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Review Article

Motivational interviewing in eHealth and telehealth interventions for weight loss: A systematic review

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ABSTRACT

The alarming prevalence of adult obesity warrants consideration of treatments with broad reach; digital health interventions meet this need and have demonstrated efficacy for weight loss. One approach that can be delivered remotely is motivational interviewing – a counseling style that helps resolve ambivalence to change unhealthy behavior. This is the first review to systematically examine eHealth and telehealth interventions that incorporate motivational interviewing for weight loss. We searched four electronic databases (PubMed, Embase, PsycInfo, CINAHL) for publications from November 2009–May 2018. Included papers were weight loss RCTs conducted among adults with overweight or obesity that examined eHealth or telehealth interventions with motivational interviewing, compared to any type of treatment arm without it. Results were presented separately by comparison arm (control vs. active comparator). Sixteen papers (15 trials) were included. Twelve used telephone-based counseling to deliver motivational interviewing, two used email and phone, and one used online chats. When compared to a no-treatment control arm, the motivational interviewing arm was associated with greater weight loss on 6 of 11 occasions, but performed better than an active comparator on only 1 of 7 occasions. Retention and engagement were generally high, though few trials examined the relation with weight loss. No trial had high risk of bias, but five lacked power calculations and only two reported fidelity to motivational interviewing. Telephone-based interventions that incorporate motivational interviewing hold promise as effective obesity treatments. There is a dearth of evidence to support the use of motivational interviewing via eHealth, signaling a needed research area.

1. Introduction

The alarming prevalence of adult obesity – 40% in the US (Hales et al., 2018) – warrants consideration of treatments with broad reach and scalability. Digital health interventions meet this need and have the potential to promote clinically meaningful weight loss (Semper et al., 2016; Schippers et al., 2017; Hutchesson et al., 2015). With 95% of US adults owning a cellphone (Mobile Fact Sheet, 2018) and 89% using the internet (Internet/Broadband Fact Sheet, 2018), digital health strategies hold particular promise in targeting populations often considered hard-to-reach (Bennett et al., 2018) – such as people with lower incomes or those living in rural settings – and may appeal to individuals looking for lower-intensity treatment. These digital health interventions encompass either eHealth (e.g., email, internet, social media, smartphone apps) (Eysenbach, 2001) or telehealth (e.g., telephone coaching, videoconferencing) (What Is Telehealth?, 2018) approaches, which can serve as an adjunct to standard obesity treatments (i.e., high-intensity, in-person lifestyle interventions). They can also serve as standalone interventions, entirely remotely-delivered, which remove traditional transportation and time constraint barriers.

Given that many people with obesity are not interested in losing weight or fully ready to make the behavioral changes required of weight loss (Snook et al., 2017; Wachsberg et al., 2011), strategies are needed that help resolve ambivalence to change. Motivational interviewing (MI) is an evidence-based treatment approach that targets this ambivalence and bolsters intrinsic motivation (Miller and Rollnick, 2013). It works by fostering patients' unique reasons for seeking change and helps them envision future goals. Further, by using a collaborative

Abbreviations: MI, motivational interviewing

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counseling style, MI guides patients toward personalized, autonomous decisions instead of providing a prescriptive approach, as well as emphasizing respect and empathy while avoiding confrontation.

MI has been used in weight management treatment, as summarized by a systematic review by Armstrong et al. (Armstrong et al., 2011). The authors of this review conducted a search through November 2009, and found that 12 randomized controlled trials met eligibility criteria. Four of the trials included phone counseling (Greaves et al., 2008; Woollard et al., 1995; Armit et al., 2009; Befort et al., 2008), while none incorporated eHealth modalities. The review concluded that motivational interviewing enhances weight loss outcomes with an effect size of 0.51 SDs. Given that almost a decade of research has occurred since Armstrong et al.'s review, an update and extension is warranted. The present study is the first to systematically examine MI in eHealth and telehealth interventions for weight loss. In light of the proliferation of digital health strategies for obesity treatment in recent years, and a call by the American Heart Association, American College of Cardiology, and The Obesity Society (AHA/ACC/TOS) for further study on remotely-delivered lifestyle interventions (Jensen et al., 2014), we sought to examine the extent to which MI has been incorporated in this delivery context. If effective, MI delivered via digital health strategies may have the potential to extend reach and dissemination.

This systematic review examined randomized controlled trials to address the following research questions: *Among adults with overweight or obesity, how do behavioral weight loss interventions incorporate motivational interviewing delivered* via *eHealth or telehealth strategies, and what is their efficacy?* The primary aim was to examine weight loss outcomes, stratifying by whether in-person counseling was provided along with remote delivery, given underlying differences in delivery channels and treatment intensity. We further examine weight loss outcomes by type of comparison arm (i.e., whether it was a no-treatment control arm or an active comparator arm). We chose to separate analyses in this way as the magnitude of weight change between the MI arm of interest and the comparison arm could differ depending on the type of comparison. Secondary aims were to: 1) assess trial retention, 2) investigate how MI is incorporated in treatment, 3) identify the types of eHealth and telehealth technologies used for MI, 4) describe fidelity measures of MI, and 5) determine engagement in the MI component of the intervention and its association with weight loss outcomes. These aims were selected to characterize digital health interventions that incorporate MI (secondary aims 2–4) and to discern whether the combination of MI plus digital health impacts outcomes (secondary aims 1 and 5).

2. Methods

The systematic review was conducted using a predetermined protocol registered with PROSPERO (CRD42018094147; https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=94147), and conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009).

2.1. Eligibility criteria

Table 1 outlines the eligibility criteria according to the five PICOS components: participants, interventions, comparators, outcomes, and study design (Moher et al., 2009); this tool is used to formulate the research question in systematic reviews. Articles were eligible if published in English between November 2009 (i.e., when Armstrong's search ended (Armstrong et al., 2011)) and May 2018. Studies were limited to randomized controlled trials, to enhance methodological quality. Trials of bariatric surgery, feeding studies, and pharmacological agents were excluded given the focus on behavioral interventions that would generalize more broadly among adults seeking to lose weight. While we recognize MI could be combined with bariatric surgery treatment, the outcomes from these trials are not directly comparable to those from lifestyle interventions given differences in intensity and reach (e.g., bariatric surgery is often restricted to those with a body mass index, BMI, ≥35).

Table 1
Eligibility criteria.

Inclusion criteria	
Paper characteristics	Full-text papers with outcomes, published after Nov. 2009
Population	
Age	Adults (≥18 years old)
Weight	Overweight or obese (BMI ≥25 kg/m^2) at baseline
Study design	Randomized controlled trial
Intervention	≥12 weeks Behavioral intervention for weight loss Motivational interviewing strategy is delivered via technology/tele-health
Comparison	Any comparison condition that does not include motivational interviewing
Outcomes	Weight loss outcomes (in kg, lb., or % body weight lost) at baseline and at least 1 follow-up visit

Exclusion criteria	
Paper characteristics	Review paper, protocol or design paper, conference abstract, qualitative paper Not in English
Population	Pregnant or postpartum women; patients currently undergoing active cancer treatment
Intervention	Feeding study Bariatric surgery Pharmacological treatment Weight gain prevention Weight maintenance

2.2. Data sources and search strategy

The medical librarian (MBB) and the first author (MLP) constructed the search strategies. The major concepts searched were motivational interviewing, body weight, and technology and these combined concept searches were completed in four electronic databases: PubMed, Embase, PsycInfo, and CINAHL. See Supplemental Table 1 for the tailored search strategies. Hand-searching was conducted of the reference lists of included articles, relevant post-2009 systematic reviews (Semper et al., 2016; Schippers et al., 2017; Hutchesson et al., 2015; Barnes and Ivezaj, 2015; Lundahl et al., 2013; Siopis et al., 2015; Raaijmakers et al., 2015; Sherrington et al., 2016; Levine et al., 2015), and relevant journals (Obesity, JMIR, Annals of Behavioral Medicine). This step was conducted to help further identify articles that may not have been captured in the database search.

2.3. Study selection

After importing the searches into EndNote software version X7, duplicates were removed using EndNote's deduplication program and two reviewers (MLP and LNW) independently screened all titles and abstracts of the remaining studies and classified papers as potentially eligible or not eligible. All papers deemed potentially eligible by at least one reviewer were then independently evaluated in the full-text review. During this phase, the same two reviewers completed an electronic questionnaire (Qualtrics) to screen articles using exclusion criteria that were presented in a hierarchy (Fig. 1). Discrepancies were resolved through reviewer consensus. All screening processes were blinded.

2.4. Risk of bias assessment

Two reviewers (MLP and LNW) independently assessed the risk of bias of each included trial, using a previously published adaptation of the Cochrane Risk of Bias Scale (Bennett et al., 2014; Higgins and Green, 2008; Young et al., 2012). The assessment comprised 10

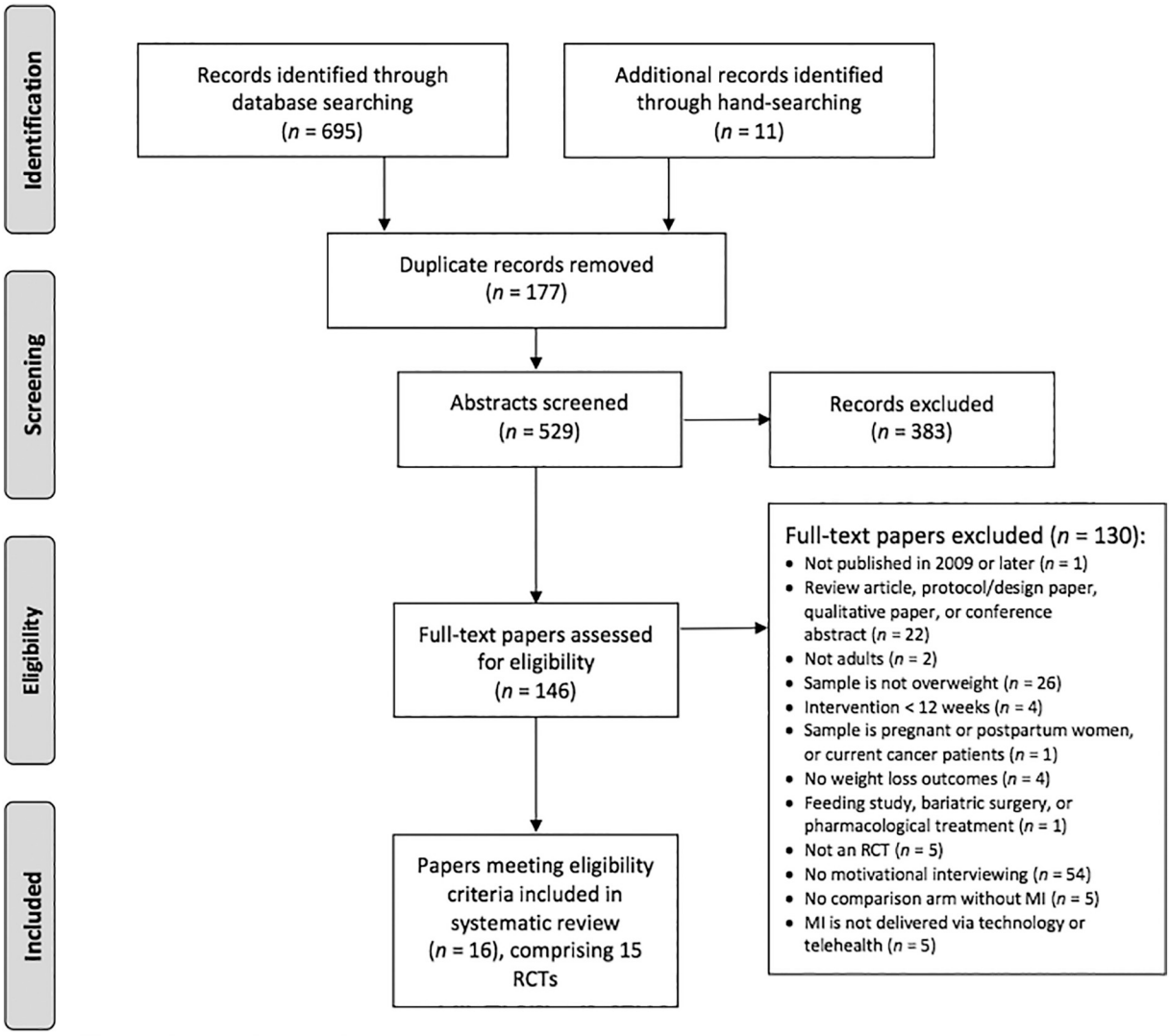

Figure 1: PRISMA flow diagram

Fig. 1. PRISMA flow diagram.

predefined criteria (see Table 2), each rated as present (1 point) or absent or inadequately described (0 points). Discrepancies were resolved through discussion with a third reviewer (JYB). Potential scores ranged from 0 to 10, with scores of 0–3 indicating high risk of bias, scores of 4–7 as medium risk, and scores of 8–10 as low risk.

2.5. Data extraction

When multiple papers pertained to the same trial, details were combined. The first author (MLP) extracted data from all included trials using a standardized form. A second reviewer (LNW) verified the accuracy of this information. If available, we extracted additional information from a baseline or methods paper from the same trial. Weight loss outcomes data were stratified by whether in-person counseling was included in the intervention arm(s) of interest, given differences in treatment delivery and scalability. Arms with at least one in-person session were considered to have an in-person component. We further separated analyses by type of comparator arm (i.e., no-treatment control vs. active comparator). MI engagement metrics were gathered to assess how much participants engaged with the MI component of the digital health intervention, for example, the number of MI contacts made during the intervention or the average call length. We further stratified results by type of comparison arm: a no-treatment control arm or an active comparator arm. The active comparator arm could include any type of behavioral weight loss intervention without MI (i.e., it could be delivered with or without technology).

3. Results

3.1. Study selection

Fig. 1 depicts the flow of papers throughout each stage, with 695 papers identified from the database search, and another 11 papers identified through hand-searching. Ultimately, 16 papers – consisting of 15 unique studies – met all inclusion criteria (Anderson et al., 2014; Anderson et al., 2018; Appel et al., 2011; Barnes et al., 2014; Bennett et al., 2012; Fischer et al., 2016; Hersey et al., 2012; Huber et al., 2015; Olson et al., 2016; Pearson et al., 2013a; Pearson et al., 2012; Reeves et al., 2017; Rock et al., 2015; Svetkey et al., 2015; West et al., 2016; Young et al., 2017).

3.2. Study characteristics

The 15 included studies had a mean of 260 participants and a range of 45–1755 participants per trial (Table 3). Across studies, mean age was 48 years (mean range: 21–64 years) and mean baseline BMI was

Table 2
Risk of bias assessment for included studies.

Study	Baseline characteristics reported separately for each group	Randomization clearly described and adequately done	Drop out: ≤20% for follow-up 6 months or earlier; ≤30% for > 6 months follow-up	Assessor blinding to treatment allocation	Weights reported ≥6 months after baseline	Intention-to-treat analyses for weight outcomes	Methods to address missing data were described	MI fidelity was assessed	Power calculations reported; adequate power	Weight measured objectively [a]	# of Criteria Met [b]
Anderson et al. (2014)	1	1	1	1	1	1	1	0	1	1	9
Anderson et al. (2018)	1	1	0	1	0	0	0	0	0	1	4
Appel et al. (2011)	1	1	1	1	1	1	1	1	1	1	10
Barnes et al. (2014)	1	0	1	0	1	1	1	1	0	1	7
Bennett et al. (2012)	1	1	1	0	1	1	1	0	1	1	8
Fischer et al. (2016)	1	1	1	0	1	1	1	0	1	1	8
Hersey et al. (2012)	1	1	0	0	1	1	1	0	1	1	7
Huber et al. (2015)	1	1	1	0	1	0	1	0	0	1	6
Olson et al. (2016)	1	0	0	0	1	1	0	0	1	1	5
Pearson et al. (2012) and Pearson et al. (2013a)	1	1	0	0	1	1	1	0	0	1	6
Reeves et al. (2017)	1	1	1	1	1	0	1	0	1	1	8
Rock et al. (2015)	1	1	1	0	1	0	1	0	1	1	7
Svetkey et al. (2015)	1	0	1	0	1	1	1	0	1	1	7
West et al. (2016)	1	1	1	0	1	1	1	0	1	1	8
Young et al. (2017)	1	0	0	1	1	0	0	0	0	1	4
Total # studies meeting criterion	15 (100%)	11 (73%)	10 (67%)	5 (33%)	14 (93%)	10 (67%)	12 (80%)	2 (13%)	10 (67%)	15 (100%)	Mean: 7/10

Note. Rating of Each Criterion: 1 = present; 0 = absent or unclear or inadequately described.
[a] Objective weight measurement refers to weight measured on a scale in person by study personnel.
[b] Risk of Bias Total Score: 0–3 = high risk; 4–7 = medium risk; 8–10 = low risk.

Table 3
Characteristics of included studies.

Study	Trial name	Participants						Study design				
		n	% Female	Mean age (years)	Age range (years)	BMI range (kg/m^2)	Race/ethnicity[a]	Location	Intervention duration	Assessment schedule	Year of intervention	Study population
Anderson et al. (2014), Caswell et al. (2012) and Craigie et al. (2011)	BeWEL	329	26%	63.6	50–74	≥25	99%W, 1%O	Scotland	12 months	BL, 3mo, 12mo	2010–2013	People who had undergone colonoscopy after a positive fecal occult blood test
Anderson et al. (2018)	Living-WELL	78	88%	47.1	≥18	≥25	99%W, 1%O	Scotland	12 weeks	BL, 12 weeks	2015–2016	People with a family history of breast cancer or colorectal cancer
Appel et al. (2011)	POWER Trial	415	64%	54	≥21	30–50	56%W, 41%B, 2% H, 2%O, 1%A	USA	24 months	BL, 6mo, 12mo, 24mo	2008–2011	Patients w/ at least 1 cardiovascular risk factor in primary care
Barnes et al. (2014)	n/a	89	76%	47.9	> 18	> 25 to < 55	65%W, 20%B, 6% M, 4%MH, 4%WH	USA	12 weeks	BL, 12wk, 24wk	NR	Patients at an academic primary care center
Bennett et al. (2012) and Greaney et al. (2009)	Be Fit, Be Well	365	69%	54.5	≥21	30–50	71%B, 13%H, 8% M, 4%W, 2%A-I, 1%A, 1%H/PI, 1% U	USA	24 months	BL, 6mo, 12mo, 18mo, 24mo	2008–2011	Socioeconomically disadvantaged patients who receive hypertension treatment in primary care
Fischer et al. (2016)	n/a	163	76%	46.4	≥18	25–50	NR	USA	12 months	BL, 6mo, 12mo	2014–2015	Patients with prediabetes at a federally-qualified health center
Hersey et al. (2012)	HEALTH	1755	74%	46.7	18–64	25–50	84%W, 16%O	USA	12 months	BL, 6mo, 12mo, 15-18mo	2006–2008	Non-active duty TRICARE beneficiaries
Huber et al. (2015)	n/a	90	74%	47.9	18–55	30–39.9	93%W, 7%O	USA	3 months	BL, 6 wks, 12 wks, 18 wks, 24 wks	2011–2012	Patients in a large academic primary care practice
Olson et al. (2016)	SHIFT	452	14%	47.8	NR	≥27	77%W, 9%H, 7%B, 6%M, 6%O, 1%AI/AN,1%H/PI	USA	6 months	BL, 6mo	2012–2014	Truck drivers who worked for 1 of 5 companies
Pearson et al. (2012), Pearson et al. (2013a) and Pearson et al. (2013b)	The CHANGE Study	45[b]	76%	20.9	18–24	≥30	69%W, 11%A, 7% B, 7%LA, 7%O	Canada	12 weeks	BL, 6 weeks, 12 weeks, 3 months, 6 months	2010–2011	Students from a large, urban university
Reeves et al. (2017)	Living Well After Breast Cancer Pilot Trial	90	100%	55.3	18–75	25–40	97%W	Australia	6 months	BL, 6mo	2010–2012	Women who recently completed treatment for stage I-III breast cancer
Rock et al. (2015) and Rock et al. (2013)	ENERGY	692	100%	56	≥21	25–45	79%W, 10%B, 7% H, 4%M/O	USA	24 months	BL, 6mo, 12mo, 18mo, 24mo	2010–2014	Survivors of early-stage breast cancer
Svetkey et al. (2015) and Batch et al. (2014)	CITY	365	70%	29.4	18–35	≥25	56%W, 36%B, 8% O, 6%H	USA	24 months	BL, 6mo, 12mo, 24mo	2010–2014	Young adults with overweight or obesity
West et al. (2016) and Krukowski et al. (2016)	iReach^2	398	90%	48.4	≥18	25–50	24%B	USA	18 months	BL, 6mo, 18mo	NR	Community-based participants
Young et al. (2017)	n/a	237[c]	5%	54.5	≥18	≥30, or 28–30 with gain ≥10 lbs. in last 3mo	45%B, 40%W, 5% M, 5%NR, 3%A-I, 3%A, 1%P-I	USA	6 months	BL, 3mo, 6mo	2012–2014	People with serious mental illness who are patients at the VA

Abbreviations: A – Asian; A-I – American Indian; AN – Alaskan Native; B – Black/African American; BL – Baseline visit; H – Hispanic/Latino; H/PI – Hawaiian/Pacific Islander; LA – Latino American; M – Mixed race and/or ethnicity; mo – Months; n/a – Not applicable; NR - Not reported; O – Other race/ethnicity; U – Unknown race/ethnicity; W – White/Caucasian.
Notes. Age range and BMI range represent what was allowed for inclusion in the trial and does not necessarily represent the actual range of participants; in the Study column, included are additional references that pertain to the study of interest, such as a baseline/methods paper.

[a] Numbers may not add up to 100% due to incomplete reporting or may add up to over 100% due to race and ethnicity reported separately.

[b] In Person et al., 78 participants were initially enrolled but the paper only included those who completed the intervention and had at least 1 follow-up visit.

[c] In Young et al., 276 participants were randomized. Analyses only included 237 who received the intervention, and demographics are presented only for this subset.

34.2 kg/m^2 (mean range 31–37 kg/m^2). Overall, 71% of participants were women, and 29% were from racial/ethnic minority groups (range: 1–96%). Most trials (11/15) were conducted in the United States. Mean intervention length was 12 months (range: 3–24 months), with four trials gathering weight outcomes beyond this period.

Five trials included three treatment arms (Appel et al., 2011; Barnes et al., 2014; Hersey et al., 2012; Svetkey et al., 2015; Young et al., 2017) while the remaining ten included two arms. Among the 35 total treatment arms across the 15 trials, 16 arms included MI via an eHealth/telehealth modality, 8 arms were active comparator arms, and 11 were no-treatment control arms. Roughly half (7/16) of the arms with MI delivered via an eHealth/telehealth modality also included in-person counseling, all of which incorporated MI into these in-person sessions (Anderson et al., 2014; Anderson et al., 2018; Appel et al., 2011; Barnes et al., 2014; Bennett et al., 2012; Rock et al., 2015; Svetkey et al., 2015). Among the 8 active comparator conditions, none included MI, and 5 had a counseling component—2 via in-person sessions (Barnes et al., 2014; Young et al., 2017), 1 via a mix of in-person and coaching calls (Rock et al., 2015), 1 via coaching calls (Pearson et al., 2013a), and 1 via online synchronous chat groups (West et al., 2016).

3.3. Risk of bias assessment

Table 2 presents the risk of bias assessment for the included trials. Six studies were low risk (Anderson et al., 2014; Appel et al., 2011; Bennett et al., 2012; Fischer et al., 2016; Reeves et al., 2017; West et al., 2016), nine were medium risk (Anderson et al., 2018; Barnes et al., 2014; Hersey et al., 2012; Huber et al., 2015; Olson et al., 2016; Pearson et al., 2013a; Rock et al., 2015; Svetkey et al., 2015; Young et al., 2017), and none were high risk. On average, 7 out of 10 criteria were met, and one trial met all 10 criteria (Appel et al., 2011). All studies measured weight objectively (i.e., weight measured on a scale in person by study personnel) and reported baseline characteristics separately for each treatment arm. Only two studies assessed fidelity to MI (Appel et al., 2011; Barnes et al., 2014). Two-thirds (10/15) of trials used intent-to-treat analyses.

3.4. Primary aim: weight loss outcomes

Fig. 2 depicts weight change across treatment arms, stratified by whether in-person counseling was included in the intervention. Table 4 presents weight outcomes at each time point.

3.4.1. MI via both remote delivery and in-person counseling

Among the 7 treatment arms that had *both* remotely-delivered and in-person MI components (Anderson et al., 2014; Anderson et al., 2018; Appel et al., 2011; Barnes et al., 2014; Bennett et al., 2012; Rock et al., 2015; Svetkey et al., 2015), weight change at the end of the intervention period ranged from −1.1 kg to −5.1 kg (mean: −2.5 kg). Of these, the only trial with at least one additional follow-up time point had weight change of −1.2 kg, a slight drop from −1.5 kg at the end of treatment (Barnes et al., 2014).

When compared to a no-treatment control arm, the arm with both remote and in-person MI had significantly greater weight loss at end of intervention in 3 trials (Anderson et al., 2014; Appel et al., 2011; Bennett et al., 2012), with no difference between arms in the other 3 trials (Anderson et al., 2018; Barnes et al., 2014; Svetkey et al., 2015), 2 of which did not report adequate power (Anderson et al., 2018; Barnes et al., 2014). When compared to an active comparator arm at end of intervention, the arm with both remote and in-person MI had greater weight loss in 1 trial whose comparison was a lower-intensity intervention (Rock et al., 2015), while 2 other trials found no significant difference (Barnes et al., 2014; Svetkey et al., 2015).

The POWER trial was the only trial with more than one treatment arm with MI delivered remotely, one of which also included an in-person component (Appel et al., 2011). The investigators found no significant difference between the remote-only MI arm and the arm with both remote and in-person MI at any time point (6, 12, or, 24 months).

3.4.2. MI via remote delivery only

Among the 9 treatment arms that had only remotely-delivered MI (Appel et al., 2011; Fischer et al., 2016; Hersey et al., 2012; Huber et al., 2015; Olson et al., 2016; Pearson et al., 2013a; Reeves et al., 2017; West et al., 2016; Young et al., 2017), weight change at the end of the intervention period ranged from −1.1 kg to −5.8 kg (mean: −3.1 kg). Among the two trials with at least one additional follow-up time point, weight loss was maintained at follow-up (Hersey et al., 2012; Huber et al., 2015).

The remotely-delivered MI arm had significantly greater weight loss at end of intervention than a no-treatment control arm in 3 trials (Appel et al., 2011; Olson et al., 2016; Reeves et al., 2017), with no significant differences between arms in the other 2 trials (Fischer et al., 2016; Huber et al., 2015), one of which was a pilot study without adequate power (Huber et al., 2015). When compared to an active comparator arm, the remotely-delivered MI arm had a lower magnitude of weight loss at end of intervention in 1 trial whose comparison was the empirically supported LEARN program (Pearson et al., 2013a), and had no significant differences in 2 trials (Hersey et al., 2012; West et al., 2016), including both active comparators in Hersey et al. (Hersey et al., 2012). The trial by Young et al. reported a significant interaction of treatment arm and time for participants with obesity, but they did not report whether differences were found between the three arms, nor did they find significant differences of their whole sample (including adults with both overweight and obesity); of caution, this trial did not report power calculations (Young et al., 2017). No remotely-delivered MI arms displayed greater weight loss than an active comparator arm. See Fig. 3 for a summary of weight loss findings.

Among the 10 trials that reported weight outcomes at multiple time points, the pattern of significance between arms in weight change seldom varied; Svetkey et al. demonstrated a disappearance of significantly different weight outcomes over time (Svetkey et al., 2015), while Bennett et al. found initial difference between arms, then no difference at 18 months followed by significant difference again at 24 months (Bennett et al., 2012).

3.4.3. Clinically significant weight loss

Ten trials reported the percentage of participants who achieved at least 5% weight loss from baseline, which is considered a clinically significant amount of weight loss (Jensen et al., 2014). Among this subset, a mean of 32% (range: 17–44%) of participants in the arms with both remote and in-person MI achieved this threshold (Anderson et al., 2014; Anderson et al., 2018; Appel et al., 2011; Barnes et al., 2014; Bennett et al., 2012; Rock et al., 2015; Svetkey et al., 2015), compared to 32% (range: 19–38%) in the remote-only MI arms (Appel et al., 2011; Fischer et al., 2016; West et al., 2016; Young et al., 2017), 23% (range: 17–30%) in active comparator arms (Barnes et al., 2014; Svetkey et al., 2015; West et al., 2016; Young et al., 2017), and 15% (range 0–25%) in no-treatment control arms (Anderson et al., 2014; Anderson et al., 2018; Appel et al., 2011; Barnes et al., 2014; Bennett et al., 2012; Fischer et al., 2016; Svetkey et al., 2015; Young et al., 2017).

3.5. Secondary aims

3.5.1. Trial retention

Mean overall trial retention at the end of the intervention period was 79% (range: 33–97%; see Table 4). For studies that included at least one additional follow-up visit (n = 4) (Barnes et al., 2014; Hersey et al., 2012; Huber et al., 2015; Pearson et al., 2013a), retention ranged from: 30% (Hersey et al., 2012) to 96% (Barnes et al., 2014). Only 3 studies (20% of trials) (Hersey et al., 2012; Reeves et al., 2017; West

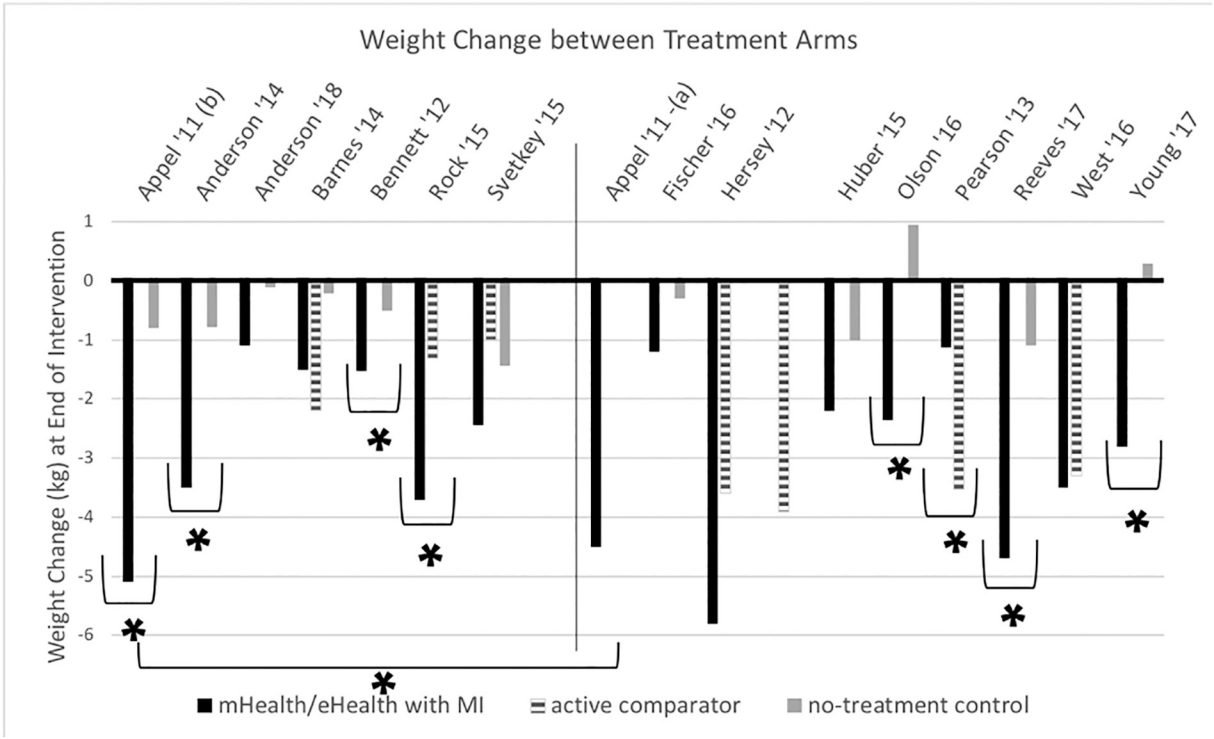

Fig. 2. Weight change between treatment arms at end of treatment.
Notes. Asterisks indicate statistically significant differences between treatment arms; to the left of the vertical line represents treatment arms with in-person counseling; the outcome of Rock et al. is reported in % weight loss and was included for comparison. All others are in kg. The trial by Young et al. had three arms – the active comparator arm had exactly 0.0 kg weight change, thus this arm does not appear in the figure; this trial found a significant interaction of treatment arm and time but did not report specific details.

et al., 2016) reported whether retention differed by treatment arms; none yielded differential attrition.

3.5.2. Method of MI delivery

One trial used an MI manual (Barnes et al., 2014), one used a semi-structured MI interview (West et al., 2016), and the other trials used principles of MI incorporated in the intervention. Table 5 displays MI details.

Most trials (12/15) delivered MI solely via phone coaching, 2 trials used email communication and phone coaching (Hersey et al., 2012; Rock et al., 2015), and 1 trial used online synchronous chats (West et al., 2016). Among the trials with phone coaching, the average number of intended sessions was 15 (range: 2–33 sessions) and the average intended length of calls was 20 min (range: 10–45 min). Five trials with phone coaching did not report intended call length. One trial had optional phone coaching (Fischer et al., 2016). The professional background of the coaches who delivered MI varied, with lifestyle coaches being most prevalent; other trials used coaches such as dietitians, psychologists, and medical assistants.

Seven studies (47%) delivered MI both remotely and through in-person sessions (Anderson et al., 2014; Anderson et al., 2018; Appel et al., 2011; Barnes et al., 2014; Bennett et al., 2012; Rock et al., 2015; Svetkey et al., 2015). Among these in-person sessions, two had individual counseling (Anderson et al., 2014; Barnes et al., 2014), three had group counseling (Bennett et al., 2012; Rock et al., 2015; Svetkey et al., 2015), one had a combination of each format (Appel et al., 2011), and one did not report format (Anderson et al., 2018). The number of MI in-person sessions ranged from 1 to 39, with a median of 6 sessions. The Bennett et al. trial described these sessions as optional (Bennett et al., 2012). Expected duration of the in-person sessions was roughly 60 min in most trials (Anderson et al., 2014; Anderson et al., 2018; Barnes et al., 2014; Rock et al., 2015). In the Appel et al. trial, the group-based in-person sessions were expected to last 90 min while the individual-based in-person sessions were to last 20 min (Appel et al., 2011); the remaining trials did not report expected duration of the in-person sessions (Bennett et al., 2012; Svetkey et al., 2015).

3.5.3. MI training

All but two trials (Anderson et al., 2014; Fischer et al., 2016) reported that coaches were trained in MI. Some trials hired coaches with previous training, while others conducted initial training before treatment started, and 9 trials reported providing training and/or supervision throughout the course of the treatment period. Two trials provided training from a member of the Motivational Interviewing Network of Trainers (Barnes et al., 2014; West et al., 2016). Few trials reported who provided the training and/or supervision, how long initial training lasted, and how often and for what duration ongoing supervision occurred.

3.5.4. MI fidelity

Only the Barnes et al. trial included a formal measure of MI fidelity (Barnes et al., 2014) – the Independent Tape Rater Scale – while the Appel et al. trial monitored MI fidelity informally through observation of coaches (Appel et al., 2011). Four trials mentioned assessing intervention fidelity but did not specifically link it to MI components (Anderson et al., 2018; Reeves et al., 2017; Svetkey et al., 2015; West et al., 2016). Nine trials did not assess (or report assessing) MI fidelity (Anderson et al., 2014; Bennett et al., 2012; Fischer et al., 2016; Hersey et al., 2012; Huber et al., 2015; Olson et al., 2016; Pearson et al., 2013a; Pearson et al., 2012; Rock et al., 2015; Young et al., 2017).

3.5.5. Engagement in the MI component, and associations with weight loss

Most trials (11/15) reported engagement metrics for the MI component, though operationalizations of engagement varied. Five trials described the mean number of MI sessions completed (Bennett et al., 2012; Olson et al., 2016; Svetkey et al., 2015; West et al., 2016; Young

Table 4
Retention and weight change outcomes.

Study	Treatment arms[a]	Retention		Weight				
		Retention	Significance	Baseline BMI (kg/m^2)	Baseline weight (kg)	Change in weight (kg) from baseline[b]	Significance	5% Weight loss
MI via both remote delivery and in-person counseling								
Anderson et al. (2014)	(a) MI phone coaching + MI in-person (b) control	3 months: (tot) 95% (a) 94% (b) 97% 12 months: (tot) 93% (a) 91% (b) 95%	NR	(tot) 30.7 (a) 31.0 (b) 30.4	(tot) 89.3 (a) 90.2 (b) 88.4	3 months: (a) −2.10 (b) −0.67 **12 months:** (a) −3.50 (b) −0.78	3 months: a > b 12 months: a > b	12 months: (a) 36% (b) 12%
Anderson et al. (2018)	(a) MI phone coaching + web + MI in-person (b) usual care	12 weeks: (tot) 75% (a) 77% (b) 74%	NR	(tot) 32.7 (a) 33.1 (b) 32.3	(tot) 89.6 (a) 90.9 (b) 88.2	**12 weeks:** (a) −1.1 (b) −0.1	12 weeks: a = b	12 weeks: (a) 37% (b) 0%
Appel et al. (2011)[c]	(a) MI phone coaching + web + email (b) MI phone coaching + web + email + MI in-person (c) control	6 months: (tot) 88% (a) 93% (b) 90% (c) 82% 12 months: (tot) 86% (a) 89% (b) 89% (c) 78% 24 months: (tot) 95% (a) 95% (b) 96% (c) 93%	NR	(tot) 36.6 (a) 36.0 (b) 36.8 (c) 36.8	(tot) 103.4 (a) 102.1 (b) 105.0 (c) 104.4	6 months: (a) −6.1 (b) −5.8 (c) −1.4 12 months: (a) −5.7 (b) −5.4 (c) −1.1 **24 months:** (a) −4.6 (b) −5.1 (c) −0.8	6 months: a > c; a = b; b > c 12 months: a > c; a = b; b > c 24 months: a > c; a = b; b > c	24 months: (a) 38% (b) 41% (c) 19%
Barnes et al. (2014)	(a) MI phone coaching + web + MI in-person (b) nutrition psychoeducation in-person + web (c) usual care	12 weeks: (tot) 97% (a) 93% (b) 100% (c) 97% 24 weeks: (tot) 96% (a) 90% (b) 100% (c) 97%	NR	(tot) 35.3 (a) 34.7 (b) 35.1 (c) 36.1	NR	**12 weeks:** (a) −1.5 (b) −2.2 (c) −0.2 24 weeks: (a) −1.2 (b) −2.6 (c) +0.2	12 weeks: a = b; a = c; b > c 24 weeks: a = b; a = c; b > c	12 weeks: (a) 17% (b) 17% (c) 7% 24 weeks: (a) 23% (b) 28% (c) 10%
Bennett et al. (2012)	(a) MI phone coaching + MI in-person (b) usual care	6 months: (tot) 75% (a) 73% (b) 76% 12 months: (tot) 69% (a) 63% (b) 75% 18 months: (tot) 67% (a) 62% (b) 72% 24 months: (tot) 86% (a) 82% (b) 90%	NR	(tot) 37.0 (a) 37.0 (b) 37.0	(tot) 100.2 (a) 99.7 (b) 100.6	6 months: (a) −1.25 (b) −0.13 12 months: (a) −1.37 (b) −0.32 18 months: (a) −1.28 (b) −0.33 **24 months:** (a) −1.53 (b) −0.50	6 months: a > b 12 months: a > b 18 months: a = b 24 months: a > b	24 months: (a) 20% (b) 20%
Rock et al. (2015)	(a) MI phone coaching and/or MI email + MI in-person (b) coaching in-person + phone and/or email coaching	6 months: (tot) 90% (a) 92% (b) 88% 12 months: (tot) 85% (a) 86% (b) 83% 18 months: (tot) 78% (a) 81% (b) 75% 24 months: (tot) 85% (a) 87% (b) 82%	NR	(tot) 31.5 (a) 31.6 (b) 31.4	(tot) 84.8 (a) 85.0 (b) 84.7	6 months: (a) −5.9% (b) −1.3% 12 months: (a) −6.0% (b) −1.5% 18 months: (a) −4.7% (b) −1.3% **24 months:** (a) −3.7% (b) −1.1%	6 months: a > b 12 months: a > b 18 months: a > b 24 months: a > b	12 months: (a) 55% (b) NR 24 months: (a) 44% (b) NR
Svetkey et al. (2015) and Lin et al. (2018)	(a) Smartphone app (b) MI phone coaching + smartphone app + MI in-	6 months: (tot) 92% (a) 94% (b) 96% (c) 85%	NR	(tot) 35.2 (a) 35.7	(tot) 101.0 (a) 102.4	6 months: (a) −0.87 (b) −3.07 (c) −1.14	6 months: a = c; b > c; b > a 12 months: a = c; b = c;	24 months: (a) 26%

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Table 4 (*continued*)

Study	Treatment arms[a]	Retention		Weight				
		Retention	Significance	Baseline BMI (kg/m^2)	Baseline weight (kg)	Change in weight (kg) from baseline[b]	Significance	5% Weight loss
	person (c) control	12 months: (tot) 89% (a) 89% (b) 92% (c) 86% 24 months: (tot) 86% (a) 85% (b) 87% (c) 85%		(b) 34.9 (c) 35.1	(b) 99.3 (c) 101.3	12 months: (a) −1.48 (b) −3.58 (c) −2.25 **24 months:** (a) −0.99 (b) −2.45 (c) −1.44	b > a 24 months: a = c; b = c; b = a	(b) 28% (c) 22%
MI via Remote Delivery Only								
Fischer et al. (2016)	(a) MI phone coaching + SMS (b) usual care	6 months: NR 12 months: (tot) 92% (a) 92% (b) 92%	NR	NR	(tot) 89.9 (a) 88.4 (b) 91.4	6 months: (a) −1.7 (b) −1.0 **12 months:** (a) −1.2 (b) −0.3	6 months: a = b 12 months: a = b	12 months: (a) 19% (b) 14%
Hersey et al. (2012)	(a) MI phone coaching + MI email + interactive web (b) interactive web (c) basic web	6 months: (tot) 60% (a) 61% (b) 61% (c) 59% 12 months: (tot) 33% (a) 34% (b) 34% (c) 30% 15–18 months: (tot) 30% (a) 30% (b) 31% (c) 28%	6mo: a = b = c 12mo: a = b = c 15–18mo: a = b = c	(tot) 33.6 (a) NR (b) NR (c) NR	(tot) 101.1 (a) 101.1 (b) 100.6 (c) 99.9	6 months: (a) −5.7 (b) −3.7 (c) −3.4 **12 months:** (a) −5.8 (b) −3.6 (c) −3.9 15–18 months: (a) −6.1 (b) −3.7 (c) −4.0	6 months: a = b = c 12 months: a = b = c 15–18 months: a = b = c	12 months - 7%: (tot) 29%
Huber et al. (2015)	(a) MI phone coaching (b) usual care	6 weeks: NR 3 months: (tot) 87% (a) 84% (b) 89% 18 weeks: NR 6 months: (tot) 84% (a) 82% (b) 87%	NR	(tot) 36.3 (a) 36.5 (b) 36.1	(tot) 101.6 (a) 99.6 (b) 103.6	6 weeks: NR **3 months:** (a) −2.2 (b) −1.0 18 weeks: NR 6 months: (a) −2.6 (b) −1.1	6 weeks: NR 3 months: a = b 18 weeks: NR 6 months: a = b	NR
Olson et al. (2016)	(a) MI phone coaching + web (b) usual care	6 months: (tot) 61% (a) 59% (b) 63%	NR	(tot) 35.6 (a) 35.7 (b) 35.4	(tot) 107.1 (a) 107.9 (b) 106.4	**6 months:** (a) −2.36 (b) +0.95	6 months: a > b	NR
Pearson et al. (2012) and Pearson et al. (2013a)	(a) MI phone coaching (b) LEARN program phone coaching	Among those randomized: 3 months: (tot) 53% 6 months: (tot) 49% among those included in present analysis: 3 months: (tot) 91% (a) NR (b) NR 6 months: (tot) 48% (a) NR (b) NR	NR	NR	(tot) 100.4 (a) 100.6 (b) 100.1	**12 weeks:** (a) −1.13 (b) −3.52	6 weeks: NR 12 weeks: a < b 3 months: NR 6 months: NR	NR
Reeves et al. (2017)	(a) MI phone coaching (b) usual care	6 months: (tot) 82% (a) 89% (b) 76%	6mo: a = b	(tot) 31.0 (a) 30.6 (b) 31.4	(tot) 83.3 (a) 82.3 (b) 84.2	**6 months:** (a) −4.7 (b) −1.1	6 months: a > b	NR
West et al. (2016)	(a) MI online individual chat sessions + online group chat sessions + web + email (b) online group chat sessions + web + email	6 months: (tot) 90% (a) 88% (b) 91% 12 months: (tot) 83% (a) 83% (b) 83% 18 months:	6mo: a = b 18mo: a = b	(tot) 36.0 (a) 35.9 (b) 36.1	(tot) 98.3 (a) 98.4 (b) 98.2	6 months: (a) −5.1 (b) −5.5 **18 months:** (a) −3.5 (b) −3.3	6 months: a = b 18 months: a = b	6 months: (a) 47% (b) 50% 18 months: (a) 33% (b) 30%

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Table 4 (*continued*)

Study	Treatment arms[a]	Retention: Retention	Retention: Significance	Weight: Baseline BMI (kg/m²)	Weight: Baseline weight (kg)	Weight: Change in weight (kg) from baseline[b]	Weight: Significance	Weight: 5% Weight loss
Young et al. (2017)	(a) MI phone coaching + web (b) coaching in-person (c) usual care	(tot) 81% (a) 82% (b) 80% 3 months: (tot) 80% (a) 73% (b) 79% (c) 90% 6 months: (tot) 79% (a) 68% (b) 80% (c) 90%	NR	(tot) 34.4 (a) 33.9 (b) 35.0 (c) 34.4	(tot) NR (a) NR (b) NR (c) NR	6 months (ow + obese): NR **6 months (obese):** (a) −2.8 (b) 0.0 (c) +0.3	6 months (ow + obese): a = b 6 months (obese): significant interaction	6 months (obese): (a) 37% (b) 18% (c) 25%

Abbreviations: MI – motivational interviewing; mo – month; NR - not reported; ns – not statistically significant; obese – adults who have obesity; ow – adults who have overweight; tot – total sample; web – website

[a] Control refers to a no-treatment control arm.

[b] Time point in bold indicates end of treatment.

[c] Appel et al. had 1 treatment arm with in-person counseling and 1 treatment arm without in-person counseling.

et al., 2017), while two trials reported the median (Appel et al., 2011; Reeves et al., 2017); other descriptions of engagement included the percentage of participants with all sessions completed(n = 2) (Anderson et al., 2014; West et al., 2016), the mean call length (n = 3) (Anderson et al., 2018; Fischer et al., 2016; Reeves et al., 2017), the percentage of participants who completed at least a portion of calls (n = 2) (Anderson et al., 2014; Hersey et al., 2012), and the total number of calls completed among all participants (n = 1) (Fischer et al., 2016).

Only three trials reported the relation between MI engagement and weight loss (Hersey et al., 2012; Svetkey et al., 2015; West et al., 2016); two of which found a significant, positive relationship (Hersey et al., 2012; West et al., 2016). In particular, Hersey et al. found that participants who completed ≥20% of calls were more likely to achieve at least 7% weight loss, compared to those with < 20% call completion (Hersey et al., 2012). West et al. found that MI engagement mediates the effect of group chat completion on weight loss, such that among participants who had high engagement in group chats, those who also had high MI engagement lost more than those with low MI engagement (West et al., 2016). The CITY trial did not find a significant association between call completion rate and weight change category (Svetkey et al., 2015; Lin et al., 2018).

4. Discussion

The present study summarized the results of 15 randomized controlled trials of weight loss interventions that incorporated motivational interviewing delivered via digital health. Extending past research on using MI for weight loss (Armstrong et al., 2011; Lundahl et al., 2013; DiLillo and West, 2011), we found mixed evidence regarding digital health interventions with MI being effective in producing weight loss. Just over half (55%) of the MI interventions demonstrated greater weight loss than a no-treatment control arm (Anderson et al., 2014; Appel et al., 2011; Bennett et al., 2012; Olson et al., 2016; Reeves et al., 2017), with mean weight loss at end of treatment ranging from −1.1 to −5.8 kg; similar outcomes occurred regardless of whether in-person counseling was provided (which occurred in 44% of treatments). Thus, remote delivery of MI performed just as well as remote plus in-person delivery of MI, suggesting that this higher intensity approach may not be needed, allowing for resources to be used elsewhere. Interestingly, all but one trial included phone coaching, indicating a clear fit between MI and phone delivery. Telehealth methods rely on simply a standard cell phone, which 95% of US adults own (Mobile Fact Sheet, 2018), making it a feasible intervention delivery strategy. Further, phone coaching can mirror in-person delivery by capturing the "spirit of MI" (e.g., displaying compassion, emphasizing autonomy), which has been demonstrated to be a mechanism of MI (Copeland et al., 2015); this in turn illustrates a potential limitation of delivering MI via eHealth strategies, whereby there is no human contact (Shingleton and Palfai, 2016).

Our study suggests MI interventions are comparable to non-MI interventions at promoting weight loss. At end of treatment, approximately one-third of MI participants achieved a clinically significant threshold of at least 5% weight loss, compared to roughly one-quarter of those in an active comparator arm. These results are better than those found in a 2015 review of MI in primary care (Barnes and Ivezaj, 2015) whereby 13% to 36% of participants achieved the 5% threshold. Of note, the MI arms in our review performed better than an active comparator arm in only one trial (Rock et al., 2015) and the comparator arm in that trial was of relatively lower intensity. Therefore, this review provides little evidence that an MI approach *is superior to* other behavioral treatment. Nevertheless, these findings suggest that MI approaches are as effective as non-MI approaches for weight loss. It is likely that variations in intervention fidelity and differing treatment dose impacted outcomes; further, nonspecific treatment factors (e.g., therapeutic alliance, collaboration, trust) may impact the degree to

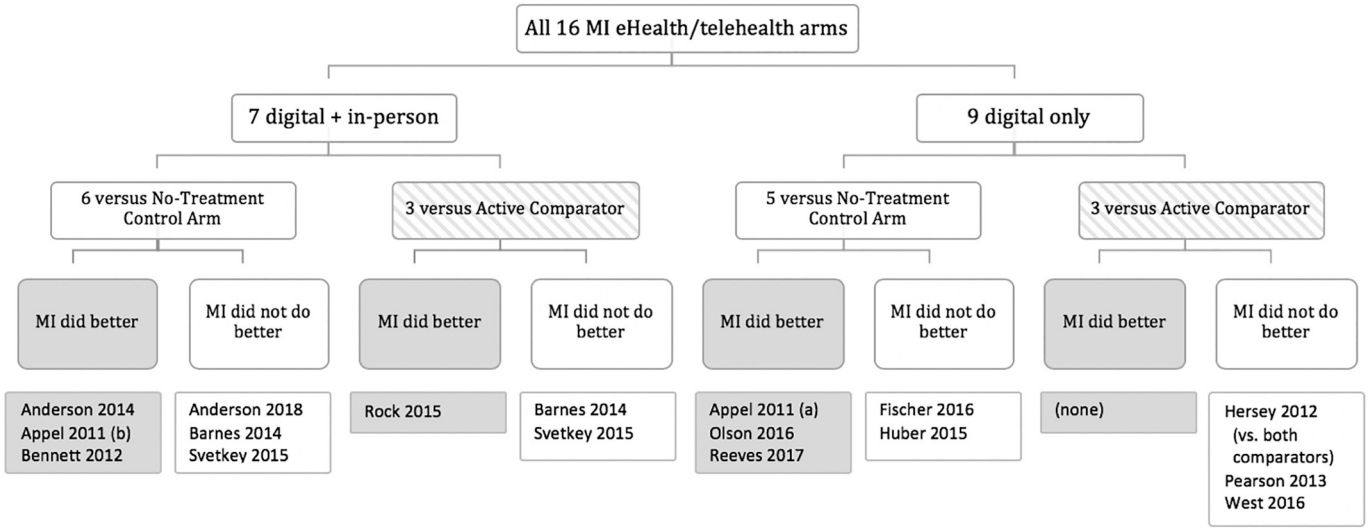

Fig. 3. Summary of Weight Loss Findings at End of Intervention.
Notes. The number of digital + in-person treatment arm comparisons adds up to > 7 given that some trials had more than two comparison arms. Of note, the trial by Young et al. is not listed because no results between treatment arms were provided; the study reported only that there was a significant interaction of treatment arm and time.

which an individual changes behavior (Huibers and Cuijpers, 2014). Future research could examine the impact of these treatment features.

In line with the notion that MI improves retention (Goldberg and Kiernan, 2004), 67% of trials in the current review had retention of at least 80% at end of treatment, versus 58% of trials included in a systematic review of eHealth interventions for weight loss (Hutchesson et al., 2015); studies of direct comparisons are needed to make causal claims about whether MI improves retention. Unfortunately, only three trials in the present review reported whether retention differed between treatment arms, signaling a clear need for more comprehensive reporting. Further, in the current review, few studies examined eHealth delivery methods for MI – just two used email and one used online synchronous chats. This is surprising considering that other health behavior domains (e.g., high-risk sexual behavior, substance use) have begun delivering MI via digital health methods, such as text messaging, chat rooms, and video – most of which were fully-automated – as highlighted in a recent review of 41 studies (Shingleton and Palfai, 2016).

Engagement with the MI component was high. Of the studies that were effective at producing significant weight loss (Anderson et al., 2014; Appel et al., 2011; Bennett et al., 2012; Olson et al., 2016; Reeves et al., 2017; Rock et al., 2015), all but one (Rock et al., 2015) reported MI engagement outcomes, and all had high engagement. In contrast, among the studies that did not achieve significantly greater weight loss, five did not report engagement metrics – perhaps a marker of poor engagement – and of those that did, two had low engagement (Hersey et al., 2012; Young et al., 2017) and two had moderate-to-high engagement (Svetkey et al., 2015; West et al., 2016). It is unclear why Svetkey et al. had high engagement but minimal weight loss, though the authors proposed that it may have been due to insufficient tailoring of the intervention to the young adult population and use of a researcher-developed app instead of a commercial app (Svetkey et al., 2015). The finding that most trials reported MI engagement metrics is an improvement since Armstrong et al.'s review (Armstrong et al., 2011). However, different metrics were used across trials and few studies examined how engagement and weight loss are related.

Besides engagement, other potential contributors to meaningful weight loss include intervention duration, greater frequency of sessions, and fully-powered trials. Interventions that lasted at least 6 months tended to have better engagement and weight loss outcomes than shorter interventions, which is consistent with a recent meta-analysis of text-messaging interventions (Armanasco et al., 2017), suggesting that longer duration may be relevant—or perhaps is a signal for higher methodological quality. In fact, no studies with < 6 months of treatment (n = 4) found significant weight loss differences, nor did any report engagement metrics, meet the low risk of bias cutoff, or report power calculations (Anderson et al., 2018; Barnes et al., 2014; Huber et al., 2015; Pearson et al., 2013a).

In line with the Centers for Medicare & Medicaid Services' coverage requirements for obesity treatment (Decision Memo for Intensive Behavioral Therapy for Obesity (CAG-00423N), 2011), the AHA/ACC/TOS 2013 obesity guidelines recommend that lifestyle interventions be of high-intensity (i.e., at least 14 contacts over 6 months), though they also found evidence to support moderate-intensity interventions (i.e., 1–2 sessions per month), and found poor evidence for the validity of low-intensity interventions (i.e., sessions occurring less than monthly); they cautioned that no trials directly manipulated the frequency of sessions (Jensen et al., 2014). The 2018 US Preventive Services Task Force guidelines reiterated the difficulty in identifying the impact of number of sessions on weight loss given heterogeneity across trials (Curry et al., 2018); recent trials have begun comparing dose of counseling sessions (Perri et al., 2014; Ariel and Perri, 2016), but none to our knowledge have been conducted solely via telephone-based counseling. In the current review, we found that over half of interventions (5/8) with at least 14 intended MI contacts (i.e., the guideline's minimum threshold of high-intensity) resulted in significant weight differences, compared to only 2 of 8 interventions with fewer than 14 sessions.

More work is need to understand *for whom remotely-delivered MI interventions are most useful*, a question that addresses the "whiches conundrum" involving understanding which treatments work best for which subgroups, in which contexts, in order to achieve optimal behavior change (King, 2013). Further, lack of adequate power appeared related to null findings, such that none of the five trials without adequate power demonstrated significant weight differences, suggesting the need for fully-powered trials to determine true impact.

None of the 15 trials in this review had a high risk of bias. Other strengths of the included trials were the perfect reporting of baseline characteristics by treatment arm and objective measurement of weight. The trials were limited by infrequent blinding of study team members to treatment allocation. Further, as demonstrated in past MI reviews (Armstrong et al., 2011; Barnes and Ivezaj, 2015), there was insufficient

Table 5
Motivational interviewing characteristics.

Study	MI intervention in tech arm (s)	MI details				MI outcomes	
		Non-tech MI components	MI delivery	MI training	MI fidelity	MI engagement outcomes	Association of MI engagement with weight loss
MI via both remote delivery and in-person counseling							
Anderson et al. (2014)	(a) Phone coaching: (15 min) 9 total calls over 12 months	(a) 3 F2F (60 min) 1:1 in mo1–3	Trained lifestyle counselors	NR	NR	59% of pts. completed all 9 calls; 95% completed ≥5 calls	NR
Anderson et al. (2018)	(a) Phone coaching: (15 min) 4 total calls over 12 weeks (in week 2, 5, 9, 12)	(a) 1 F2F (65 min estimated); unclear if group or individual format	Lifestyle counselors w/ nursing background	Received bespoke training	Monitoring MI fidelity not explicitly stated; overall intervention fidelity assessed by lifestyle counselors who randomly sampled and analyzed recorded calls	Mean 15 min call (range 5–30 min)	NR
Appel et al. (2011)[a]	(a) Phone coaching: (20 min) 33 total calls over 24 months (weekly in mo1–3, then monthly) (b) Optional phone coaching: (20 min) monthly in mo7–24	(a) None (b) 30 group F2F: (90 min) weekly in mo1–3; monthly in mo4–6; monthly in mo7–24; also 1:1 F2F (20 min) monthly in mo1–3, 2×/mo in mo4–6, monthly F2F or phone imo7–24	Via phone: employees of Healthways; via F2F: employees of university	Trained before enrollment then on a quarterly basis	MI fidelity assessed by a case-management team who observed the coaches; feedback provided monthly in mo1–3, mo4–24: quarterly	(a) > months 1–6: median 14 calls completed > months 7–24: median 16 calls completed (b) > months 1–6: median 4 calls completed > months 7–24: median 11 calls completed	NR
Barnes et al. (2014)	(a) Phone coaching: (20 min) 2 total calls (in weeks 3 and 9)	(a) 1 F2F 1:1 (60 min; 40 min = MI focused) at baseline; 2 F2F 1:1 sessions at weeks 6 and 12	Medical assistants	2, 8 h trainings by Motivational Interviewing Network of Trainers; 3 mock and 1 real MI session prior - adequate MI skills required; group supervision every 3 weeks	MI fidelity assessed by research-clinicians who used the Independent Tape Rater Scale to rate recorded sessions on MI adherence	NR	NR
Bennett et al. (2012)	(a) Phone coaching: (15-20 min) 18 total calls over 24 months	(a) 12 optional F2F monthly group sessions (length NR)	Trained community health educators	General training (by study investigators) and certification at baseline; recertified annually; received weekly supervision	NR	70.6% of calls completed over 24 months (calls 1–6: 80.4%, calls 7–12: 65.0%, calls 13–18: 66.7%)	NR
Rock et al. (2015)	(a) Phone coaching and/or email contacts: (10-15 min) 24–38 total contacts over 24 months (depending on need for support)	(a) 29 F2F groups (60 min); weekly in months 1–4 then biweekly in months 5–6, then monthly until 12 months	Dietetics, psychology, and/or exercise physiology	General training provided by the coordinating center at UCSD; weekly teleconferencing initially, then monthly	NR	NR	NR
Svetkey et al. (2015) and Batch et al. (2014)	(b) Phone coaching: (20 min) 21 total calls (monthly from week 7 to month 24)	(b) 6 weekly group F2F during first 6 weeks (120 min)	Dietitians	Previous MI training; ongoing training by study intervention director	Monitoring MI fidelity not explicitly stated; overall intervention fidelity assessed by the intervention director who observed group sessions and reviewed audiotaped monthly calls	> months 7–12: 92.3% (SD: 20.8) of calls completed > months 13–24: 87.8% (SD: 21.2) of calls completed	Completion rate of calls not associated with weight change categories from 7 to 12 months ($r = -0.066$, $p = .13$) or from 13 to 24 months ($r = -0.019$, $p = .92$)
MI via remote delivery only							
Fischer et al. (2016)	(a) Optional phone coaching (expected length NR)	(a) None	Health coach	NR	NR	Mean call length 3.6 min (range 1–20 min); 111 calls completed among all pts	NR

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Table 5 (*continued*)

Study	MI intervention in tech arm (s)	MI details				MI outcomes	
		Non-tech MI components	MI delivery	MI training	MI fidelity	MI engagement outcomes	Association of MI engagement with weight loss
Hersey et al. (2012)	(a) Alternate between phone coaching and email: (15–20 min) every 2 weeks for 15–18 months	(a) None	BA & Master's-level trained healthy lifestyle coaches	2 weeks training from clinical psychologists	NR	20% of pts. completed ≥20% of calls	If completed ≥20% of calls, percent of pts. who achieved ≥7% weight loss: 44% vs. 20%
Huber et al. (2015)	(a) Phone coaching: (20 min) 7 total calls over 3 months	(a) None	master's level wellness coach	Coach had training in MI	NR	NR	NR
Olson et al. (2016)	(a) Phone coaching: (length NR) 4 total calls (1st within 2 weeks, remaining based on pt. preference)	(a) None	3/4 were members of the Motivational Interviewing Network of Trainers	Supervised by a lead coach	NR	2.73 (SD = 1.52) calls completed	NR
Pearson et al. (2012) and Pearson et al. (2013a)	(a) Phone coaching: (45 min) 12 total calls over 12 weeks	(a) None	volunteer Certified Professional Co-Active Life Coach	certified via the Coaches Training Institute	NR	NR	NR
Reeves et al. (2017)	(a) Phone coaching: (length NR) 16 total calls over 6 months (weekly for 6 weeks, followed by 10 biweekly calls)	(a) None	Dietitians	Dietitians were previously trained in MI; biweekly supervision used to monitor fidelity	Monitoring MI fidelity not explicitly stated; overall intervention fidelity assessed by coaches who used checklists and listened to random calls	Median 13 calls completed; avg. duration 28 min	NR
West et al. (2016)	(a) 1:1 online synchronous chats (30 min) on study website: 6 total chats over 18 months (at beginning, after session 5, then at 3-month intervals)	(a) None	Clinical psychologists with past MI experience	Training and ongoing supervision from a member of MI Network of Trainers and clinical psychologist; weekly group supervision	Monitoring MI fidelity not explicitly stated; supervisor reviewed MI chat transcripts and provided feedback	Average of 3.8 out of 6 (63%) online chats attended; 29% of pts. attended all 6 MI chats	Positive effect of MI engagement and weight loss at 6mo and 18mo ($p < .0001$); pts. high on MI engagement and group chats lost more weight than those high on group chats but low on MI engagement
Young et al. (2017)	(a) Phone coaching: (length NR) weekly over 6 months	(a) None	(a) Peer wellness coaches who were individuals with lived experience with mental illness	(a) Didactic training in the manualized protocol along w/ experiential training in coaching, a weekly individual supervision (from a psychologist)	NR	7.9 calls completed	NR

Abbreviations: 1:1 – individual counseling (as opposed to group-based); avg – average; F2F – in-person face-to-face counseling; hr – hour; MI – motivational interviewing; mo – month; NR – not reported; pts – participants; SD – standard deviation.

[a] Appel et al. had 1 treatment arm with in-person counseling and 1 treatment arm without in-person counseling.

or no reporting of MI fidelity, which precludes appraisal of the quality of the MI that was delivered. Some studies also failed to report details on who provided the MI training or supervision.

Interventionists designing trials with MI are encouraged to include fidelity measures (Miller and Rollnick, 2014), provide ongoing supervision to counselors (Miller et al., 2004), and collect weight measurements after a period of no contact to assess whether outcomes are sustained once treatment ends (LeBlanc et al., 2018) – only 3 trials did the latter. In future publications, we recommend that study teams report additional information, when applicable, to improve clarity and comparison across trials. The following details were missing to some extent in several studies included in this review, thus preventing direct comparison:

- both the intended (per protocol) and actual length of counseling sessions, and whether they are individual- or group-based
- both the mean/median and % of all sessions completed
- whether attrition rates differed between treatment arms
- whether fidelity to MI was assessed, and whether fidelity was achieved
- the duration and frequency of counselor training in MI and ongoing supervision
- the professional background of the supervisor
- the proportion of participants who achieved clinically significant weight loss (≥5% and another relevant cutoff, if applicable); this would help improve comparability across trials
- whether engagement was related to weight loss
- If limited on space, include the study protocol with full intervention details in an appendix, or publish a methods/design paper

Strengths of this review include using the PICOS framework, preregistering, and adhering to PRISMA guidelines, as well as collaborating with a medical librarian (MBB) and searching multiple databases. It was outside the scope of this review to evaluate other weight-related or health outcomes, such as waist circumference or blood pressure, or to understand exactly how MI-based interventions promotes greater weight loss. Further, the multicomponent nature of behavioral weight loss interventions precludes evaluating the unique impact of MI on treatment outcomes. Using strategies such as factorial designs or comparative effectiveness trials would allow for a clearer picture of the independent treatment effect of MI offered via remotely-delivered strategies. It was not this review's purpose to directly compare remote versus in-person delivery of MI, though fully-powered trials of this type are warranted, particularly in settings where remote methods may be preferred (e.g., rural settings or among those with time or transportation issues). Lastly, given the expected heterogeneity in intervention and study design, no meta-analysis was performed; nevertheless, this narrative synthesis suggests moderate efficacy of digital health interventions that incorporate MI for weight loss.

5. Conclusions

This review aims to help clinicians and researchers decide whether incorporating MI via remote delivery is worthwhile. In the U.S., a staggering 72% of adults have overweight or obesity (Obesity and Overweight, 2017), signaling the need for treatment strategies that have broad dissemination potential. The current review provides some evidence that digital health interventions with MI can produce meaningful weight loss, with no apparent improvements when in-person MI is included versus only remote-delivery of MI. However, not all studies achieved meaningfully greater weight loss when compared to a control arm (this was most common when trials were not fully-powered or had few, or optional, MI sessions). In addition, the review demonstrates that interventions that include MI perform comparable to but not better than other types of behavioral interventions, though we are unable to gauge the exact impact of MI given that only one study (West et al., 2016) isolated this component. Given the potential for technology-based interventions to expand reach and the long journey of weight loss replete with fluctuating motivation levels, the synthesis of MI and digital health, particularly telehealth, may be a useful treatment approach.

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Declaration of Competing Interest

None.

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