Use of motivational interviewing in behavioural interventions among adults with obesity: A systematic review and meta-analysis

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Summary
This review aimed to identify whether motivational interviewing (MI) (a counselling approach for supporting behaviour change [BC]) helps to reduce bodyweight and BMI in an adult obesity context. This included evaluating effectiveness of MI interventions within this population and reporting the methodology used, including theoretical underpinnings and identification of BC and MI techniques. Eight databases were searched using controlled vocabulary. Eligible studies included adults with obesity (BMI \( \geq 30 \) kg/m\(^2\)), author-reported interventions using MI aiming to reduce body weight or BMI, and comparator groups not receiving an MI intervention. Data extraction and quality appraisal tools were used to identify study characteristics, intervention content was coded for techniques, and random-effects meta-analysis were conducted to investigate effects. Meta-analysis of 12 studies indicated no overall pooled effect on bodyweight and BMI outcomes between intervention and control groups (SMD = 0.01 [95%CI -0.13 to 0.12, \( P = .93 \)]). Findings were limited by multiple sources accounting for risk of bias, and poor reporting of intervention fidelity and content. Intervention and control content descriptions indicated similar techniques, with social support, goal setting (behaviour) and self-monitoring of behaviour occurring most frequently across both. Findings do not contribute additional evidence for MI use in this context, however methodological limitations were identified which must be resolved to better identify the intervention effects on obesity-related outcomes.

KEYWORDS
motivational interviewing, obesity, overweight, weight loss

1 | INTRODUCTION

Worldwide, researchers estimate that the prevalence rate of obesity has nearly tripled since 1975, meaning that 39% of adults have overweight and 13% have obesity.\(^1\) In the European region, up to 47.6% of adults are predicted to have obesity or overweight.\(^2\) Obesity is characterized by excess body weight and is defined in the United Kingdom...
and United States as a Body Mass Index (BMI) of 30 and higher. It holds serious implications for health including an increased risk of illnesses such as Type 2 diabetes, hypertension and cardiovascular disease when compared to individuals without obesity. Research has identified a multifactorial basis for the condition, stemming from genetic, behavioural, environmental and social aspects which may be impacted by the obesogenic environment. These prevalence rates indicate need for development of evidence-based, effective interventions that reduce bodyweight and the risk of adverse health outcomes. Particularly important is identification of interventions that can be implemented in a range of settings to boost accessibility of effective treatment through methods such as telehealth.

Motivational interviewing (MI) is a communication approach designed to assist an individual in reducing ambivalence about behaviour change, via four core processes: engaging with an individual, focusing on specific behaviours to change, evoking change talk, and planning to enact change. It is a patient-centred, non-judgemental, directive set of skills utilized by practitioners to discuss changing patient behaviours for improved health outcomes. Skills that align with the core spirit of MI (partnership, compassion, evocation, and acceptance) and aim to respect the individual’s autonomy and build upon motivation for change are used. These include open-ended questions, affirmations, reflective statements and expressions of empathy among other recently defined specific skills. MI is one approach used to support preparation for behaviour change and maintenance of progress within weight-loss settings through raising motivation, self-efficacy and improving adherence to other weight-related interventions. Whilst there is evidence across health behaviour settings such as alcohol and substance use, there are less conclusive findings as to the appropriate quantity and delivery of MI within obesity care. In 2019, Patel and colleagues identified 15 trials utilizing MI within telehealth settings for weight loss in adults living with overweight and obesity and found it performed better than no treatment in around 54% of 11 occasions, but in the majority of cases using an active comparator, MI did not perform better. Armstrong and colleagues conducted in 2011 a meta-analysis of randomized controlled trials recruiting adults with overweight and obesity, and identified an overall significant, moderate (SMD = 0.51) effect of MI to improve weight loss over comparator interventions such as treatment as usual and advice from non-MI trained practitioners. Barnes and colleagues’ recent review of papers utilizing MI with adults with overweight and obesity (2015) drew similar narrative conclusions to the earlier findings with 54.2% of included studies reporting clinically significant weight loss of at least 5% baseline body weight, although this did not quantitatively synthesize findings using meta-analytic techniques. Providing greater detail about specific intervention components, such as which skills are utilized, would assist with ensuring methodological replication. This would also allow identification of intervention components necessary for effective weight loss and maintenance.

One way to provide greater specificity within intervention reporting is to code descriptions for behaviour change techniques (BCTs). BCTs are formal descriptors for the active components of behaviour change interventions that are “observable, replicable, and irreducible … designed to alter or redirect causal processes that regulate behaviour.” and can be utilized to provide more specific detail about what was delivered within interventions. Understanding of relevant BCTs may assist in replication and therefore, development of effective, targeted interventions. A taxonomy of 93 techniques clustered into 16 groups has been created by Michie and colleagues for use within intervention design and reporting. Within the obesity management context, health authorities have recommended use of techniques such as goal setting (1.1), self-monitoring of behaviour (2.3), review of behavioural goals (1.5), feedback on performance (2.2) and action planning (1.4) as effective for weight loss outcomes. Accounting for the fact that MI includes techniques additional to those defined within existing taxonomies, researchers have recently developed a taxonomy of techniques specific to MI which can be used to clarify what is occurring within MI implementation. There is currently no clear understanding of the influence of techniques within MI interventions for obesity-related outcomes. Previous reviews have not explicitly identified the BCTs reported in published trials of MI for weight outcomes through coding the intervention design specifically within MI and weight loss contexts, but recent research has begun to identify techniques present within in-person physical activity counselling sessions. MI is a popular approach and further investigation to clarify the efficacy of the intervention and its individual components is required. The use of Hardcastle and colleague’s technique framework will support identification of present components in MI interventions.

The primary objective of this review was to investigate the effectiveness of MI for adiposity outcomes in populations with obesity aiming to lose bodyweight, and to evaluate its effectiveness utilizing meta-analytic methods. Additionally, the review aimed to report the presence of BCT and MI specific techniques, and theoretical underpinnings in MI research to inform understanding of how MI is utilized in research. Specifically, this review aimed to synthesize studies of participants with obesity that included at least one group receiving an intervention of MI and a non-MI comparator group, and reported outcomes of bodyweight including BMI and kilograms as change scores or final measurements.

## 2 METHODS

Methods are reported in accordance with the Preferred Reporting Items for a Systematic Review and Meta-Analysis guidelines (PRISMA; see supplementary files [Appendix S1] for checklist). The protocol can be accessed from PROSPERO (https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42018114697).

### 2.1 Study eligibility

For inclusion, trials were required to recruit adults (18 years and above) with a BMI of 30 kg/m² and higher examining the use of MI for the reduction of bodyweight. Trials needed include at least one arm providing MI and one arm offering a comparator without MI. Studies required at least one follow-up point and the full-text needed to be available in English. Both published and unpublished work was eligible for inclusion. Cross-sectional or single-group studies were not eligible, nor were studies recruiting participants with obesity as a result of a pre-existing condition or as a secondary effect of medication.
2.2 | Search strategy

Original searches took place 13–16 March 2018 and were updated in 2020. The following databases were searched from 2002 to 25th November 2020: CINAHLPlus, Cochrane Library, ProQuest Dissertations International, PsycINFO, PubMed (covers Medline), Scopus, Web of Science, University of Liverpool search facility (covers CINAHLPlus, PsycINFO, PubMed, Scopus, Web of Science). This date was selected due to the publication of the second edition of a textbook published by Miller and Rollnick. Articles published before 2002 may utilize vocabulary or concepts since updated. Searches were developed through locating key terms from published articles, controlled vocabulary, and initial results from scoping searches to develop comprehensive strategies dependent on the search database of interest. Broadly, the following key words combined with Boolean operators were used: Motivational Interviewing, weight loss, weight reduction, obesity (see supplementary materials [Appendix S1] for full example searches). Additionally, database-specific search strategies were employed for the following databases: Medical Subject Headings (MeSH) for PubMed and the Cochrane Library, and Thesaurus of Psychological Index Terms for PsycINFO. Articles were stored using Microsoft Excel for screening and data extraction and Review Manager 5.3 software for assessing risk of bias and meta-analysis.

After removal of duplicates, researchers screened the remaining articles at title, abstract and full-text level. Papers were assessed with responses of “yes,” “no,” or “unclear” for eligibility characteristics. Articles assessed as ‘yes’ or ‘unclear’ were included for the next stage. Screening was carried out by one researcher with 25% second-screened by an external researcher.

2.3 | Risk of bias

Papers were assessed for risk of bias following data extraction. Randomized controlled trials were assessed using the Cochrane Collaboration risk of bias tool. This determines a separate value for each type of bias, and determining an overall risk level for each paper is not recommended but permits comparison. This assessed each paper for bias related to: random sequence generation and allocation concealment, blinding, blinding of outcome assessment, attrition and selective reporting as high, unclear, or low risk. 50% of studies were assessed for by a second researcher. Disagreements were resolved through discussions. Nonrandomized articles were assessed for risk of bias using the Newcastle-Ottawa quality assessment scale which utilizes a starring system to report on selection, comparability, and outcome.

2.4 | Extraction of data

Where multiple intervention arms were in place, the most passive intervention with data reported was selected as the comparator. This was defined as the arm closest to providing treatment as usual/no treatment. Outcome measurements from baseline and the latest follow-up point were extracted as reported. Additionally, behavioural measures such as outcomes of physical activity or dietary intake were extracted. Where multiple papers were published on the same dataset, the latest possible follow-up point was used for extraction and earlier papers reviewed for methodological information.

Data extraction forms were designed using the template for intervention description and replication checklist (TIDieR). This included a description of the intervention delivery methods and content, interventionist backgrounds, setting, and frequency. Information regarding the use of fidelity tools was extracted if reported. The primary outcome was measures of adiposity, such as BMI and weight in kilograms. Secondary outcomes of interest were measures of motivation or adherence to other treatments, such as behavioural weight loss programmes (BWLP). Where reported, both BMI and bodyweight information was extracted. Also extracted was information about attrition, reasons for drop-out and how analyses handled this, such as use of intent-to-treat analysis or data transformation. 25% of papers were extracted a second time by a researcher external to the research team to confirm accuracy of extraction.

2.5 | Coding of BC techniques and MI techniques

Intervention content was coded for techniques in line with the Behaviour Change Technique Taxonomy v1 (BCTTv1) and MI-specific techniques, including content-based (eg, agenda mapping) and relational techniques (eg, offer emotional support) as defined by Hardcastle and colleagues. Intervention techniques were coded only when clearly present and applied to a target behaviour related to the outcome behaviour (eg, weight loss through dietary or nutritional changes, activity level changes, adherence to other intervention designed for weight loss outcomes such as BWLP). Intervention content was examined through the published article, any supplementary materials and protocols. Intervention technique coding was conducted by one researcher (HM) and 50% were second coded (AC). Intervention and comparator descriptions were reviewed and each technique noted as present or absent. Both researchers completed the BCTTv1 online training module and coded using agreed definitions. Any discrepancies were resolved through discussion. To quantify agreement between coders, prevalence-adjusted bias-adjusted kappa statistics were calculated for each set of coding. Use of prevalence and bias adjusted kappa allows for a high prevalence of absent or present responses from the coders and is reported in addition to Cohen’s kappa.

2.6 | Data analysis plan

Quantitative data was synthesized using Review Manager 5.3. Reported outcome measurements differed between studies. Both BMI and bodyweight in kilograms were reported as change scores or final measurement values; to examine the pooled effect, only final measurement values for these were inputted as means and SD to Review Manager as more papers reported this outcome rather than
change scores. As BMI and bodyweight in kilograms represent different scales it was not possible to combine both change and final value measurements from each scale within a SMD meta-analysis. The final measurement of both outcomes were pooled within an SMD meta-analysis. If SDs were not reported, they were calculated from 95% confidence intervals or SE using procedures from the Cochrane Handbook. Where papers reported both BMI and bodyweight, BMI was selected for inclusion within pooled effects analysis. Additional analyses using mean difference were not pre-specified within the review protocol. Papers were grouped by the outcome measure of weight in kilograms and BMI and each outcome type examined in a separate analysis. This allowed for the examination of pooled change from baseline and final measurement scores within each scale individually, as it is assumed that the SD represents the same thing, increasing the number of studies that could be included in analyses.

Review Manager weighted the effects according to sample size and provides a mean difference (MD) or standardized mean difference (SMD) score along with a significance value and 95% confidence intervals for continuous data. Heterogeneity was assessed by checking I² values. This was examined using a significance cut-off of \( P < 0.10 \) with percentages of 0 to 40% for potentially not important, 30 to 60% as moderate, 50 to 90% as substantial and 75% + for significant heterogeneity. It was expected due to differences in MI delivery and study populations that significant heterogeneity would be present and therefore random effects meta-analyses were conducted.

3 | RESULTS

The number of papers assessed for inclusion is summarized in Figure 1. Initial database searches yielded 1588 records. Following title and abstract screening, 157 full texts were screened for inclusion. The most frequent reasons for exclusion were a non-Motivational Interviewing intervention or single group design. Thirty-one papers were deemed appropriate for inclusion in the review with high reliability between researchers for the screening process (\( k = 0.75 \)). Figure 1 reports the identification of studies.

3.1 | Study characteristics

Publication dates ranged from 2008 to 2020. Sample sizes ranged from 19 to 864 with 6249 participants recruited across all studies. Participants were recruited from settings including primary (\( n = 12^{27-28} \)) and specialized healthcare (\( n = 9^{39-47} \)), fitness centres (\( n = 1^{15} \)), and education centres/workplaces (\( n = 2^{48,49} \)) and community-based advertisements (\( n = 6^{50-59} \)). Recruitment methods were unclear for 1 paper. Where reported, average BMI of the total sample ranged from 32.86 to 47.80. Average age ranged from 19 years for an intervention designed for college students to 63 years for a population recruited through health screening services. Comparator conditions were behavioural weight loss programs without MI elements, treatment as usual, non-MI content of a similar duration, use of traditional advice or leaflets, and waitlists. Several non-randomised and cluster randomized trials were identified through searches and are narratively discussed to provide understanding of intervention methodology. Randomisation status was unclear for three studies. Cluster-randomized trials were not included in meta-analysis of effects to avoid over precise confidence intervals resulting from unit-of-analysis errors, and non-randomized trials were not included as confidence intervals may not truly reflect effects. Eighteen studies reported both bodyweight (KG) and BMI data. See Table 1 for a summary of characteristics.

The most frequent mode of delivery was face-to-face, identified in 25 papers. Four studies used a group format of MI. Some studies utilized distance methods to investigate scalability of MI. Fifteen papers used telephone or online methods of delivering sessions with components of MI. Ten of these used a distance format in addition to face-to-face methods. Duration of in-person MI sessions ranged from 90 minutes over 3 months in addition to a behavioural program in an individual format to 32 hours over 26 months in group settings, with a median of 180 minutes overall. Discounting one study of a brief in-person session and follow-up “booster calls” 2 weeks later, MI telephone sessions ranged from 120 minutes over 4 months to 374 minutes over 6 months. Participants receiving telephone MI
| Study | Population | Randomisation, blinding | Sample characteristics | Total sample mean BMI | Intervention | Comparator | General information provided? | Group, individual | Mode (face-to-face, telephone, online) | Aims | Intervention BCTs | Control BCTs | Done (months/minutes) | Reported training/qualifications | Fidelity measure used? | Intervention MI techniques | Reported theoretical BCTs underpinning intervention |
|-------|------------|------------------------|-----------------------|-----------------------|-------------|-----------|-----------------------------|----------------|-------------------------------|------|----------------|-------------|-------------------|-----------------------------|---------------------|----------------|-----------------|---------------------------------|
| ANDERSON2014a | United Kingdom | 329 adults (243 men, 74 women) aged >18 years, BMI > 25% recruited through cancer screening services. | Stratified by trial sites, single blind. | 66.6 (18.8) years; 99.0% white; 47.4% with obesity. | Individual MI via face-to-face and telephone focusing on support for weight loss and treatment adherence. | TAU including general information. | Yes, both groups | Individual Face-to-face, telephone | To reduce overweight/obesity through diet and PA. | 1, 2, 3, 4, 5, 6, 9, 12 | 3 months; 315 minutes. | NR | NR | NR | 01.14.17, 33.35, 37 |
| Barnet2015b | United States | 49 adults (31 men, 18 women) aged >18 years, BMI 25-35, recruited through primary care. | Stratified by Blaise Eating Disorder diagnostic, single blind. | 35.3 | Individual MI via face-to-face and telephone focusing on support for weight loss and treatment adherence. | Nutrition psychologists and internet attention control. Basic nutritional information and a website to track goals. | Yes, both groups | Individual Face-to-face, telephone | To test effectiveness of scalable intervention for weight loss outcomes. | 1, 1.1, 1.2, 1.3, 2.3, 3.1, 3.2 | 3 months; 140 minutes. | NR | NR | NR | 1, 23 |
| Befort2008c | United States | 44 adults (0 men, 44 women) aged >18 years, BMI 30-50, recruited through primary care. | Sequential randomization, single blind. | 39.8 | Individual MI via face-to-face and telephone focusing on building motivation and treatment adherence. | Health education attention control focused on providing didactic information and advice. | Yes, control only | Individual Face-to-face, telephone | To investigate the extent of MI to a culturally-targeted group-based BWLP for AA women enhanced adherence, and additional to explore effect of MI on diet and physical activity behaviors and weight loss outcomes, and motivation and self-efficacy. | 1, 1.1, 1.3, 2.3, 3.1, 4.2, 5.1, 9.2 | 3 months; 120 minutes. | Training from clinical psychologists including reading textbook, watching videos, 2-day workshop, conducting simulated counseling sessions. | 25% of MI open randomized and reviewed weekly. Checklist used to rate extent to which counselors captured the overall spirit of MI and adhered to MI strategies. | 4.9, 14.21, 32.39 |
| Braun2018d | United States | 29 adults, cancer survivors recruited from local oncology clinics to take part in an urban garden intervention. | Nonrandomized, blinded NR. | 51.2 (11.8) years; Ethnicity NR. | MI sessions offered weekly. | No MI. | Yes, both groups | Individual Telephone calls, and online diaries. | To evaluate the feasibility, efficacy and acceptability of targeted tele-MI for cancer survivors with overweight and obesity. | 2.1, 2.2, 2.3, 3.2, 4.1 | 4 months; session duration NR. | 4 x 2-hour one-to-one training sessions. | Random selection of MI audiotaped using the MI by Expert who provided MI training. | NR | 1, 2 |
| Bråklöv2014e | Sweden | 29 adults with BMI > 25% between 28-45 recruited from primary care. | Consecutively randomized, participants blinded but not running staff. | 55.7 (13.3) years; Ethnicity NR. | Total sample mean weight 86.3 ±8.6kg. Mean control group BMI 31.2 (5.9), Mean MI intervention group 31.5 (5.3). | MI grocery store, website, communication and online e-mails. MI conversations focused on discussion of lifestyle and advice provided. | Yes, both groups | Individual Face-to-face | To evaluate the long-term effects of weight reduction and quality of life and sense of coherence in a young and healthy minority MI-care based intervention, and to compare the subgroup with low and high intensity to each other. | 3.1 | 4.1 | 24 months duration NR. | 3x days of training | NR | NR |
| Busconi2015f | United States | 70 adults (50 men, 20 women) aged >21 years, BMI 25-39. Recruited from college through survey about student health behaviors. | Stratified by gender and weight status (overweight and obese), methods of randomization NR, Binding NR. | 31.6 (9.01) years; Ethnicity NR. | 328.3 (78.8) kg. | 33.9% | Caucasian, 31.1% African American, 29.2% Hispanic, 2.9% Asian, 1.4% | Yes, both groups | Individual Face-to-face, telephone | To develop a brief behavioral counseling for college students with obesity/overweight focused on decreasing BMI | 1, 1.1, 1.2, 1.3, 2.3, 3.2, 5.1, 9.2 | 3 months; 67 minutes | 30 hours of Motivation Interviewing training Manual provided for seamless. | Regular supervision | NR | 9, 20, 33 |

(Continues)
| Study | Population | Randomization, Blinding | Sample Characteristics | Total Sample BMI | Intervention | Comparator | General Information Provided? | Group, Individual, Mode (face-to-face, telephone, online) | Aims | Intervention BCTs | Control BCTs | Dose (months/ sessions) | Reported training/ qualifications | Fidelity measure used? | Intervention MI techniques | Reported theoretical underpinning |
|-------|------------|------------------------|-----------------------|------------------|-------------|------------|-----------------------------|---------------------------------------------|-------|----------------------|-----------------|--------------------------|----------------------------------------|---------------------------|-----------------------------|----------------------------------|
| Cards (2007) | United States | 55 adults (19 men, 46 women; BMI -30). Recruited through advertisements to local newspaper and University e-mail. | Recruited through advertisements in local newspaper and University e-mail. | NR | Random number generator used for randomization. Blinding NR. | 4800 (9.00) years; Mean (BMI NR); Intervention group weight (kg) 101.60 (22.5); Control group weight (kg) 101.60 (22.5); Control mean weight (kg) 96.60 (22.5). | NR | Group | Individual | Face-to-face | To use MI sessions to achieve specific treatment outcomes compared to BWLP only comparator group. | BWUP | Yes, both groups | Individual | Face-to-face | 6.7 | 8.7 | 6 months; 234 minutes (average of 5.4 sessions per participant) | NR | Randomly selected sessions coded using Motivational Interviewing Treatment Integrity (MITI) | |
| Chee (2017) | Malaysia | 210 adults (60% women; BMI -22). Type 2 Diabetes. BMI >23. Recruited from primary care clinic. | Random allocation software used for randomization. Unblinded. | NR | Median age 53 (8) years. Mean BMI (BMI NR); intervention group weight (kg) 101.60 (22.5); control group weight (kg) 101.60 (22.5); control mean weight (kg) 96.60 (22.5). | NR | Group | Individual | Face-to-face | To examine effectiveness of the low-calorie structured lifestyle intervention in comparison to usual care for diabetes-related health outcomes. | TAU | Yes, both groups | Individual | Face-to-face | 3.1, 4.1 | 4.1 | 12 months; 120 minutes | NR | NR | 35 Social Cognitive Theory |
| DiMarco (2009) | United States | 39 adults (17 men, 22 women). Age range 20-54. Recruited through advertisements. | Recruitment/MI, Blinding NR. | Mean age 39.90 (10.7); Intervention mean BMI 33.06 (3.17); Comparator mean BMI 31.62 (4.81); 71.60% Caucasian, 7.7% African American, 5.0% Hispanic, 5.1% South Asian, 2.6% East Asian. | NR | Guided self help and Motivational Interviewing. | BWUP | Guided self help | Yes, both groups | Group | Face-to-face | To assess effectiveness of MI in addition to guided self-help in comparison to usual care for diabetes-related health outcomes. | 3.1, 9.2 | 3.1, 5.3 | 11 weeks; 120 minutes | 237 minutes, 237 minutes | 3 hours of training from psychologists. | Pilot session tapes and all intervention tapes reviewed by author. | Fidelity measure used: NR | |
| Graves (2004) | United Kingdom | 141 adults (81 men, 90 women). Age > 18 years. BMI >28. Recruited from primary care settings. | Randomly allocated patients only. Blinding NR. | Mean age 54.6 years. Intervention group weight (kg) 101.60 (22.5); control group weight (kg) 96.60 (22.5). | NR | Individual MI covering dietary and physical activity. Traditional dietary and activity advice. | TAU including CVD risk information. | Yes, control only | Individual | Face-to-face, telephone | To see if changes in dietary and physical activity could be achieved with MI intervention. | 3.1, 3.5, 3.4, 8, 7, 8, 7, 8, 7, 8, 7 | Yes, intervention only | Individual | Face-to-face, telephone | 3.1, 5.3 | 6 months; 374 minutes | 3 days of MI training delivered by accredited trainer. | Yes; pilot transcripts checked using Behaviour Change Counselling Index (BCCI) | 33, 36, 92 | Transferred Model, Stages of Change, Prevention Adoption Process Model. | |
| Study | Population | Randomisation, Blinding | Sample characteristics | Total sample mean BMI | Intervention | Comparator | General information provided? | Group, individual | Mode (face-to-face, telephone, online) | Aims | Intervention duration (months/minutes) | Reported training/qualifications | Fidelity measure used? | Intervention MI techniques underpinning | Reported theoretical underpinning |
|-------|------------|------------------------|-----------------------|----------------------|-------------|-----------|-----------------------------|----------------|-----------------------------|------|------------------------------------|-----------------------------|-----------------|----------------------------------|---------------------------|
| Hardcastle (2013) | 38 adults (20 men, 18 women). Mean age 31.0 (9.0) years. | Randomised by a statistician. Researchers blinded. | 31.4 (8.7) years. | 33.4 | Face-to-face. | Comparator | Traditional dietary and activity advice. | Yes, control only | Individual | Face-to-face | 3 months; | 58 minutes. | Telephone | Theory of Planned Behaviour, SDT, Transtheoretical Model. | |
| Huber (2018) | 50 adults (7 men, 43 women). symptomatically selected. | Computer generated randomisation. Researchers blinded. | 35.6 (7.1) years. | 33.4 | Intervention mean BMI 36.1 (3.6). Comparator mean BMI 36.1 (3.6). | 9% | Participants received brief MI consultation. Telephone calls. | Yes, control only | Individual | Telephone | 2 months; | 30 minutes. | Telephone | Theory of Planned Behaviour, SDT, Transtheoretical Model. | |
| Karlsen (2018) | 358 adults (118 men, 240 women). Mean age 52.10 (0.58) years. | Randomised by a statistician. Researchers blinded. | 33.6 (0.30). | 33.0 | Intervention mean BMI 33.6 (0.30). Comparator mean BMI 33.6 (0.30). | | Participants received brief MI consultation. Telephone calls. | Yes, both groups | Individual | Telephone | 12 months; | 90 minutes. | Telephone | Theory of Planned Behaviour, SDT, Transtheoretical Model. | |
| Littman (2019) | 67 adults aged 18-25 years. BMI > 25 and < 35. | Randomised without blinding. Outcomes assessors blinded. | 21.9 (3.9) years. | 21.9 | Both a two-part and a non-MI way. | | Same content delivered in a non-MI way. | Yes, both groups | Individual | Telephone | 4 months; | 30 minutes. | Telephone | Theory of Planned Behaviour, SDT, Transtheoretical Model. | |
| Lewis (2019) | 65 adults (47 women, 18 men). Mean age > 18 years. BMI > 25. | Randomised by computer and sequentially numbered. | 47.8 (6.1) years. | 47.8 | Intervention involved routine telephone calls and text messaging. | | To test the feasibility of recruitment and to evaluate if MI enhanced approach is feasible | Yes, both groups | Individual | Telephone calls and text | 12 weeks; | 2 sessions 75-90 minutes. | Telephone | Theory of Planned Behaviour, SDT, Transtheoretical Model. | |
| Utton (2019) | 19 adults with lower extremity amputation, BMI > 25. | Randomised by computer and sequentially numbered. | 54.0 (9.3) years. | 54.0 | Tailored programme for individuals with lower extremity. | | Tailored dietary and activity advice, self-monitoring tools. | Yes, both groups | Individual | Face-to-face, telephone | 4 months; | 0 minutes. | Telephone | Theory of Planned Behaviour, SDT, Transtheoretical Model. | |
| Study | Population | Randomization, Blinding | Sample characteristics | Total sample mean BMI | Intervention | Comparator | General information provided? | Group, individual | Mode (face-to-face, telephone, online) | Aims | Intervention BCTs | Control BCTs | Dose (months/minutes) | Reported training/qualifications | Fidelity measure used? | Intervention MI technique | Reported theoretical underpinning |
|-------|------------|-------------------------|------------------------|-----------------------|--------------|------------|-----------------------------|----------------|-------------------------------|------|----------------|--------------|---------------------|-----------------------------|------------------------|--------------------------|---------------------------------|
| Law et al. (2013) | United States | 36 adults (30 men, 6 women) with obesity. Recruited from routine cardiology appointments. | Randomization, Blinding NR. | Total mean age 61.20 (9.30) years. Total mean BMI 38.00 (4.80). Ethnicity NR. | 3.8 | face-to-face consultations with trained undergraduate students. General protocol followed. | Traditional dietary advice. | Yes, only | Individual | Face-to-face | To test the effectiveness of MI over a 3-month period using a replicable protocol. | 1.1, 1.9, 6.1, 8.1, 15.1 | 05 months, 600 minutes. | NR | NR | Social cognitive learning theory, Protection Motivation Theory. |
| Meybodi (2011) | Iran | 30 adults (0 men, 30 women) aged 18–55 years. Recruited from notices. | Randomized, methods unclear, Blinding NR. | Age NR | Intervention group baseline BMI 25.9 (3.19). Control group baseline BMI 25.1 (3.17). Ethnicity NR. | | | | | To decrease weight. | | | | | | |
| Mirkarimi (2017) | Iran | 100 adults (0 men, 100 women). BMI 25-35. Recruited from clinical records at a nutrition clinic. | Random block allocation used. Researchers blinded. | MI group mean age 36.30 (8.90). MI group mean BMI 28.25 (2.21). Control group mean age 39.90 (9.10). Control group mean BMI 28.80 (1.59). | 3.1 | | | | | To investigate the effect of MI on a weight loss programme in order to improve weight efficacy lifestyle. | | | | | |
| Moeller (2020) | Denmark | 37 adult women with polycystic ovary syndrome and obesity recruited from hospital setting. | Randomized by computer in blocks of 2 and 4. Authors blinded to allocation. | Median age of the control group was 27. Median age of the MI group was 34. Median BMI of the control group was 35.9 (range 28.3 to 40.5). Median BMI of the MI group was 29.6 (range 23.2 to 48.3). Ethnicity NR. | | | | | | To investigate if MI as an add-on to standard advice improved weight loss and increased quality of life in women with obesity with PCOS compared to standard advice only. | | | | | |
| Mos et al. (2017) | Canada | 125 adults (20 men, 105 women) BMI >25. Recruited through gym. | Computer generated randomization. Participants blinded. | Mean age 45.16 (11.30) years. Mean BMI 33.58 (6.58). MI group mean age 45.56 (9.78) years. Mean BMI 33.37 (6.58). Control group mean age 44.67 (9.74) years. Control group mean BMI 33.27 (6.58). | 3.18 | Behavioral weight loss program focusing on sustainable weight loss and lifestyle changes, and brief MI sessions. | Semi-structured interview addressing health equivalent duration to intervention. | Yes, both groups | Individual | Face-to-face, video calls. | To examine the effect of MI and BPLP on weight outcomes in comparison to attention control | | | | | |

TABLE 1 (Continued)
### TABLE 1  (Continued)

| Study | Population | Randomisation, blinding | Sample characteristics | Total sample mean BMI | Intervention | Comparator | General information provided? | Group(s), mode (face-to-face, telephone, online) | Aims | Intervention BCTs | Control BCTs | Dose (months/minutes) | Reported training/qualifications | Fidelity measure used? | Intervention theoretical underpinning | Reported theoretical underpinning |
|-------|------------|-------------------------|------------------------|-----------------------|--------------|------------|-----------------------------|-----------------------------------------------|------|-------------------|--------------|----------------------|-------------------------------|------------------------|----------------------------------|----------------------------------|
| Olson (2016) | United States | Cluster randomization. Unblinded. | 452 adults (452 men, 0 women) BMI > 27 recruited through transportation companies. | Total sample means NR. Total sample mean age 47.90 (11.20) years. | Intervention mean BMI 35.73 (8.77). | Control group mean BMI 35.44 (8.96). | Intervention condition 1.8% Native American, 9.8% African American, 74.7% White, 6.2% > 1 race, 7.6% Other. | Yes, control only Individual Telephone | To investigate effect of MI on BMI, diet, blood pressure, physical activity and sleep in comparison to control. | 1.1, 1.3, 2.2, 3.1 | 4 sessions, duration NR. | 4 sessions, duration NR. | Yes, control only | Cluster randomisation. | To assess change in bodyweight at 12 and 24 months compared to the control group. | 1.1, 1.4, 1.5, 3.1 | 24 months, 3,920 minutes. |
| Peiris (2009) | United Kingdom | Pre-prepared random allocation lists stratified by sex and glucose values. Researchers and participants unblinded, data collection staff blinded where possible. | 102 adults (42 men, 60 women) aged ≥ 40 years. BMI ≥ 25. Recruited from primary care physician referral for at risk of impaired glucose regulation. | Total sample mean age 56.80 years. | Intervention mean BMI 34.10 (5.50). | Control mean BMI 33.50 (4.60). | Ethnicity NR. | Yes, both groups Individual Face-to-face | To investigate the long-term impact of MI intervention on changes in dietary habits, bodyweight and metabolic markers. | 1.1, 1.4, 1.5, 3.1 | 9.1 | 12 months; 300 minutes. | Yes, both groups | Cluster randomisation. | To assess change in bodyweight at 12 and 24 months compared to the control group. | 1.1, 3, 13, 14, 20, 33, 35 | Stages of Change |
| Rodriguez-Gil (2017) | Spain | Cluster randomisation. (Blinding NR.) | 864 adults (197 men, 667 women) aged 30-70 years. BMI > 25 recruited through healthcare centres. | Total sample mean age NR. Total sample mean BMI 34.10 (4.80). | Intervention group mean BMI 34.10 (4.80). | Control mean BMI 34.10 (4.80). | Intervention group mean age 33.99 (6.49) years. | Yes, both groups Group Face-to-face | To assess change in bodyweight at 12 and 24 months compared to the control group. | 1.1, 2.2, 2.3, 3.1 | 9.1 | 12 months; 300 minutes. | Yes, both groups | Cluster randomisation. (Blinding NR.) | To assess change in bodyweight at 12 and 24 months compared to the control group. | 1.1, 3, 13, 14, 20, 33, 35 | Stages of Change |
| Safavi (2016) | Iran | MTH stage random sampling. (Blinding NR.) | 327 adults (150 men, 177 women) BMI 25-35, age > 18 years. Recruited from primary care services. | Total sample mean BMI NR. | Intervention group mean BMI NR. | Control mean BMI NE. | Intervention group mean age NR. | Yes, both groups Individual MI sessions about recognizing emotions which may contribute to resistant behaviours. Discussion of pros and cons of behaviour change. Information about traditional lifestyle advice. | Individual Face-to-face | To investigate the long-term impact of MI intervention on changes in dietary habits, bodyweight and metabolic markers. | 1.4, 3, 5, 7, 9, 11, 12, 11.2 | 9.1 | 12 months; 300 minutes. | Yes, both groups | MTH stage random sampling. (Blinding NR.) | To assess change in bodyweight at 12 and 24 months compared to the control group. | 1.1, 3, 4, 9, 11, 35 | Stages of Change |

Note: NR = Not Reported.
| Study | Population | Randomisation, blinding | Sample characteristics | Total sample mean BMI | Intervention | Comparator | General information provided? | Group, individual | Make (face-to-face, telephone, online) | Aims | Intervention BCTs | Control BCTs | Date (months / minutes) | Reported training / qualifications | Fidelity measure used? | Reported theoretical MI techniques underlying principles |
|-------|------------|-------------------------|------------------------|----------------------|--------------|------------|-----------------------------|-----------------|-----------------------------|------|----------------|-------------|----------------|-------------------------------|------------------|---------------------------------|
| Simpson (2015) | United Kingdom | Remote telephone randomisation stratified by region, age, gender, ethnicity, source of recruitment, percentage weight loss to date and current BMI | Unblinded. | Total sample age 46% under 30, 46% 30-59 years, 14% over 60 years. Total sample mean BMI 34.2 (6.4) | Individual MI sessions: about challenges, self-monitoring, goal-setting and implementation intentions, habits, emotional eating and weight loss, diet, physical activity, barriers to maintenance, support and self-efficacy. Diaries provided but not reviewed by interventionist. | Yes, both groups | Individual | Face-to-face | To investigate effects on maintaining progress already made in weight loss. | 1, 1.1, 1.2, 1.4, 1.5 | 12 months 180 minutes (intensive arm) | 2 days MI training. Audio recordings of face-to-face sessions analysed to assess fidelity. | A random sample was assessed using MITI coding scale. A stratified sample included sessions delivered in the high and low intensity arms and by all practitioners. Skills in MI delivery were assessed prior to study entry via audio recorded mock consultations with patient actors. In order to be recruited, individuals were required to reach the MITI proficiency threshold. |
| Sun (2019) | China | Closed envelope randomisation. Binding NR. | NR | Mean age intervention group 45 (12) years. Mean age control group 45 (12) years. | MI training and education. | Yes, both groups | Individual | Face-to-face, telephone | To apply an MI intervention to postoperative weight control. | 3.1, 4, 4.2, 4.3, 5.1, 13.3 | 6 months 30 minutes duration NR. | NR | NR | NR |
| West (2007) | United States | Closed envelope randomisation. Interventions and outcome assessors blinded. | NR | Total sample mean age 53 (18) years. Total sample mean BMI 36.5 (5.5). | BWMUP | Yes, both groups | Individual | Face-to-face | To build and maintain motivation for weight loss. | 1, 1.1, 1.2, 1.4, 1.5, 1.9, 2, 2.2, 2.3, 3, 5.1, 8.7, 13.5 | 12 months 225 minutes. | Ongoing clinical supervision and protocol fidelity monitoring. Randomly selected audio tapes reviewed weekly by 2 clinical psychologists using a standardised coding format. | 1, 3, 13, 21, 22 | NR |
| Study | Population | Randomisation, blinding | Sample characteristics | Total sample mean BMI | Intervention | Comparator | General information provided? | Group, individual | Mode (face-to-face, telephone, online) | Aims | Intervention BCTs | Control BCTs | Dose (months/minutes) | Reported training/qualifications | Fidelity measure used? | Intervention theoretical underpinning |
|-------|------------|-------------------------|-----------------------|-----------------------|--------------|------------|-----------------------------|-----------------|-------------------------------|------|----------------|-------------|---------------------|-------------------------|--------------------------|-----------------------------|
| West (2011) | United States | 358 adults (6 men, 352 women). Age > 30 years, BMI 25-50, >10 episodes of urinary incontinence. Unclear how participants were recruited. | Cluster randomized within 18 study groups. Outcome assessed only blinded. | Total sample mean age 53 (10) years. Total sample mean BMI 36 (6.0). | 6-month behavioural weight loss program followed by group meetings delivered by dietitians, exercise physiologists, nurses, and psychologists. Participants provided with self-monitoring diaries and weighed at each session. Motivation-focused maintenance program focused on increasing and sustaining motivation through eliciting personal motivation, confirming progress, creating reinforcers. | BWUP and group meetings only. | Yes, both groups | Face-to-face | To evaluate a novel weight loss maintenance program specifically targeting motivational factors. | 1.2, 1.3, 2.1, 2.3, 3.1, 8.7, 13.3, 13.5 | 1.2, 1.3, 2.3, 3.1, 8.7, 13.3, 13.5 | 12 months; 1560 minutes. | Explicit training of the intervention staff and ongoing supervision of treatment delivery. | Yes, both groups | Audiotapes of 10% sessions were reviewed by independent raters to assure protocol consistency, attention paid to inclusion of prescribed elements and exclusion of prohibited elements. Corrective feedback provided to intervention staff as necessary. |
| West (2016) | United States | 398 adults (41 men, 357 women). Age > 18 years, BMI 25-50. Recruited through community newspaper, flyers, fairs, targeted email through mailing lists, word of mouth. | Randomisation stratified by baseline BMI percentile value, used biased coin approach. Blinding NR. | Total sample mean age 48.4 (10.1) years. Total sample mean BMI 36.0 (6.0). | 18-month online group behavioural lifestyle program and 6 individual MI sessions using interactive, synchronous form of private chat integrated within a web-based by group weight loss program. Focused on eliciting and elaborating change talk and identifying goals. | BWUP. | Yes, both groups | Individual Online | To examine the addition of individual MI web chats to a group-based internet-delivered behavioural weight control program to weight loss outcomes compared to the behavioural weight control program alone. | 1.2, 1.4, 2.1, 2.4, 3.1, 6.7, 8.7, 13.2, 13.5 | 1.2, 1.4, 2.1, 2.4, 3.1, 6.7, 8.7, 13.5 | 18 months; 180 minutes. | Training from researcher. | Ongoing supervision from MI trainer and psychologist. Transcripts reviewed and constructive feedback provided. Ongoing group telephone conversations. | 1, 3, NR | Rothman's Theory-Based Analysis of Behavioural Maintenance, Self-Regulation Theory, Self-Identity Theory |
| Study               | Sample size (N randomized to relevant arms) | ITT? | Intervention duration | Measurement taken | n allocated | Baseline (Intervention) M(SD) | Post (Intervention) M(SD) | Intervention change score within group (SD) | n allocated | Baseline (Comparator) M(SD) | Post (Comparator) M(SD) | Comparator change score within group (SD) | Between groups effect size |
|---------------------|--------------------------------------------|------|-----------------------|-------------------|-------------|-------------------------------|--------------------------|---------------------------------|-------------|----------------------------|--------------------------|----------------------------------|---------------------------|
| Meybodi (2011)³⁴    | 30                                         | N    | NR 2 months           | 2 months          | NR          | 30.61 (3.14)                  | NR                       | NR                              | NR          | 31.51 (3.70)                  | NR                       | NR                              | Follow-up scores NR.          |
| DiMarco (2009)³⁰     | 39                                         | Y    | 2.75 months           | 2.75 months       | 20          | 33.06 (3.17)                  | 31.58 (3.08)            | NR                              | 19          | 31.62 (2.81)                  | 30.92 (3.05)             | NR                              | Cohen’s d 0.21, 95% CI -0.56 to 0.99 |
| Buscemi (2011)⁴⁸     | 70                                         | Y    | 3 months              | 03 months         | 34          | 33.43 (4.88)                  | 33.61 (4.70)            | −0.04                           | 36          | 32.26 (4.49)                  | 32.56 (4.60)             | −0.07                           |                           |
| Befort (2009)³⁰⁸     | 44                                         | N    | 4 months              | 04 months         | 21          | 39.4 (7.1)                    | NR                      | −1 (1.5)                        | 23          | 40.4 (5.8)                    | NR                       | −1.1 (2)                        |                           |
| Lewis (2019)⁶³       | 61                                         | NR   | 4 months              | 04 months (crossover) | 29          | 49.7 (NR)                     | NR                      | −1.74 (2.23)³⁵                 | 32          | 46.1 (NR)                     | NR                       | 0.10 (2.3)³⁵                  |                           |
| Braun (2018)⁵⁰       | 29                                         | N    | 6 months              | 06 months         | 17          | 31.3 (5.50)                   | 29.6 (5.36)             | −1.7 (2.10)³⁵                   | 12          | 32.6 (4.65)                   | 31.5 (5.34)             | −1.1 (1.03)³⁵                 |                           |
| Mirkarimi (2017)⁴¹   | 100                                        | N    | 2 weeks               | 06 months         | 50          | 28.25 (2.21)                  | 26.53 (2.17)            | NR                              | 50          | 28.84 (1.59)                  | 26.68 (2.53)             | NR                              | Cohen’s d −0.35, 95% CI -1.10 to 0.39 |
| Moeller (2019)⁶⁵     | 37                                         | N    | 6 months              | 06 months         | 19          | Median 37.6 (35.2–48.1)       | NR                      | Median 0.2 (−3.1–1.2)           | 18          | Median 35.9 (33.9–38.8)       | NR                       | Median – 0.6 (−2.3–0.6)       | Follow-up scores NR.                              |
| Olson (2016)⁶⁹       | 472                                        | Y    | 6 months              | 06 months         | 225         | 35.73 (12.33)b                | 35.00 (12.54)b          | −0.73 (NR)                      | 247         | 35.44 (12.76)b                | 35.75 (13.18)b           | 0.27 (NR)                      | Cohen’s d 0.03, 95% CI -0.21 to 0.14 |
| Sun (2020)⁶⁶         | 101                                        | NR   | 6 months              | 06 months         | 50          | 33.72 (2.30)                  | 31.94 (3.15)            | NR                              | 33.64 (2.30) | 33.88 (2.45)                  | NR                       | NR                              |                           |
| Chee (2017)³¹        | 173                                        | Y    | 6 months              | 12 months         | 58          | 31.8 (6.85)b                  | 29.5 (6.85)b            | −2.3 (3.05)b                    | 115         | 29.6 (4.3)b                   | 29.5 (4.3)b              | −0.1 (2.14)b                    |                           |
| Study                  | Sample size (N randomized to relevant arms) | Intervention duration | Measurement taken | Intervention change score within group (SD) | Baseline (Comparator) M(SD) | Post (Comparator) M(SD) | Comparator change score within group (SD) | Between groups effect size |
|-----------------------|-------------------------------------------|-----------------------|-------------------|---------------------------------------------|---------------------------|------------------------|--------------------------------------------|---------------------------|
| Barnes (2017)         | 59                                        | Y                     | 3 months          | 30                                          | 34.65 (7.06)              | 35.12 (2.02)           | NR                                         | NR                        |
| Saffari (2014)        | 327                                       | N                     | 12 months         | 12 months                                   | NR                        | 35.11 (6.11)           | NR                                         | NR                        |
| Simpson (2015)        | 170                                       | Y                     | 12 months         | 12 months                                   | 34.40 (6.2)               | 33.3 (6.50)            | −1 (−4.50)                                | 58                        |
| Hardcastle (2013)     | 358                                       | Y                     | 3 months          | 15 months                                   | 33.66 (5.12)              | 33.68 (4.77)           | NR                                         | 131                        |
| West (2007)           | 217                                       | N                     | 12 months         | 18 months                                   | 36.5 (5.5)                | NR                     | NR                                         | 108                       |
| West (2016) + follow-up |                                           |                       |                   |                                             |                           |                        |                                            |                           |
| Brautigam-Ewe (2020)  | 286                                       | NR                    | 24 months         | 24 months                                   | 31.6 (2.1)                | 31.2 (2.4)             | NR                                         | NR                        |
| Penn (2009)           | 102                                       | Y                     | 5 years           | 60 months                                   | 34.1 (5.5)                | NR                     | 51                                         | NR                        |
| Karlsen (2013)        | 187                                       | N                     | 7–8 months        | NR                                          | 35.6                      | NR                     | −1 (1.7)                                  | 77                        |
| Weight (kg) 2 to 6-month follow-up |                                           |                       |                   |                                             |                           |                        |                                            |                           |
| Bucemi (2011)         | 70                                        | Y                     | 3 months          | 03 months                                   | 92.01 (36.10)             | 92.34 (35.97)          | NR                                         | 36                        |
| Low (2013)            | 56                                        | Y                     | 20 weeks          | 03 months                                   | 110.04 (40.8)             | 105.94 (2.9)           | NR                                         | 18                        |
| Befort (2008)         | 44                                        | N                     | 4 months          | 04 months                                   | 103.7 (20.8)              | NR                     | −2.6 (4.2)                                | 23                        |
| Lewis (2019) + Follow-up |                                           |                       |                   |                                             |                           |                        |                                            |                           |

(Continues)
| Study               | N randomized to relevant arms | ITT? | Intervention duration | Measurement taken | n allocated | Baseline (Intervention) M(SD) | Post (Intervention) M(SD) | Intervention change score within group (SD) | n allocated | Baseline (Comparator) M(SD) | Post (Comparator) M(SD) | Comparator change score within group (SD) | Between groups effect size |
|---------------------|-------------------------------|------|-----------------------|-------------------|-------------|-------------------------------|---------------------------|---------------------------------------------|-------------|----------------------------|----------------------------|------------------------------------------|--------------------------|
| Littman (2019)      | 15                            | y    | 20 weeks             | 20 weeks          | 7           | 107.3 (16.2)                  | 104.0 (18.1)             | NR                                          | 8           | 104.6 (17.8)               | 106.4 (18)                | NR                                       |                          |
| Braun (2018)        | 29                            | N    | 6 months             | 06 months         | 17          | 83.6 (15.78)                  | 78.8 (14.89)             | -4.8 (5.63)*                                | 12          | 87.60 (17.20)              | 85.0 (19)                 | -2.6 (4.62)*                             |                          |
| Carels (2007)       | 55                            | Y    | 6 months             | 06 months         | 28          | 101.6 (22.5)                  | 95.9 (24.5)              | -5.8 (5.5)                                  | 27          | 96.6 (22.1)                | 92.8 (23.6)               | -3.8 (4.9)                               |                          |
| Greaves (2008)      | 141                           | Y    | 6 months             | 06 months         | 72          | 91.6 (13.3)                   | 91.3 (13.7)              | NR                                          | 69          | 94.4 (14.2)                | 92.6 (15.0)               | NR                                       |                          |
| Huber (2015)        | 90                            | N    | 3 months             | 06 months         | 45          | 99.6 (14.0)                   | NR                       | -2.6 (4.4)                                  | 45          | 103.6 (18.9)               | NR                        | -1.1 (3.7)                               |                          |
| Moss (2017)         | 135                           | N    | 3 months             | 06 months         | 69          | 95.11 (21.45)                 | 91.32 (20.78)            | NR                                          | 66          | 90.34 (19.46)              | 85.77 (16.65)            | NR                                       |                          |
| Moeller (2019)      | 37                            | N    | 6 months             | 06 months         | 19          | Median 108.6 (96.5-124)       | NR                       | Median 0.4 (-8.9-3.5)                       | 18          | Median 106.1 (97.8-113.9) | NR                        | Follow-up scores NR. |                                      |
| Sun (2020)          | 100                           | NR   | 6 months             | 06 months         | 50          | 84.13 (14.98)                 | 79.80 (12.62)            | NR                                          | 50          | 85.81 (13.13)              | 85.33 (12.94)            | NR                                       |                          |
| Olson (2016)        | 472                           | Y    | 6 months             | 06 months         | 225         | 107.88 (40.39)                | 105.52 (41.67)           | -2.36 (NR)                                 | 247         | 106.40 (41.67)*            | 107.35 (42.52)*           | 0.95 (NR)                               | Cohen’s d = 0.04, 95%CI -0.22 to 0.14 |
|                     |                               |      |                      |                  |             |                              |                           |                                             |             |                           |                           |                                          |                          |
| Anderson (2014)     | 329                           | Y    | 12 months            | 12 months         | 163         | 90.2 (14.9)                   | 87.2 (15.7)              | -3.5 (4.91)                                 | 166         | 88.4 (14.3)                | 88.1 (14.2)               | -0.78 (3.77)                             |                          |
| Groeneveld (2010)   | 816                           | N    | 12 months            | 12 months         | 408         | 93.1 (13.2)                   | 92.2 (13.7)              | -0.9 (NR)                                  | 408         | 92.0 (12.80)               | 92.9 (13.6)               | 0.9 (NR)                                | Cohen’s d = -0.05, 95%CI -0.18 to 0.09  |
| Barnes (2017)       | 59                            | Y    | 3 months             | 12 months         | 30          | 87.99 (54.27)                 | 99.49 (12.85)            | 1.49 (12.9)                                | 29          | 99.50 (53.88)              | 98.11 (9.24)              | -14 (8.2)                               |                          |
| Chee (2017)         | 173                           | Y    | 6 months             | 12 months         | 58          | 82.8 (19.80)                  | 75.9 (19.03)             | -6.9 (9.90)                                | 115         | 78.1 (13.94)               | 77.3 (15.01)              | -0.8 (5.36)                              |                          |
| Saffari (2014)      | 327                           | N    | 12 months            | 12 months         | NR          | 80.96 (15.00)                 | 77.82 (14.94)            | -3.14 (NR)                                 | NR          | 81.77 (9.86)               | 80.35 (9.93)              | -1.42 (NR)                              |                          |

*Table 2 (Continued)*
| Study                | Sample size (N randomized to relevant arms) | ITT? | Intervention duration | Measurement taken | n allocated | Baseline (Intervention) M(SD) | Post (Intervention) M(SD) | Intervention change score within group (SD) | n allocated | Baseline (Comparator) M(SD) | Post (Comparator) M(SD) | Comparator change score within group (SD) | Between groups effect size |
|---------------------|------------------------------------------------|------|-----------------------|-------------------|-------------|-------------------------------|--------------------------|-----------------------------------------------|-------------|----------------------------|--------------------------|-----------------------------------------------|---------------------------|
| Hardcastle          | 358 Y                                          | 3 months | 15 months             | 15                 | 203         | 93.64 (15.93)                 | 94.12 (15.66)            | NR                                             | 131         | 91.38 (16.88)               | 92.75 (17.37)            | 0.12 (1.37)                                  |                           |
| West (2007)         | 217 N                                          | 12 months (MI) | 18 months BWLP     | 18                 | 109         | 97 (17)                       | NR                       | −3.5 (8.8)b                                 | 108         | 97 (15)                     | NR                       | −1.7 (8.9)b                                  |                           |
| West (2011)         | 338 N                                          | 6 months | 18 months             | 18                 | 113         | NR                           | NR                       | −5.34 (8.32)b                               | 113         | NR                         | NR                       | −1.38 (6.58)b Follow-up scores NR.          |                           |
| West (2016)         | 398 Y                                          | 18 months | 18 months             | 18                 | 199         | 98.40 (19.00)                 | NR                       | −3.5 (7.7)                                  | 199         | 98.20 (18.40)               | NR                       | −3.3 (7.1)                                  |                           |
| Brautigam-Ewe       | 286 N                                          | 24 months | 24 months             | 24                 | 113         | 89.5 (11.3)                   | 88.4 (11.5)              | NR                                             | 173         | 88.9 (12.3)                 | 88 (12.3)                | NR                                            |                           |
| Rodriguez-Cristobal | 864 N                                          | 7.35 months | 24 months             | 24                 | 402         | 85.50 (13.87)b               | 83.20 (15.55)b           | 2.5 (9.26)b                                 | 447         | 87.10 (14.48)b              | 84.90 (13.04)b          | 1 (5.64)b                                    |                           |
| Penn (2009)         | 102 Y                                          | 5 years   | 60 months             | 60                 | 51          | 93.4 (16.0)                   | NR                       | −2.3 (NR)                                    | 51          | 90.6 (12.5)                 | NR                       | 0.01 (NR) SD NR.                            |                           |
| Karlsen (2013)      | 187 N                                          | 7–8 months | NR                   | NR                | 110         | 90.7                          | −1 (1.7)                 | 77                                             | 97          | 92.7                       | −0.4 (1.3)               | SD NR.                                       |                           |

% weight loss

| Study                | Sample size (N randomized to relevant arms) | ITT? | Intervention duration | Measurement taken | n allocated | Baseline (Intervention) M(SD) | Post (Intervention) M(SD) | Intervention change score within group (SD) | n allocated | Baseline (Comparator) M(SD) | Post (Comparator) M(SD) | Comparator change score within group (SD) | Between groups effect size |
|---------------------|------------------------------------------------|------|-----------------------|-------------------|-------------|-------------------------------|--------------------------|-----------------------------------------------|-------------|----------------------------|--------------------------|-----------------------------------------------|---------------------------|
| LaRose (2020)       | 47 Y                                          | 03 months | NR                   | NR                | 24          | NR                           | NR                       | −3.3(3.8)%                                   | 23          | NR                         | NR                       | −2.2(4.1)% Follow-up scores NR.              |                           |

Note: Effect size calculated as M1−M2/pooled SD.
Abbreviation: NR, not reported.
Calculated from SE.
Calculated from CI.
| Study name                  | Measure                                                                 | Intervention duration | Timepoints reported                        | Findings                                                                                                                                 |
|----------------------------|-------------------------------------------------------------------------|-----------------------|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Anderson (2014).39 United Kingdom | Physical activity (SenseWear armband); Dietary intake (questionnaire) | 12 months            | 0 months; 3 months; 12 months.             | Intervention group spent more time active, consumed more fruit and vegetables and less fat than the comparator group. No difference for other nutritional intakes or alcohol use, but higher % of the intervention group reduced weekday alcohol consumption. |
| Barnes (2017).27 United States  | Motivation (Autonomous Motivation subscale of the TSRQ); Disordered eating symptomology (EDE-Q); Depression symptomology (BDI) | 12 weeks             | 0 months; 15 months.                       | No significant changes in depressive symptomology. Significant decreases in motivation for all participants ($P = .008$). Significant decrease in disordered eating symptomology for all participants ($P < .005$). |
| Befort (2008).28 United States  | Adherence (number of sessions); Adherence (number of self-monitoring logs returned); Dietary intake (24-hour recall); Physical activity (CHAMPS), Self-efficacy (Questionnaire) | 16 weeks             | 0 weeks; 16 weeks.                         | No significant difference in adherence between groups. Both groups significantly decreased kcal daily intake and fat intake ($P = .001$). Both groups significantly increased number of fruit and vegetable servings ($P = .007$) and decreased fat intake ($P = .006$). No effect on physical activity. Motivation ($P = .001$) and exercise self-efficacy ($P = .01$) was significantly reduced for both groups over time but there were no effects of condition. |
| Braun (2018).40 United States  | Dietary intake (FFQ, HEI); General self-efficacy; Physical activity (step count) | 6 months             | 0 weeks; 6 months.                         | MI participants experienced significant improvements in HEI ($P = .02$), and a nonsignificant trend of improvements was seen for non-MI ($P = .15$). Increases in general self-efficacy for the intervention group ($P = .08$), not for the comparator group ($P = .84$). No significant difference between groups ($P = .16$). No significant changes for either MI ($P = .40$) or non-MI group ($P = .32$) and no significant differences between groups ($P = .63$). |
| Bräutigam-Ewe (2020).38 Sweden | Quality of life (EuroQOL 5); Dietary intake (fruit/vegetable intake) | 2 years              | 0 months; 24 months.                       | Improvements in anxiety/depression scores in the intervention group. Significant difference between groups at 2 years for anxiety/depression ($P = .013$), usual activities ($P = .004$), pain/discomfort ($P = .041$). Significantly higher fruit and vegetables intake in the MI group at follow-up ($P = .005$). |
| Buscemi (2011).48 United States  | Physical activity (one-month recall); Dietary intake (FFQ); Stages of Change (Contemplation Ladder) | 2 weeks              | 0 weeks; 12 weeks.                         | Condition did not significantly predict moderate exercise ($P = .56$), vigorous exercise ($P = .80$), fast food consumption ($P = .07$), sweetened drink intake ($P = .12$), fruit intake ($P = .40$) or vegetable intake ($P = .20$). Moderate ($d = .56$, $d = .50$) effects on motivation to change weight and activity, and large effect ($d = .75$) on motivation to change diet. This did not predict actual change at 3 months. |
| Carels (2007).52 US | Physical activity (daily diary); Dietary intake (96-hour recall) | 24 weeks             | 0 weeks; 24 weeks.                         | Intervention participants engaged in significantly more physical activity at followup ($P = .05$, $d = .60$). No effects on dietary intake. |
| Chee (2017).21 Malaysia | Dietary intake (72-hour recall); Physical activity (IPAQ-SF) | 6 months             | 0 months; 3 months; 6 months; 9 months; 12 months. | MI group energy intake significantly reduced overall ($P < .001$) and activity duration significantly increased ($P < .001$). |
| Study name | Measure | Intervention duration | Timepoints reported | Findings |
|------------|---------|-----------------------|---------------------|----------|
| DiMarco (2009).50 US | Depression symptomology (BDI); Quality of life/life satisfaction (Q-LES-Q-SF); Eating behaviour (EDE-Q, TEFQ) | 11 weeks | 0 weeks; 11 weeks | Intervention group scored significantly lower on the disinhibition scale of EDE-Q (\(P = .02\)), but no significant effect of time. No significant effects of treatment group on any other variables. Significant decreases in EDE-Q restraint over time (\(P = .01\)), shape concern (\(P = .01\)), increases in flexible control (\(P = .01\)), and rigid control (\(P < .001\)). |
| Greaves (2008).32 United Kingdom | Physical activity (proportion reaching target activity level) | 24 weeks | 0 weeks; 24 weeks | No significant difference in physical activity targets reached. |
| Groeneveld (2010).33 Netherlands | | 24 weeks | | NR |
| Hardcastle (2013).37 United Kingdom | Physical activity (IPAQ, walking); Stages of change for physical activity (flowchart); Dietary intake (DINE, FACET). | 6 months | 3 months; 6 months; 18 months | Intervention group significantly increased physical activity (walking) between baseline and 6 months (\(P = .006, d = .24\)) and baseline and 18 months (\(P = .032, d = .20\)) but no significant differences between groups over time. Stages of change showed significant increases between baseline and 6 months (\(P < .001, d = .29\)) and significant decreases from 6 to 18 months (\(P < .001, d = .29\)) for MI group. Decrease in fat intake for MI group (\(P < .001, d = .43\)) between baseline and 6 months, which was maintained to 18 months (\(P < .001, d = .38\)). |
| Huber (2015).34 United States | Physical activity (IPAQ 7-day recall); Dietary intake (FFQ questionnaire); Self-efficacy (WEL questionnaire) | 12 weeks | 0 weeks; 6 weeks; 12 weeks; 18 weeks; 24 weeks | No significant differences in physical activity, dietary intake, or theory-based measures between groups. Significantly greater change from baseline in the intervention group for self-efficacy (\(P = .07\)), and re-structuring plans (\(P = .006\)). |
| Karlsen (2013).47 Denmark | | NR | NR | NR |
| LaRose (2020).51 United States | Autonomous self-regulation (TSRQ); Autonomy support (HCCQ) | 3 months | 0 months; 3 months. | Modest increases in autonomous self-regulation observed in both groups over time, but no significant differences by condition (\(P = .83\)). Reductions in controlled motivation observed, no significant differences between groups (\(P = .56\)). Perception of autonomy support at post-treatment higher in MI group (\(P = .08, d = .77\)). |
| Lewis (2019).43 Australia | Dietary intake (FFBQ); Physical activity (energy expenditure, step count); Weight self-efficacy (WEL-SF); Exercise self-efficacy (PAII); Treatment self-regulation (TSRQ) for diet and exercise. | 4 months (cross-over trial) | 0 months; 4 months; 8 months. | A significant interaction between time and condition (\(P = .002\)) for dietary intake with a mean change of 0.06 for intervention. Significant interaction for time and condition (\(P = .02\)) for physical activity step counts, indicating significant increases in steps for the intervention group at 4 months which was not maintained to 8 months. Control-MI group did not significantly change step counts in the first 4 months but significantly increased between 4 and 8 months. Significant interaction effects for weight and exercise self-efficacy further when receiving the MI support component of the trial. No significant |
| Study name          | Measure                                                                 | Intervention duration | Timepoints reported       | Findings                                                                 |
|---------------------|-------------------------------------------------------------------------|-----------------------|----------------------------|--------------------------------------------------------------------------|
| Littman (2019)      | Physical activity (sedentary time; decisional balance); Diet quality (dietary recall) | 20 weeks              | 0 months; 20 months.       | Changes over time between groups were not significantly different for “get up and go” tasks ($P = .23$). No significant difference in step counts over time between groups ($P = .39$). No significant difference in changes over time for sedentary behaviour ($P = .63$), nor decisional balance of pros ($p = .39$) and cons ($p = .39$), nor of diet quality changes over time ($P = .45$). Depression scores and quality of life NR. |
| Low (2012)          | Stages of change (Weight Loss Stages of Change Questionnaire); Quality of life (OWQOL-LITE); Mood; physical activity; self-efficacy (questionnaire NR). | 3 months              | 0 weeks; 3 months.         | No significant differences in quality of life between groups over time. Self-efficacy ratings increased only in the intervention group. Readiness to change showed increases over time. |
| Meybodi (2011)      | Self-efficacy (WEL)                                                     | 4 weeks               | 0 weeks; 12 weeks.         | Participants in the intervention group significantly improved their self-efficacy from pre to post intervention. Intervention group had significantly greater scores for negative emotions, social pressures, physical discomfort and positive activities than the comparator. Significant effect of condition ($P = .001$) overall and on negative emotion ($P = .024$), social pressure ($P = .040$) physical discomfort ($P = .006$) and positive activities ($P = .017$), indicating higher scores in the intervention group. |
| Mirkarimi (2017)    | Self-efficacy (WEL)                                                     | 2 weeks               | 0 weeks; 2 months; 6 months. | MI group scored significantly higher on self-efficacy, social pressures, food availability, physical discomfort, negative emotions, and positive activities than the comparator. |
| Moeller (2020)      | Wellbeing (WHO-5)                                                      | 6 months              | 0 months; 6 months.        | No significant differences between groups at baseline or follow-up. Pooled data from all participants showed improvements in wellbeing over time ($P = .028$). |
| Moss (2017)         | Adherence (number of sessions); Readiness to change (questionnaire)     | 12 weeks              | 0 weeks; 36 weeks.         | No significant differences in adherence between groups. No significant differences for confidence for change, importance and readiness. |
| Olson (2016)        | Dietary intake (recall questionnaire); Physical activity (HPAS); Sleep (PSQI) | 24 weeks              | 0 weeks; 24 weeks.         | Significant increase in fruit and vegetable servings and physical activity levels for the intervention group ($P = .005$). Increases in sleep quality but no significant difference between groups. No significant interaction effect on number of days with 30 minutes physical activity. |
| Penn (2009)         | Health status (questionnaire); Dietary intake (72-hour recall); Physical activity (72-hour recall) | 52 weeks              | 0 weeks; annually until endpoint. | No significant difference between groups at any year. |
| Rodriguez-Cristobal (2017) | Smoking (number of packets/year)                                      | 24 months             | 0 weeks; 52 weeks; 104 weeks. | NR |
sessions in addition to face-to-face contact had a median 140 minutes of MI. The timepoint used was between 1 and 6 months for eight studies,28,42-44,48,50,51,54 6 months for nine studies,10,32,34,40,41,45,46,49,52 12 months for six studies,27,31,33,35,36,39 13 to 24 months for six studies,30,37,38,53,55,56 5 years for one study,29 and unclear for one.47 Reported interventionist backgrounds included undergraduates, nurses, dieticians and psychologists. Seventeen papers gave no information on training or qualifications. Where reported, training duration ranged from between 4 and 8 hours to 3 days. Regarding fidelity, 58% of papers10,27,29,31,33,34,35,37-39,41-43,45-48,54 made no reference to use of supervision or measures. Other studies used the Motivational Interviewing Treatment Integrity measure58 (n = 436,40,51,52) or the Behaviour Change Counselling Index59 (n = 129). Eight studies referred to supervision from trainer or researcher trained in MI to confirm consistency to the approach, through listening to audio recordings or reviewing transcripts (n = 828,33,44,50,51,53,55,56).

Twenty-one27-29,32,34,35,38-40,44-55 studies did not identify theories of behaviour used in intervention development. Of studies that did report theoretical underpinnings, the most common were Self-Determination Theory (n = 310,36,37), the Stages of Change/Transtheoretical Model (n = 430,33,37,42), Social Cognitive Theory (n = 236,41), and Theory of Planned Behaviour (n = 137). One hundred eighty BCTs were present in the intervention. The most frequently occurring BCT within the interventions was social support - unspecified (3.1), as MI is coded as 3.1 within the BCT taxonomy.15 Following this, goal-setting of behaviours (1.1) was identified in 12 intervention descriptions, and self-monitoring of behaviour (2.3) was identified in 15 descriptions. Consideration of the pros and cons (9.2) was identified in 9 intervention descriptions, and information about health consequences (5.1) in 9. Regarding comparator group methodological descriptions, 76 BCTs were identified in total. Most prominently these were self-monitoring of behaviour (2.3), appearing in 10 descriptions, social support - unspecified (3.1) coded in 9, instruction on how to perform behaviour (4.1) and information about health consequences (5.1).
both present in 7 descriptions and goal-setting of behaviour (1.1) coded in
6. Regarding MI-specific techniques, of 38 defined by Hardcastle & col-
leagues9 26 were identified within interventions (none identified within
comparator arms). Most frequently identified was “develop a change
plan,” 33 noted in 11 papers, and “running head start”9 identified in nine
papers. Inter-rater agreement was good for both BCT and MI technique
coding (Cohen’s kappa >0.80, prevalence-adjusted bias-adjusted kappa
>0.60). See supplementary materials (Appendix S1) for frequency counts
of BCT and MI-specific techniques.

### 3.2 | Quality assessment

Quality assessment is reported in Supplementary materials A
(Appendix S1). Risk of bias varied, but for the domains of random
sequence generation (58.6%) and attrition (37.9%) a majority of stud-
ies were graded as low risk of bias. This was due to clearly described
use of randomization techniques or software (eg,34) and participant
drop-out was explained (eg,39). Around a third of papers were con-
sidered potentially at high risk of attrition bias due to lack of
reporting about participant drop-out or handling of incomplete data
(37.9%). For the domains of performance bias related to binding of
participants and staff (41.4%), detection bias related specifically to
outcome assessor binding (51.7%) and selective reporting bias
(51.7%) a majority of studies had uncertain levels of risk. For exam-
ple, in some cases (eg,44) it was not clear who was blinded to alloca-
tion status, or if blinding of staff extended to outcome assessors.
Intended outcomes were not always specified in advance meaning it
was unclear if they were reported selectively. For nonrandomised
studies, some risk of bias was present due to selection of participants
to conditions and clarity of follow-up measure procedures, however
follow-up durations and engagement data were clearly reported
(Table 2).

### 3.3 | Behavioural outcomes

In addition to investigating bodyweight outcomes, 96.7% also exam-
ined behavioural outcomes such as physical activity, dietary intake,
adherence, motivation or self-efficacy and related constructs or sleep
quality. Within 15 papers reporting outcomes of PA, 26.7%31,35,39,49,52
reported a significant improvement within the intervention group. For
dietary intake, 53.3%31,35,37-40,43,49 of 15 papers reported improve-
ments within the intervention group. Motivation appeared to
decrease over time for all participants27 whilst stages of change and
self-efficacy measurements had no significant changes for one study48

and appeared to increase over time in the intervention group for others.34,41-43,54 Table 3 reports findings of non-bodyweight outcomes.

Twelve studies were eligible for inclusion within the SMD meta-analysis of final measurements of BMI and kilogram outcome measures. Change scores and final measurement scores cannot be combined within SMD meta-analysis as the standard deviations are representing different things.26 However, seven studies were eligible for inclusion within separate BMI analyses and 15 within separate kilogram outcome analyses.

FIGURE 4 Forest plot demonstrating effects for final measurement and change scores of bodyweight measured in kilograms

FIGURE 5 Forest plot demonstrating effects for BMI final measurement and change scores
3.4 | Effect of MI on pooled adiposity outcomes (BMI and bodyweight final measurements)

Overall, 1683 participants took part in 12 studies reporting final measurement values for BMI and KG with a total sample baseline BMI of >30. Where possible, final measurement BMI was extracted for inclusion; for several papers only bodyweight in kilograms was reported and thus the final bodyweight in kilograms was utilized for the pooled outcome analysis. Using a random-effects meta-analysis, the SMD of the effect on BMI and KG final measurement outcomes was –0.01 (95%CI –0.13 to 0.12, P = .93), indicating no significant effect of MI on the pooled final measurement outcomes. See Figure 2 for forest plot providing meta-analysis with 95%CI.

The primary reason for exclusion of randomized trials from the SMD meta-analysis was that only change scores were reported. To check publication bias, the funnel plot (see Figure 3) was visually examined for asymmetry and indicated that there may be small study publication bias. Potential sources of bias may result from selective reporting of results, or inclusion of studies with small sample sizes.

3.5 | Effect of MI on bodyweight outcomes (kilograms)

Additionally, 15 papers reporting bodyweight outcomes in kilograms in final measurements or change scores in KG were analysed using a random-effects meta-analysis. Several papers were eligible for inclusion within this analysis that were not included in the pooled outcome analysis. Results indicated no significant effect of MI on bodyweight (kilograms) outcomes, with a mean difference (MD) of –0.52 KG between loss in the intervention compared to the comparator group (95%CI –1.34 to 0.31, P = .22). See Figure 4 for forest plot presenting data with 95%CI.

3.6 | Effect of MI on BMI outcomes

Further, eight papers reporting BMI change scores and final measurements were analysed using random-effects meta-analysis; this indicated no evidence of a statistically significant effect of MI on BMI outcomes (MD = –0.10, 95%CI –0.73 to 0.53, P = .76). See Figure 5 for forest plot with 95%CI.

4 | DISCUSSION

This review aimed to evaluate the effectiveness of MI for weight loss and report the methodology and content of interventions; including theoretical underpinnings and identification of BCTs and MI techniques. No evidence of significant overall effects was identified. Findings suggested that similar BCTs were present in both conditions, indicating possible treatment contamination if arms did not differ sufficiently. Future research could more clearly report the content of control conditions and practitioner approach, particularly when relational elements of MI may be an influential factor of effectiveness. Work investigating participant experiences involved in one included trial identified themes of monitoring and support and listening support. Specifically, participants reported that contact with, and health checks from practitioners incentivized adherence to lifestyle changes. It may be possible in other research that the control group's treatment as usual or active comparator offered a form of maintained contact and support in behaviour change from practitioners who may have delivered this in an MI-adherent manner. Without clearer understanding of comparator and delivery routes it is difficult to disconfirm that these relational components were not vital to the behaviour change. Potential overlap in what was delivered to participants within studies should be a consideration for interpretation, and future research could closely consider the interpersonal style of comparator delivery within trials.

To further understanding of what mechanisms may be utilized to support the intended behaviour change, reported methods were systematically considered. “Social support – unspecified” (3.1) was the most frequently identified intervention code (see Supplementary materials [Appendix S1]). Within the BCT taxonomy, MI is coded under “social support – unspecified” (3.1) which may not accurately represent the complexity of components. When this code is discounted, more than half (58.94%) of all identified BCTs were in the goals and planning and feedback and monitoring categories. Some items from the MI-specific taxonomy overlap with BCTs. For example, discussion of the pros and cons of behaviour change was coded as 9.2 within the BCTTv1 and within the MI taxonomy as “running head start.” Prevalence rates for such items from the two taxonomies were similar, supporting that MI techniques identified by Hardcastle and colleagues are a viable tool for examination of MI-specific components. While no MI techniques have defined overlap with the feedback and monitoring group of BCTs, 30.7% of identified MI techniques in intervention descriptions had specific overlap with BCTs from the goals and planning group. This supports that a goal of MI, to make plans for change actions, utilizes specific techniques. No MI techniques were identified within comparator arms. MI techniques may be more accurately identified within audio transcriptions of sessions than brief study descriptions. The BCTTv1 identified similar techniques present within intervention and comparator content that the MI techniques did not. However, fewer BCTs were coded for the control conditions. Without access to in-depth content, it is possible that utilized techniques were coded as absent due to limited information available. Meta-regression of techniques may provide further contextualized information regarding predictive elements of effective behaviour change interventions but was outside of the current scope.

In comparison to earlier work, meta-analysis did not find evidence of significant difference between final physiological measurements of MI and non-MI group participants. Armstrong and colleagues identified studies with a BMI ≥25 kg/m² and without additional intervention components, and completed a meta-analysis identifying significant effects. This was in terms of an increased bodyweight reduction compared to a control group of –1.47KG. We identified...
There are important limitations to consider. Searches were limited to material accessible in English language; this may exclude relevant papers and lead to location bias. However, 12 studies were identified that were based outside of the US and UK. Use of final measurement score over time is less ideal for inclusion within meta-analysis than use of change scores, but this was dependent on outcomes published in the articles. Inaccessibility of data meant some articles were not included within meta-analyses, which may skew findings. Studies may have been underpowered to identify true effects. Although findings should be interpreted with care, there are key strengths to the current review. It has built upon the existing evidence-base in a number of ways including: (1) the identification of articles not included in previous reviews, (2) inclusion of trials that used novel intervention formats, and (3) meta-analysis of study data. Additionally, use of technique taxonomies furthers understanding of what is involved within session content, and can support further research in identifying effective interventions.

To conclude, this review identified that a range of methodologies of MI have been researched for effectiveness of weight loss outcomes, and a meta-analysis found no significant overall effect. However, no significant increases in weight comparable to the comparator groups were observed. Frequently reported BCTs included social support, self-monitoring of behaviour, problem solving, goal setting and assessment.

DATA AVAILABILITY STATEMENT
Data extracted from published research articles. The data used for meta-analyses are available in the tables presented in this article.

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**SUPPORTING INFORMATION**

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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