques were self-monitoring, problem solving, social support, goal setting, and shaping knowledge, which is consistent with other systematic reviews exploring weight loss and weight maintenance eHealth interventions [70], postoperative behavioral management [9], and diet and physical activity interventions [40,71,72]. Consolidated Standards of Reporting Trials (CONSORT) guidelines call for precise reporting of behavior change interventions, including a “description of the different components of the interventions” [73]. While the included studies all provided detail regarding intervention content, the active components of behavior change were often described with different labels; for example, self-monitoring could be labeled as food diaries. In addition, the same labels could be applied to different techniques (e.g., “counseling” could involve “shaping knowledge” or “feedback and monitoring”) and hence could not be coded owing to the subjectivity. It is recommended that future studies report interventions as per the BCTT as this will “lay the foundation for the reliable and systematic specification of behavior change interventions” in this field or research [39].

eHealth may serve to counter eating psychopathology, as interventions showed statistically significant improvement on various assessments. This is encouraging considering disordered eating and binge eating are common in patients who undergo bariatric surgery [74,75] and are associated with less weight loss and/or more weight regain postoperatively [75,76]. Notably, the studies with intervention effect included acceptance and commitment therapy [51,54], cognitive behavioral therapy [46,49], emotional freedom techniques [45], or a behavior lifestyle intervention [56]. Current evidence regarding psychosocial interventions for bariatric surgery patients is strongest for the impact of cognitive behavioral therapy on improving disordered eating behaviors and eating pathology [77]. The optimal time to initiate treatment is thought to be early in the postoperative period before significant problematic eating behaviors and weight regain occur [77]. A systematic approach to postoperative patient assessment may be of benefit to identify patients at risk of weight regain and hence a potential candidate for further support. It should be noted that, like weight loss, clarity is needed regarding whether eHealth is a delivery mechanism for interventions such as cognitive behavioral therapy or whether it changes the nature of the treatment [62]. Further research is required to answer this relevant clinical question.

Modalities varied across the interventions, including traditional telehealth methods (telephone, email, and internet) and eHealth (mobile applications, text messaging programs, and WiFi devices). Four studies delivered postoperative interventions without usual care and 4 delivered postoperative interventions in addition to usual care. Of those delivered in addition to usual care, 3 implemented a

combination of modalities. There was no indication of a stepped care approach; rather, components were all provided at the same time. The 2019 updated AACE/TOS/ASMS Clinical Practice Guideline recommends postoperative “interventions should first include dietary change, physical activity, behavioral modification with frequent follow-up, and then, if appropriate, pharmacologic therapy and/or surgical revision” [2]. eHealth can provide additional options to increase the availability of support and address behavior modification before resorting to more intense approaches. Stepped care is an increasingly popular treatment model to overcome discrepancies between the demand and supply of healthcare services and reduce the existing healthcare burden [78]. Benefits of stepped care models include minimal interventions that can provide equivalent health gains, making current healthcare resources available to be used more efficiently, and it is generally well accepted by patients and professionals [79].

A case for stepped care for weight management after bariatric surgery was presented by Kalarchian et al. [80], suggesting it could begin with careful self-monitoring postoperatively via eHealth modalities such as mobile applications and weight-transmitting WiFi scales. A stepped eHealth approach would see patients offered a low-intensity and cost-effective intervention first, followed by stepping up to more intensive, expensive, and laborious treatments that are necessary based on outcomes [80], such as weight regain, clinically significant depression symptoms, and food addiction symptomology. In addition, the impact of COVID-19 and public health responses have necessitated a shift from in-person to remotely delivered bariatric care. The rapid uptake of eHealth has been instrumental in extending care to patients during the pandemic [81]. Psychosocial intervention to support mental health and bariatric care during COVID-19 could also follow a stepped approach. Starting with shaping knowledge and stress management followed by self-management via mobile applications, expanding support via videoconferencing or virtual support groups, and as required delivering virtual cognitive behavioral therapy [81].

The strengths of this review include a thorough search strategy, 2 independent review authors, and risk of bias assessment with the Cochrane tool. Limitations include substantial heterogeneity, which made quantitative comparisons difficult; hence, qualitative descriptions have been provided. One publication was transcribed using Google Translate, and we acknowledge that extraction via this method is more prone to error than extraction of English language articles [38]. While the search was conducted sometime after COVID-19 affected society, none of the included studies were conducted in the context of the pandemic. This will be an important consideration for future reviews, and with time, studies may be able to compare eHealth delivered during the pandemic with historical control groups to gain further insight. Research in this area, especially with the

pre-bariatric surgery population, is still in preliminary stages. Further research studies are needed to better understand if eHealth can support postoperative success. This review focused on including studies with control conditions and, as a result, studies without a control were excluded that may be able to add valuable insight.

Conclusion

When bariatric surgery patients have limited or no access to healthcare teams or require additional support, eHealth may be a suitable option, given that it was found to deliver an equal effect or be more effective for weight loss. Furthermore, eHealth may counter eating psychopathology, which is positive given the known impact disordered eating and binge eating have on postoperative weight loss and weight maintenance. Of the available follow-up studies, both eHealth and control groups demonstrated weight gain in the longer term. Future studies implementing eHealth interventions would benefit from reporting intervention components as per the BCTT and further consideration of delivering eHealth in a stepped care approach would be beneficial.

Disclosures

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Supplementary materials

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