International Journal of Behavioral Medicine
https://doi.org/10.1007/s12529-020-09934-0

INTEGRATIVE REVIEW

Motivational Interviewing for Weight Management Among Women: a Meta-Analysis and Systematic Review of RCTs

Kameron B. Suire[1] · Jan Kavookjian[2] · Robyn Feiss[1] · Danielle D. Wadsworth[1]

Accepted: 5 October 2020

Abstract

Background Motivational interviewing (MI) is a communication skill set used by clinicians to help facilitate adherence to numerous health behaviors. Currently, MI's evidence supports its use among adults in various realms; however, clarity is needed regarding weight management among females. The purpose of this systematic review and meta-analysis is to synthesize the literature examining the use of MI and its impact on anthropometric measures among adult females.

Method The authors conducted a modified Cochrane method of systematic search and review in several relevant databases to explore and report evidence and gaps in the literature for MI in weight management among females in addition to meta-analyses for weight and BMI. Criteria for retention included randomized controlled trials with open inclusion of studies with varied settings, methods, interventionists, target behaviors, and outcomes.

Results Of the 3289 references initially identified, 10 intervention arms met the criteria across review tiers. Seven of 10 intervention groups reported significant anthropometric changes compared with a control group, as well as significant changes in non-anthropometric outcomes related to weight management. Using a random-effects model, the effect size of MI on reduction in body weight (kg) was 0.19 (95% CI − 0.13, 0.26; $p < 0.01$), and the effect size of MI on reduction in BMI was 0.35 (95% CI 0.12, 0.58; $p < 0.01$).

Conclusions Results suggest that MI interventions are useful for weight management among females. Future studies would enhance the current base of literature by utilizing advanced anthropometric outcomes, including sex-specific results, and including more diverse and larger sample sizes.

Keywords Motivational interviewing · Anthropometric outcomes · Females · Lifestyle behaviors · Nutrition · Physical activity

Introduction

Background

Obesity continues to be a global health issue. In 2015 alone, over 603 million adults had obesity and 4 million deaths were attributed to high body mass index (BMI) globally [1]. Obesity is associated with numerous physical health conditions: mortality, hypertension, dyslipidemia, type 2 diabetes, coronary heart disease, stroke, gallbladder disease, osteoarthritis, sleep apnea and breathing problems, and certain cancers [2–4], as well as psychological conditions including clinical depression, anxiety, and other psychological disorders [5–7]. In addition to health burdens, obesity has a tremendous economic cost. In 2008 alone, it was estimated that $147 billion dollars was spent on medical treatment for obesity-related issues [8]. Furthermore, obesity is associated with a loss of worker productivity and nonattendance with estimated costs ranging from $3.38 billion to $6.38 billion [9]. It appears obesity impacts females at a higher rate than males globally. It was estimated that 15% of all females were obese in 2016 compared with 11% of males [10]. One study also found that a staggering 87% of 151 countries included in an analysis showed a higher female obesity prevalence compared with males [11].

Behavior modification is typically the first treatment for obesity, primarily consisting of changes in physical activity

✉ Kameron B. Suire
kameronsuire@gmail.com

1 School of Kinesiology, Auburn University, 301 Wire Rd, Auburn, AL 36849, US

2 Harrison School of Pharmacy, Auburn University, Auburn, AL, US

Published online: 20 October 2020

and other behaviors that may influence weight. An increase in physical activity has several health benefits and consistent physical activity is pivotal in chronic disease prevention, weight management, bone health, cardiovascular health, mental health, and sleep health [12, 13]. However, 31.7% of women are inactive while 23.4% of men are inactive globally [14]. With females having higher rates of obesity and physical inactivity, it has been suggested that interventions and evidence are needed that specifically target females for weight management [15].

While health professionals often suggest behavioral modification, adherence to health behaviors is difficult to accomplish due to a lack of consistent motivation [16–18]. It appears evident that many diet and exercise programs ignore motivation [19], despite the evidence, which shows motivation plays a pivotal role in behavioral modification or maintenance [20–22]. Motivational interviewing (MI) is one approach that is directly focused on eliciting and using the client's own motivation, rather than the practitioners' motivation thus making it person-centered in nature [23]. MI is an emerging counseling method shown to help facilitate an increase in adherence to numerous health behaviors through a series of person-centered strategies and adhering to the MI way of being, which includes being collaborative, compassionate, eliciting of patient's inputs/goals first, and accepting/nonjudgmental. In addition to addressing motivation, psychological strategies may enhance adherence due to the psychological processes needed to engage and maintain health behaviors. MI uses a variety of skills to stimulate the patient psychologically: asking open-ended and thought-provoking questions, developing discrepancy, rolling with resistance, and eliciting and responding to change talk, among others [23]. The spirit of MI is vital to MI intervention implementation and is summarized as collaborative, compassionate, evoking, and accepting [23].

Researchers have applied MI in numerous behavior change fields and target behaviors to increase health status [24–26]. This includes health behaviors related to weight loss among adult populations [27, 28], which demonstrated positive to mixed results. One of the questions posed by a previous meta-analysis was whether MI has more of an effect depending on sex, which is not currently clear [27]. With a majority of studies having more female participants and a recent influx of female-exclusive studies, a review of female-specific results is possible. Past reviews have also questioned the effectiveness of MI among non-white women due the limited research gathered and lack of demographical information [27, 28]. An exclusive focus on females using an updated literature base is needed to address these questions.

Due to the potential of MI as an effective weight management technique, the high rates of obesity among females, and current questions in the literature regarding sex and ethnicity, an updated synthesis of the literature is necessary. To our knowledge, there has been no comprehensive review of the impact of randomized controlled trials (RCTs) of MI on anthropometric measures in females. Therefore, the objectives of this review are to (1) systematically explore the literature for effects of a physical activity and nutrition-based MI intervention on anthropometric outcomes among females and (2) report implications for practice and research based on evidence and gaps in the literature for outcomes of MI intervention with females.

Methods

Search strategy: Databases, terms, and inclusion/exclusion criteria

A modified Cochrane method of systematic search and review [29] was conducted within seven databases (e.g., PsycINFO, PsycARTICLES, Academic Search Premier, MEDLINE, CINAHL, Health Source: Nursing/Academic Edition, and SPORTDiscus) by the lead author with the latest search taking place in January 2020. This systematic review used the rigorous systematic search-and-review approach applied to a more exploratory research question regarding evidence and gaps in the literature for MI as an intervention for behavior change for weight management for women whereas a typical Cochrane review compares specific outcomes surrounding a more narrowly defined research question between two interventions in a specific population. The keywords used were Motivational Interviewing AND weight or weight management or weight loss or physical activity or exercise or nutrition or BMI or body mass index or lifestyle or females. The keywords remained consistent across databases. The authors used hand searches of references lists within identified study articles and reviews to determine if additional articles were available, which were not returned in the initial search.

Inclusion criteria: (1) RCT study design as a rigorous study design from which to draw valid conclusions, (2) utilized MI independently of other interventions, (3) reported female-specific results, (4) involved both healthy eating habits and physical activity, (5) contained anthropometric outcomes, (6) published in English language during the timeframe of 1990 to January 2020, and (7) conducted at least a pre- and post-intervention data collection. The timeframe of 1990 is relevant as this is a period when MI applications began to move beyond their origins in the addiction's field and into health behaviors for self-management of chronic disease management and prevention.

Review tiers and data extraction

The title and abstract review tier was conducted by one researcher; full-text review tier was conducted by three researchers with discussion to consensus for disagreements about retain/reject decisions for study articles. Each of the final retained study details were entered into a data extraction tool that was tailored to this project for efficient extraction, organization, and report of study characteristics. Information on participants, study duration, MI sessions, MI delivery, control group, anthropometric outcomes, and secondary outcomes were extracted.

Assessment of methodological quality

It is vital to assess the methodological quality of retained articles in a review since rigor plays an important role in the validity implications of conclusions drawn from results. All the retained articles in this review were next assessed for methodological quality using the Cochrane Risk of Bias tool [29]. This method involves evaluation of each article study design and methods across five domains of bias risk (e.g., selection bias, performance bias, attrition bias, reporting bias, and detection bias). Each article was independently evaluated for each domain and for a designation of either a “high risk,” “low risk,” or an “unclear risk” (when scarce information was available or reported within the article and a bias risk decision could not be directly achieved).

Data analysis

Meta-analyses were completed for each primary outcome (weight and BMI) using the “metafor” package in R Studio [30]. Following data extraction, standardized mean change scores using raw score standardization (SMCR) was used to compute Hedge’s *g* effect size estimates and the 95% confidence interval for each group via the “escalc” function. Next, the effect sizes were pooled via a random-effects model using the “rma” function and visualized using the “forest” function to assess the impact of the interventions on anthropometrics across all studies. Average effects of the intervention and control were compared using an independent-samples *t* test to compare effect sizes between intervention and control groups. Lastly, linear regressions were used to assess the influence of dosage (in min), study length (in weeks), and the number of sessions on intervention effects. Heterogeneity was assessed via the Cochrane’s Q and I^2 statistic. Potential publication bias was assessed using the Egger’s regression test [31]. If the Egger’s regression test indicated that potential publication bias was present, a trim-and-fill analysis was used in place of the traditional random-effects model [32–34]. All analyses were conducted using RStudio (RStudio Inc, Version 1.2.5033) running R software (R Foundation, version 3.5.3), and significance was set to $p < 0.05$ for all analyses.

Results

The initial search of databases yielded 3284 citations; five additional studies were located manually for a total initial pool of 3289 articles. See Fig. 1, the PRISMA trial flow diagram, which describes results for each search and review tier, with reasons for rejection. After removing duplicates, 2170 studies were identified for initial review of titles and abstracts. This led to an exclusion of 2088 articles. For the next review tier, 82 full-text articles were reviewed with 71 excluded due to non-sex-separated data (44), no anthropometric measurements (21), combined methods (4), and being non-RCT (2). 9 RCT articles that yielded 10 intervention arms were retained that used MI as a lifestyle behavior intervention for adult females. Agreement between reviewers on the full-text review was assessed using Cohen’s kappa statistic (*k*), inter-rater reliability [35]. The level of agreement was at .87, which represents a strong level of agreement [36]. A summary of retained study characteristics and outcomes is provided in Table 1.

Types of studies and intervention designs

As per the inclusion criteria, all retained studies were RCTs. The 10 retained intervention groups were heterogeneous in that they included study designs that varied in duration, type and number of intervention contacts, type of practitioner delivering the intervention, and age of participant. All retained studies had MI as the only intervention or an addition to another form of intervention that matches the control group. The method of MI delivery varied. Most interventions were provided solely or collaboratively by psychologists ($n = 7$), a team of multidisciplinary providers (ex. dietitian, physiologists, clinical psychologist, nutritionist, nurse) ($n = 2$) or a diabetes educator/diabetes care and education specialist ($n = 1$). The number of sessions and duration of study protocols ranged from 2 to 10 sessions over a course of time ranging from 2 to 12 months. All studies included BMI or weight change as a primary outcome. Many other studies included other anthropometric measurements and other intermediate outcomes (i.e., nutritional behaviors, attendance at intervention sessions, and adherence to goals, among others).

Description of control groups

All 10 intervention arms utilized a control group. Three of 10 arms utilized attention control groups that focused on education [37, 43, 45]. Another three intervention arms

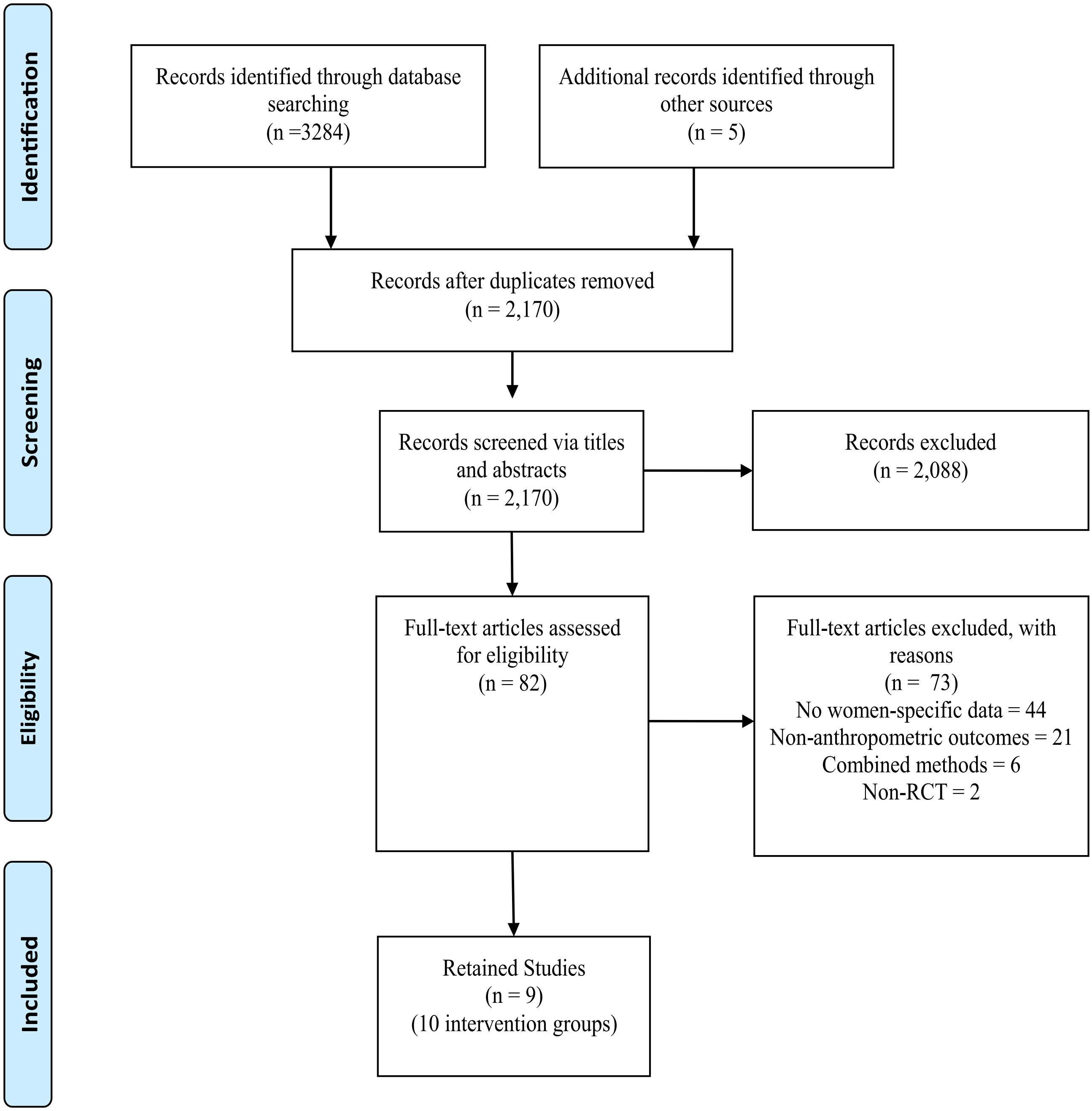

Fig. 1 PRISMA trial flow diagram

utilized extensive education as the control, almost matching the intervention group with 240 min compared with 300 min of MI [38, 39]. In one intervention, both the control and intervention groups received a 16-session, standard weight loss program [42]. In addition to this, the intervention group received MI sessions whereas the control received no additional contact. In another study, the control received one educational session compared with five MI sessions in the intervention group [41]. Reinhardt and colleagues described their control as usual care with no additional details [40]. Williams et al. reported that the control group received written educational material on three separate occasions compared with four sessions of MI in the intervention group [45].

Description of sample participants

The age in the studies ranged from 33 to 62. Sample sizes varied across studies ranging from 22 to 327 females. Three studies (four intervention groups) were conducted in Iran,

Table 1 Characteristics of retained studies

Source	Sample size	Study length	Sample description	Intervention and control description	Results
Befort et al., 2008 [37]	33	16 weeks	*M* Age = 44.3 ± 11.6 *M* BMI = 39.8 ± 6.4 100% African American	Both groups received a diabetes prevention program (90-min weekly sessions in groups of 12–14 participants) I: Doctoral clinical psychology student, MI sessions occurred at weeks 0 (in-person), 3 (by phone), 8 (in-person), and 13 (by phone) for 30 min each C: HE, attention control	SC: Wt decrease within I, reduction in energy intake/percent calories from fat, increase F/V consumption within I NS: Wt, PA compared to C
Mirkarimi et al., 2015 [38]	100	2 months	*M* Age = 38.45 ± 9.49 *M* BMI = 28.7 ± 2 Conducted among Iranian sample	I: Psychologist, 5 sessions of MI (45–60 min) over 2 weeks C: HE covering PA and diet, 4 sessions in 2 weeks (45 min–1 h per week) by a nutritionist	SC: Wt, BMI decrease compared to C, PMT construct scores: susceptibility, severity, self-efficacy, and response efficacy increase compared to C NS: PMT construct scores of rewards and cost compared to C
Mirkarimi et al., 2015 Intention Group [38]	100	2 months	*M* Age = 38.45 ± 9.49 *M* BMI = 28.7 ± 2 Conducted among Iranian sample	I: Psychologist, 5 sessions of MI (45–60 min) over 2 weeks alongside a timeline to complete objectives C: HE covering PA and diet, 4 sessions in 2 weeks (45–60 min per week) by a nutritionist	SC: Wt, BMI decreased compared C and MI without intention group, PMT construct scores: susceptibility, severity, self-efficacy, and response efficacy increase compared to C NS: PMT construct scores: rewards, cost compared to C
Mirkarimi et al., 2017 [39]	100	6 months	*M* Age = 39.9 ± 9.1 for I *M* Ag = 36.3 ± 8.9 for C *M* BMI = 28.56 ± 1.76 Conducted among Iranian sample	I: Psychologist, 5 MI sessions (2 h per session for 2 weeks) C: HE focusing on nutrition group (4 sessions, 2 h per session during 2 weeks)	SC: BMI decrease compared to C, Wt efficacy lifestyle and all sub-scales including social pressure, physical discomfort, food accessibility, positive and entertainment activities increase compared with C, negative emotion decrease compared with C
Reinhardt et al., 2012 [40]	31	5 months	*M* Age = 32.9 ± 4.9 *M* BMI = 29.2 ± 6.2 for I *M* BMI = 28.5 ± 4.9 for C Conducted in Australia	I: 2 diabetes educators, participants received 10 phone-based sessions at prearranged times weekly for 5 weeks, monthly for 5 months. Session duration lasted 10 to 30 min C: Usual care (no other details)	SC: BMI, Wt, WC decrease compared to C, decrease total fat intake, total carbohydrate intake, glycemic load compared to C, increase leisure PA compared with C
Saffari et al., 2014 [41]	327	12 months	*M* Age = 33.99 ± 6.49 for C *M* Age = 34.62 ± 5.63 for I *M* BMI = 35.09 ± 5.29 for C *M* BMI = 35.11 ± 6.11 for I Conducted among Iranian sample	I: Health psychologist with the assistance of a nutritionist, Initial education session followed by MI sessions consisted of 5, 60-min face-to-face sessions in the health centers at 1st (baseline), 3rd, 6th, 9th, and 12th months C: 1 education session low-calorie and low-fat diet, PA, by a health psychologist with the assistance of a nutritionist in the health centers to all the participants	SC: Wt, BMI decrease compared C, increase in consumption of dietary fiber, whole grain products, F/V compared with C, decrease in blood pressure, glucose, lipids, carbohydrate consumption, total/saturated fat intake, caloric intake, and meat consumption compared with C

Table 1 (continued)

Source	Sample size	Study length	Sample description	Intervention and control description	Results
Smith et al., 1997 [42]	16	4 months	*M* Age = 62.4 ± 7.0 *M* BMI = 34.7 ± 4.9 41% African American	I: Psychologists, 16 session standard behavioral wt control, Addition of 3 individual MI sessions (1 at the beginning and 2 at week 8) C: 16 session standard behavioral wt control, no additional contact	SC: Wt loss within I, increased attendance to group meetings, more food diaries, recorded blood glucose compared C, increased glucose control compared with C NS: Wt loss compared to C
Webber et al., 2010 [43]	70	4 months	*M* Age = 47.9 ± 10.8 for C *M* Age = 49.5 ± 10.4 I *M* BMI = 32.1 ± 3.6 for C *M* BMI = 31.9 ± 3.9 for I 91% Caucasian	Both groups received a separate face-to-face 2-h wt loss session at the beginning of the study led by a dietitian trained in MI I: Dietitian, received access to the study website and a 60-min MI session at 4 weeks C: Received access to the study website and a 60-min standard education session at 4 weeks for attention control	SC: Wt, WC, body fat % decreased within I, Autonomous motivation maintenance compared with C NS: Wt, WC, and body fat %, PA, caloric intake, fat intake, website visits, diaries completed, message board posts all compared with C
West et al., 2007 [44]	217	18 months	*M* Age = 53 ± 10 *M* BMI = 36.5 ± 5.5 38% African American	I: Clinical psychologists, 5 individual MI sessions at baseline, 3, 6, 9, and 12 months. Sessions lasted 45 min C: Individual HE sessions, attention control	SC: Wt at 6, 12, 18 months compared to C, A1C decrease at 6 months compared to C, increase in engagement to behavioral wt management program at 6, 12, 18 months compared to C, attendance at group sessions compared to C at 6 and 12 months NC: AIC at 12 and 18 months compared to C
Williams et al., 2014 [45]	40	12 months	*M* Age = 47.3 ± 1.8 *M* BMI = 25.1 ± 2.4 84.9% born in Australia	I: Exercise physiologist = 1 session, Dietitian = 4 sessions over 12 months, 60 min each C: Written information self-directed intervention (wt management booklets, baseline information regarding current status, and assessment materials) within 1 month after baseline, 3-month, and 12-month appt	SC: Wt, WC decrease compared to C, Diastolic blood pressure decrease compared to C NS: Body fat %, Lean mass %, Goal achievement compared to C, total cholesterol, triglycerides, LDL, HDL, glucose, systolic blood pressure all compared to C

BMI body mass index, *C* control, *F/V* fruit and vegetable, *GDM* gestational diabetes mellitus, *HE* health education, *I* intervention group, *MI* motivational interviewing, *NIDDM* non-insulin-dependent diabetes mellitus, *NS* not statistically significant, *PA* physical activity, *PMT* protection motivation theory, *SC* statistically significant changes ($p < 0.05$), SDI self-directed intervention, WC waist circumference, Wt weight and although race information was not reported, it was likely that most participants were of Middle Eastern descent [38, 39, 41]. Other studies that reported race information included subjects who were majority Caucasian other than the research from Befort and colleagues whom had an African American sample [37]. Most studies reported an inclusion criterion of overweight/obese females. 1,034 participants were included in the 10 intervention arms. There were 507 participants who underwent a MI intervention and 527 control comparator participants.

Effect of MI on body weight

Six of the nine intervention groups that measured weight demonstrated statistically significant results in weight loss compared with a control group [38–41, 44, 45]. The other intervention groups demonstrated statistically significant weight decreases within the intervention group pre to post but not compared with control, meaning all MI intervention groups lost a significant amount of weight [37, 42, 43]. The mean change in weight (kg) among the intervention groups was − 2.86 compared with that of − 1.5 respective to the control groups with a difference of − 1.36, provided by the information in Table 2. Seven eligible studies, including eight intervention groups, were included in the meta-analysis for weight. No significant publication bias was observed in the intervention groups ($z = 0.72$, $p = 0.47$) or control groups ($z = -0.74$, $p = 0.46$) that measured weight. The pooled effect size of MI on change in body mass (kg) was 0.19 (95% CI 0.13, 0.26; $p < 0.001$), indicating a significant decrease as depicted in Fig. 2. The pooled effect size for the respective control groups was 0.10 (95% CI − 0.00, 0.20; $p = 0.06$), indicating no significant change as depicted in Fig. 3. However, high heterogeneity was present for both intervention $Q(7) = 95.1965$, $p < 0.0001$ ($I^2 = 93.13\%$) and control effects $Q(7) = 107.4774$, $p < 0.0001$ ($I^2 = 97.18\%$). Additionally, the difference between the intervention and control effects across studies was not significant, $t(11.65) = 1.54$, $p = 0.15$. It is important to note that the power for this analysis (utilizing G*Power3) was very low at 0.10, indicating more studies are needed to detect a difference [46]. Lastly, dosage (in min) ($F(1,6) = 0.17$, $p = 0.69$), study length (in weeks) ($F(1,6) = 1.01$, $p = 0.35$), and number of sessions ($F(1,6) = 4.31$, $p = 0.08$) did not significantly influence changes in weight.

Table 2 Primary outcomes

Study	Outcome	Intervention			Control		
		Pre (SD)	Post (SD)	Change (SD)	Pre (SD)	Post (SD)	Change (SD)
Befort et al., 2008 [37]	Weight (kg)	101.3 (22.8)	98.6 (24.8)	− 2.6 (4.2)	109.9 (18.5)	106.7 (18.1)	− 3.2 (5.7)
Mirkarimi et al., 2015 [38]	Weight	74.25 (6.95)	72.50 (6.40)	− 1.75 (NR)	75.91 (6.05)	75.70 (6.10)	− 0.21 (NR)
Mirkarimi et al., 2015 (intention group) [38]	Weight	77.33 (6.89)	76.74 (6.85)	− 0.59 (NR)	75.91 (6.05)	75.70 (6.10)	− 0.21 (NR)
Reinhardt et al., 2012 [40]	Weight	75.3 (17.7)	74.1 (16.3)	− 1.2 (NR)	75.9 (13.5)	79.2 (13.5)	3.3 (NR)
Saffari et al., 2014 [41]	Weight	80.96 (15)	77.82 (14.94)	− 3.14 (NR)	81.77 (9.86)	80.35 (9.93)	− 1.42 (NR)
Smith et al., 1997[b] [42]	Weight	NR	NR	− 5.5 (3.9)	NR	NR	− 4.5 (2.2)
Webber et al., 2010[a] [43]	Weight	84.2 (12.1)	80.3 (NR)	− 3.9 (3.4)	84.3 (12.3)	80.9 (NR)	− 3.4 (3.6)
West et al., 2007 (12 months)[a] [44]	Weight	97 (17)	NR	− 4.8 (0.59)	97 (15)	NR	− 2.7 (0.62)
Williams et al., 2014 [45]	Weight	67.8 (8.9)	65.6 (8.5)	− 2.6 (NR)	68.6 (6.7)	67.4 (6.7)	− 1.2 (NR)
Befort et al., 2008 [37]	BMI	37.9 (6.7)	36.9 (7.4)	− 1 (1.5)	40.7 (5.9)	39.6 (6.2)	− 1.1 (2)
Mirkarimi et al., 2015 [38]	BMI	28.25 (2.22)	27.58 (2.11)	− 0.67 (NR)	28.84 (1.59)	28.85 (1.53)	0.1 (NR)
Mirkarimi et al., 2015 (intention group) [38]	BMI	29.01 (2.09)	28 (2.04)	− 1.01 (NR)	28.84 (1.59)	28.85 (1.53)	0.1 (NR)
Mirkarimi et al., 2017 [39]	BMI	29.2 (6.2)	28 (5.7)	− 1.2 (NR)	28.5 (4.9)	29.6 (5.2)	1.1 (NR)
Reinhardt et al., 2012 [40]	BMI	28.25 (2.21)	26.35 (2.17)	− 1.72 (NR)	28.84 (1.59)	28.68 (2.53)	− 0.16 (NR)
Saffari et al., 2014 [41]	BMI	35.11 (6.11)	31.05 (6.39)	− 4.06 (NR)	35.09 (5.29)	33.3 (5.26)	− 1.79 (NR)

BMI body mass index, *NR* not reported, *SD* standard deviation

[a]Imputed standard deviation from standard error

[b]Not included in meta-analysis due to lack of data

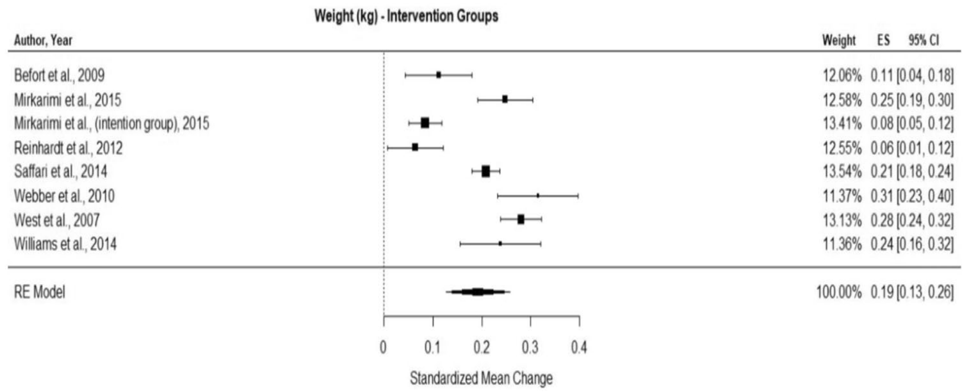

Fig. 2 Weight change intervention

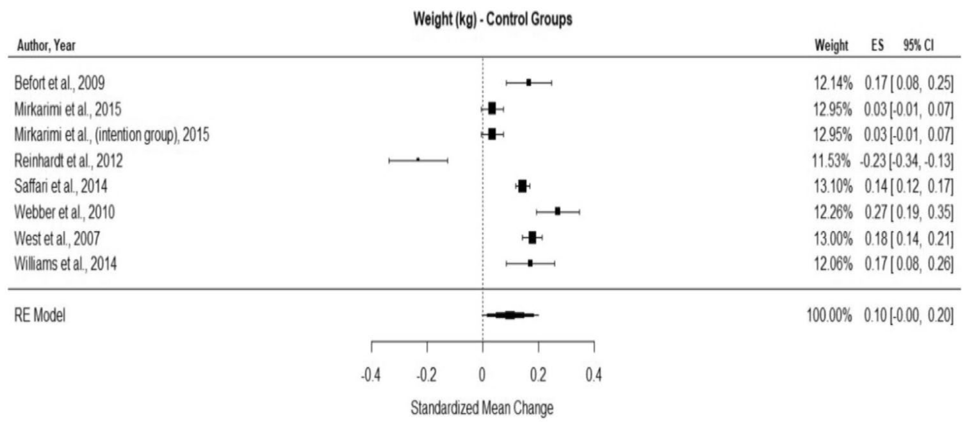

Fig. 3 Weight change control

Effect of MI on BMI

Five out of the six intervention arms that measured BMI reported statistically significantly lower BMI for the intervention group compared with the control group at post-testing [38–41]. The study that did not report statistically significant results for intervention compared with control (health education) did show a statistically significant BMI reduction within the intervention group from pre-to-post intervention [37] meaning all MI groups demonstrated significant BMI decline. The mean change in BMI (kg/m^2) among the intervention groups was – 1.54 compared with that of – 0.32 respective to the control groups with a difference of – 1.22, provided by the information in Table 2. All 5 studies, including 6 intervention groups, were included in the meta-analysis for BMI. While no significant publication bias was observed in the control groups ($z = -1.00$, $p = 0.32$), Egger's test did indicate possible publication bias for the intervention groups ($z = 2.64$, $p = 0.01$) measuring BMI. Therefore, a trim-and-fill analysis was used in place of the traditional random-effects model for the intervention groups; however, no filled studies were added (SE = 1.77), no change was observed in the effect size, and no significant changes were observed in the heterogeneity statistics. The pooled effect size of MI on change in BMI was 0.35 (95% CI 0.12, 0.58; $p < 0.01$), indicating a significant difference as depicted in Fig. 4. The pooled effect size for the respective control groups was 0.07 (95% CI – 0.08, 0.22; $p = 0.37$) indicating no significant difference as depicted in Fig. 5. However, high heterogeneity was present for both intervention $Q(5) = 220.5674$, $p < 0.0001$ ($I^2 = 98.10\%$) and control effects $Q(5) = 202.9125$, $p < 0.0001$ ($I^2 = 97.89\%$). Additionally, the difference between the intervention and control effects across studies was not significant, $t(8.60) = 2.08$, $p = 0.07$. The power for this analysis was also very low at 0.06, once again indicating the sample size was too low to detect a difference. Lastly, study length (in weeks) ($F(1,4) = 3.90$, $p = 0.12$) and number of sessions ($F(1,4) = 0.18$, $p = 0.69$) did not significantly influence changes in BMI. The influence of dosage (in minutes) on changes in BMI approached but did not reach significance ($F(1,4) = 7.58$, $p = 0.05$) and was in the expected, positive direction.

Secondary outcomes

Numerous study results reported additional secondary outcomes. Three out of four studies reporting waist

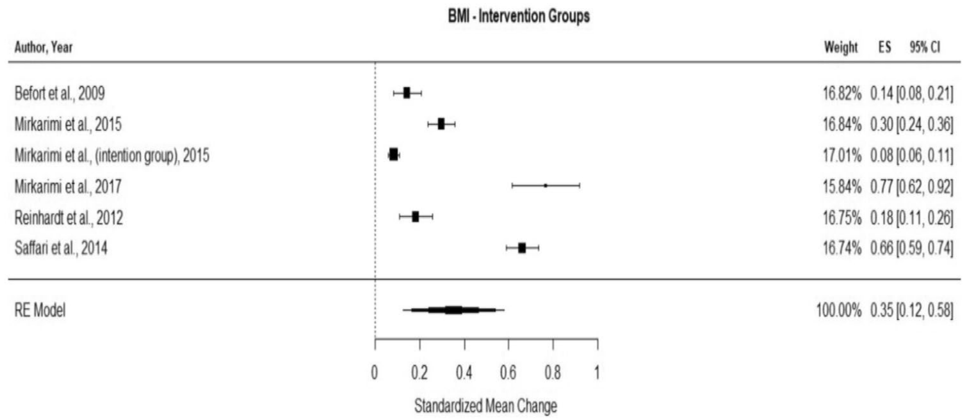

Fig. 4 BMI change intervention

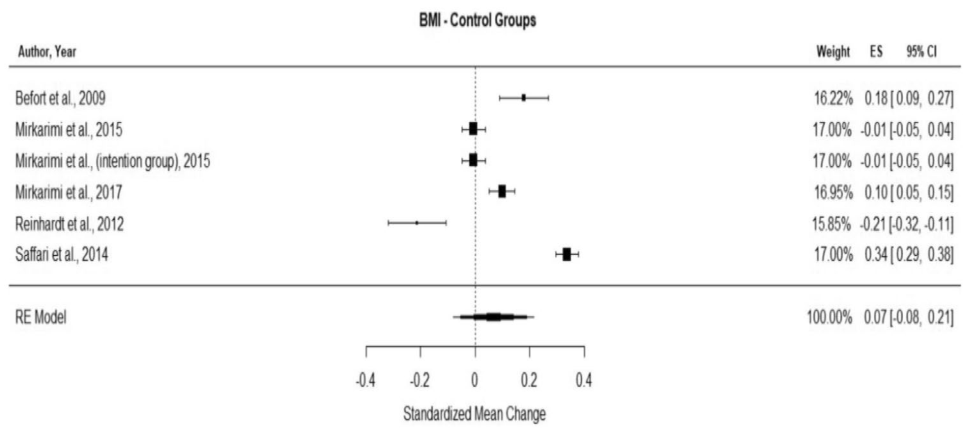

Fig. 5 BMI change control

circumference found significant decreases compared with the control group [40, 41, 45]. Webber et al. found that while there were no significant differences between groups, the MI group significantly lowered waist circumference [43]. Clinical outcomes included significant outcomes in blood pressure and A1C [42, 44, 45]. Several studies reported improvements in nutritional aspects such as increased fruit/vegetable consumption, caloric intake, fat intake, and carbohydrate consumption [37, 40, 41]. Some interventions reported psychological and motivational improvements as well, such as protection motivational theory constructs, autonomous motivation, and autonomous self-regulation [39, 42]. Two studies demonstrated increases in adherence or attendance to weight management programs [42, 44].

Intervention fidelity and MI training

Six intervention groups did state that the MI interventionist was trained [37, 38, 43–45]. Two studies reported that the interventionist was experienced in MI [40, 42]. In studies reporting training duration, this ranged from 2 to 5 days. Three studies implemented expert supervision during the study with feedback being provided to the interventionist delivering MI, as well as employing an intervention fidelity assessment plan, which included recording and scoring MI sessions for adherence to MI principles [37, 44, 45].

Risk of bias

Table 3 presents the methodological quality ratings of the 10 retained intervention arms. All studies were RCTs, which represents a consistent level of rigor among the body of work represented by the retained studies. With these interventions being randomized, a reduction in population bias and variance is present. Due to the nature of MI and behavioral interventions, blinding MI-trained professionals delivering MI cannot occur. All studies were free of major selective reporting and other biases. Allocation concealment was the domain most frequently rated as being unclear in risk level. Overall, the studies displayed a low risk of bias with these interventions displaying a high standard of methodological design.

Table 3 Assessment of methodological quality using Cochrane risk of bias tool

Source	Selection bias		Performance bias	Attrition bias	Reporting bias	Detection bias	Overall
	Sequence generation	Allocation concealment	Blinding	Incomplete data	Free of selective reporting	Other threats to validity	
Befort et al., 2008 [37]	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Mirkarimi et al., 2015 [38]	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Mirkarimi et al., 2015 (intention group) [38]	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Mirkarimi et al., 2017 [39]	Low risk	Unclear risk	Low risk	Low risk	Low risk	Low risk	Low risk
Reinhardt et al., 2012 [40]	Low risk	Unclear risk	Low risk	Low risk	Low risk	Low risk	Low risk
Saffari et al., 2014 [41]	Low risk	Unclear Risk	Low risk	Low risk	Low risk	Low risk	Low risk
Smith et al., 1997 [42]	Low risk	Unclear risk	Low risk	Low risk	Low risk	Low risk	Low risk
Webber et al., 2010 [43]	Low risk	Unclear risk	Low risk	Low risk	Low risk	Low risk	Low risk
West et al., 2007 [44]	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Williams et al., 2014 [45]	Low risk	Unclear risk	Low risk	Low risk	Low risk	Low risk	Low risk

Discussion

The purpose of this systematic review was to synthesize the current literature examining the use of MI and its impact on anthropometric measures among adult females. The results suggest that MI interventions provide positive anthropometric outcomes among females with six of the nine (67%) [38–41, 44, 45] intervention groups showing significant changes in weight compared with control groups and five out of six (83%) [38–41] intervention groups showing significant reductions in BMI compared with control groups. These results show greater MI effectiveness than a previous systematic review of adults in primary care where only 37.5% of studies showed a significant amount of weight loss compared with control groups [28]. On average, the nine MI groups that measured weight lost about 1.36 kg more than the control group, which is similar to a previous meta-analysis among overweight patients that found MI groups lost about 1.47 kg more than the control groups on average [27]. Studies measuring BMI demonstrated that on average, six MI groups lost about − 1.22 kg/m^2 more than the control, which is more effective than a previous meta-analysis that found MI groups lost about 0.25 kg/m^2 more than the control on average [27].

The interventions demonstrating significance between groups had similarities that are important to highlight. All seven of these intervention arms had at least five sessions of MI, with the average being about six sessions [38–41, 44, 45]. Our analysis showed a positive trend in regard to session length's effect on weight and dosage in minutes on BMI, possibly demonstrating the importance of numerous and longer MI contacts. While previous reviews specifically focused on anthropometric measures have yet to make this case, earlier reviews measuring MI's impact on numerous behaviors (substance abuse, diet, exercise, sexual behavior, gambling) compared with control groups demonstrated that higher dosage is associated with larger impact [24–26]. The interventions in this review also lasted relatively long, on average about 7.3 months. All but two [38] intervention groups lasted at least 24 weeks from the same study, demonstrating the time needed for MI to create behavioral adherence and the time needed for adherence to create weight changes. Our analysis further substantiates this with study length showing a positive trend on BMI. This falls in line with previous literature in this realm [27, 28]. Finally, one other commonality was the relatively large sample size. These seven interventions had an average sample size of about 131, with all but two [40, 45] interventions having at least 100 subjects. Previous research in this area does not touch upon this. As an a priori sample size, calculation was not reported; these findings may be due to the increased power associated with large sample sizes.

The three studies that did not demonstrate significant differences compared with a control [37, 42, 43] also have similarities that are important to note. All of these interventions had less than five MI sessions, with the average being three sessions, and further corroborates that the dose of MI is important. All of these interventions lasted 4 months, which is lower the average of 7.3 months of the studies demonstrating significant results. This adds to the inference that a longer-lasting invention may be needed for anthropometric outcomes. Finally, these interventions had a much smaller sample size with an average of 40 compared with that of 131.

Previous reviews have questioned the impact of MI on non-white women [27, 28]. These reviews found that most interventions were conducted among white women and those conducted with a larger share of other races/ethnicities (mostly African-American participants), the results suggested less impact [37, 42, 44], and it was suggested that more interventions include more diverse samples. These interventions were also included in this analysis; however, four new intervention arms that were not included in these reviews suggest that MI is effective among non-white participants. Four intervention groups were conducted in Iran and while a demographic breakdown was not given, based on the Iranian population, this intervention was likely conducted almost exclusively among those with a Middle Eastern descent [38, 39, 41]. These three intervention arms also had a high sample size ranging from 100–327, which is much higher than the two interventions with the largest African-American percentage [37, 42]. More research is needed to further substantiate these findings, especially among African Americans, Hispanics, and other minority groups.

Several studies reviewed in the full-text review tier included mixed sex samples but did not separate male/female results in reporting impact on target outcomes and were not retained in this review of MI impact on weight loss behaviors and outcomes in adult females. This issue may be the most critical and easy to resolve in future research. Future interventions should report a breakdown of sex-specific outcome results as this presents important information with implications for practice and research.

It is also a concern that many studies reported minimal MI training or fidelity details. Three intervention arms gave no mention of anything regarding the credibility of the MI interventionist [38, 41]. Two other studies did not provide information regarding the training of the deliverer other than the presence of prior experience [40, 42]. Seven of the 10 intervention arms gave no mention of fidelity assessment or measures, which is concerning due to the lack of evidence that MI-consistent interventions took place [38–43]. This mimics issues found in a previous review [28] with a lack of details regarding fidelity. Future studies should include details regarding training and fidelity measures to help make claims for validity for the MI intervention role in impacting outcomes.

Future studies would also benefit from utilizing recent advances in technology to detail changes in body composition. While utilizing weight, BMI, and waist circumference is useful and inexpensive, many changes in the body may go unnoticed. Utilizing the dual-energy X-ray absorptiometry (DEXA), for example, would provide information on segmental body fat percentage and segmental lean mass, and segmental bone mass density [47, 48] provides practitioners with useful information to inform person-centered decision-making and recommendations for strategies' impact (e.g., more weight bearing exercise, among others).

Future studies may also benefit from emphasizing recruitment strategies that will attract larger sample sizes. While it is not uncommon to have smaller sample sizes in studies that include intense commitment to behavior changes like those required of exercise and healthy eating, four of the 10 intervention groups had less than 50 participants, which challenges rigor of analyses as well as generalizations [37, 40, 42, 45]. Having a sample size this low may affect power and negatively influences the ability to detect differences in anthropometric outcomes. Furthermore, these studies would benefit from having an a priori sample size calculation reported.

,While the results suggest potential, these interventions do not describe why MI was impactful. The current status of research on the mechanisms of change of MI is in the beginning stages. One review was the first review to investigate mechanisms of change and found that client change talk/intention and client experience of discrepancy were related to better outcomes while therapist MI-inconsistent behavior was related to worse outcomes. It is important to mention the authors acknowledged numerous limitations and stressed many more studies are needed to quantify relationships [49]. Another review found that MI spirit and motivation were the most promising mechanisms of change in relation to health behavior [50]. It is important to note that the quality of the included studies was low and few qualitative studies were included. Both of these studies suggested that future studies would benefit from investigating a potential underlying theory. While few studies have delved into this area, there have been multiple calls for more information on the relationship between the self-determination theory (SDT) and MI from experts in both fields [51–53]. The SDT is a macro theory focused on determining the type of motivation, rather than simply assigning an amount of motivation [54]. The SDT addresses the social environment, specifically environments that bolster or inhibit motivation and have identified the three psychological needs of autonomy, relatedness, and competence that are integral to self-determined action [55]. SDT also suggests there is a continuum of motivation types [54]. This continuum moves left to right, spanning from amotivation motivation to internal motivation with external, introjected, identified, and integrated between representing various levels of internalization [56]. With the nature of MI being subject-centered, non-judgmental, and informative, the potential exists for MI to address the three psychological needs and increase more internal motivation that the SDT is based upon. Previous interventions have explored this relationship of MI and SDT in regard to weight management with positive results by having principles of both influences [57,58]. One intervention stated that the SDT informed their use of MI, and positive impact was found on anthropometric, physical activity, and SDT-related variables compared with a control [57]. Another study created a new intervention heavily influenced by MI and SDT called IMove and found an increase of moderate-vigorous physical activity compared with the control [58]. Future research should investigate this aspect of MI to provide insight into the mechanisms of change.

Limitations

While the methods employed were intended to pursue studies of valid and reliable rigor, it is important to mention potential limitations within this review. First, while these articles all focus on MI with adult females with the goal of making an impact on anthropometric measures, there was significant heterogeneity in the types of interventions, methods, and measures, challenging the ability to fully describe the ideal MI study design or protocol. The study duration, number of MI sessions, MI practitioner type, MI training, intervention fidelity assessment type (or absence), setting type, and other factors varied in a field that has a modest number of randomized controlled trials. While the body of work within this review makes a solid case for the potential of MI in various settings and approaches as a method to address to weight management among females, the generalizations are limited due to the differences; no single gold-standard type intervention protocol can be described from these findings.

An additional limitation of this review was the lack of inclusion for research not written in English. Not allowing interventions in other languages increases the potential for biased results, especially since the studies retained in this review mostly lacked diversity in participants. In the realm of behavior change research, many studies in real-world settings take place and have redeeming and practical qualities that can inform both practice and research. Future reviews might consider expanding the study inclusion criteria to consider what contributions rigorous non-RCT studies can make to exploring evidence and gaps in the literature, particularly in research in real-world settings where RCTs are uncommon or not feasible.

Conclusion

An MI approach has demonstrated a positive trend regarding anthropometric measures for females in weight management interventions. Empathic communication, non-judgmental responses, autonomy and self-efficacy support, and face-saving interventions, among other MI-based strategies, appear to have merit for consideration as an intervention framework for behavior changes that can have positive impact on females' anthropometric outcomes. Higher dosage and interventions taking place over several months appear to be important for impact on anthropometric outcomes. While more research is needed, health professionals may consider MI when treating or preventing excess weight gain among females' due to potential current and future associated health risks. Future research would benefit from focusing on larger and more diverse samples, utilizing updated technology for anthropometric outcomes, reporting more detail regarding training and fidelity information, and investigating the mechanisms of change in regard to MI and anthropometric outcomes.

Competing Interests

Dr. Kavookjian reports that she is on the Merck Speakers Bureau for non-product medical education for the topics of Motivational Interviewing, Shared Decision-Making and Health Literacy Communication; Dr. Kavookjian also consults for Merck as the motivational interviewing content expert for patient-centered education materials; Dr. Kavookjian also consults for MediMergent, LLC for motivational interviewing training.

Compliance with Ethical Standards

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

References

1. Collaborators GO. Health effects of overweight and obesity in 195 countries over 25 years. NEW ENGL J MED. 2017;377(1):13–27.
2. Bhaskaran K, Douglas I, Forbes H, dos-Santos-Silva I, Leon DA, Smeeth L. Body-mass index and risk of 22 specific cancers: a population-based cohort study of 5· 24 million UK adults. *Lancet.* 2014;384(9945):755–765.
3. National Heart, Lung, Blood Institute, National Institute of Diabetes, Digestive, & Kidney Diseases (US). Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: the evidence report (No. 98). 1998.

4. NHLBI Panel OE. Managing overweight and obesity in adults: systematic evidence review. 2013.
5. Kasen S, Cohen P, Chen H, Must A. Obesity and psychopathology in women: a three decade prospective study. Int J Obes. 2008;32(3):558.
6. Luppino FS, de Wit LM, Bouvy PF, et al. Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. Arch Gen Psychiatry. 2010;67(3):220–9.
7. Roberts RE, Deleger S, Strawbridge WJ, Kaplan GA. Prospective association between obesity and depression: evidence from the Alameda County Study. Int J Obes. 2003;27(4):514.
8. Finkelstein EA, Trogdon JG, Cohen JW, Dietz W. Annual medical spending attributable to obesity: payer-and service-specific estimates: amid calls for health reform, real cost savings are more likely to be achieved through reducing obesity and related risk factors. Health Aff. 2009;28(Suppl1):w822–31.
9. Trogdon J, Finkelstein EA, Hylands T, Dellea P, Kamal-Bahl S. Indirect costs of obesity: a review of the current literature. Obes Rev. 2008;9(5):489–500.
10. World Health Organization "Obesity and overweight." https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight#In_2016_39%_of_adults_tripled_between_1975_and_2016
11. Garawin F, Devries K, Thorogood N, Uauy R. Global differences between women and men in the prevalence of obesity: is there an association with gender inequality? Eur J Clin Nutr. 2014;68(10):1101–6.
12. Mayo Clinic. Exercise: 7 benefits of regular physical activity. https://www.mayoclinic.org/healthy-lifestyle/fitness/in-depth/exercise/art-20048389. Accessed December 14, 2019.
13. Warburton DE, Nicol CW, Bredin SS. Health benefits of physical activity: the evidence. CMAJ. 2006;174(6):801–9.
14. Guthold R, Stevens GA, Riley LM, Bull FC. Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1· 9 million participants. Lancet Glob Health. 2018;6(10):1077–86.
15. Ding D. Surveillance of global physical activity: progress, evidence, and future directions. Lancet Glob Health. 2018;6(10):1046–7.
16. Sabinsky MS, Toft U, Raben A, Holm L. Overweight men's motivations and perceived barriers towards weight loss. Eur J Clin Nutr. 2007;61(4):526–31.
17. Sharifi N, Mahdavi R, Ebrahimi-Mameghani M. Perceived barriers to weight loss programs for overweight or obese women. HPP. 2013;3(1):11.
18. Solbrig L, Jones R, Kavanagh D, May J, Parkin T, Andrade J. People trying to lose weight dislike calorie counting apps and want motivational support to help them achieve their goals. Internet Interv. 2017;7:23–31.
19. West DS, Gorin AA, Subak LL, et al. A motivation-focused weight loss maintenance program is an effective alternative to a skill-based approach. Int J Obes. 2011;35(2):259.
20. Elfhag K, Rössner S. Who succeeds in maintaining weight loss? A conceptual review of factors associated with weight loss maintenance and weight regain. OBES REV. 2005;6(1):67–85.
21. Silva MN, Markland D, Carraca EV, et al. Exercise autonomous motivation predicts 3-yr weight loss in women. Med Sci Sports Exerc. 2011;43(4):728–37.
22. Teixeira PJ, Going SB, Sardinha LB, Lohman T. A review of psychosocial pre-treatment predictors of weight control. OBES REV. 2005;6(1):43–65.
23. Miller WR, Rollnick S. *Motivational interviewing: helping people change*: Guilford press; 2012.
24. Burke BL, Arkowitz H, Menchola M. The efficacy of motivational interviewing: a meta-analysis of controlled clinical trials. J Consult Clin Psychol. 2003;71(5):843.
25. Lundahl BW, Kunz C, Brownell C, Tollefson D, Burke BL. A meta-analysis of motivational interviewing: twenty-five years of empirical studies. Res Soc Work Pract. 2010;20(2):137–60.
26. Rubak S, Sandbæk A, Lauritzen T, Christensen B. Motivational interviewing: a systematic review and meta-analysis. Br J Gen Pract. 2005;55(513):305–12.
27. Armstrong M, Mottershead T, Ronksley P, Sigal R, Campbell T, Hemmelgarn B. Motivational interviewing to improve weight loss in overweight and/or obese patients: a systematic review and meta-analysis of randomized controlled trials. OBES REV. 2011;12(9):709–23.
28. Barnes RD, Ivezaj V. A systematic review of motivational interviewing for weight loss among adults in primary care. OBES REV. 2015;16(4):304–18.
29. Higgins JP, Green S. *Cochrane handbook for systematic reviews of interventions* (Vol. 4): John Wiley & Sons; 2011.
30. Viechtbauer W. Conducting meta-analyses in R with the metafor package. J Stat Softw. 2010;36(3):1–48.
31. Egger M, Smith GD, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. BMJ. 1997;315(7109):629–34.
32. Duval SJ, Tweedie RL. Trim and fill: a simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. Biometrics. 2000a;56(2):455–63.
33. Duval SJ, Tweedie RL. A nonparametric "trim and fill" method of accounting for publication bias in meta-analysis. J Am Stat Assoc. 2000b;95(449):89–98.
34. Duval S. The trim and fill method. *Publication bias in meta-analysis: prevention, assessment and adjustments*. 2005;127–144.
35. Cohen J. A coefficient of agreement for nominal scales. EDUC PSYCHOL MEAS. 1960;20(1):37–46.
36. McHugh ML. Interrater reliability: the kappa statistic. Biochem Med. 2012;22(3):276–82.
37. Befort CA, Nollen N, Ellerbeck EF, Sullivan DK, Thomas JL, Ahluwalia JS. Motivational interviewing fails to improve outcomes of a behavioral weight loss program for obese African American women: a pilot randomized trial. J Behav Med. 2008;31(5):367.
38. Mirkarimi SK, Kabir MJ. Comparing the effect of motivational interviewing and standard nutrition education on promoting adherence to weight loss program in obese and overweight women: a randomized clinical trial. JMUMS. 2015;25(124):200–8.
39. Mirkarimi K, Kabir MJ, Honarvar MR, Ozouni-Davaji RB, Eri M. Effect of motivational interviewing on weight efficacy lifestyle among women with overweight and obesity: a randomized controlled trial. Iran J Med Sci. 2017;42(2):187.
40. Reinhardt JA, van der Ploeg HP, Grzegrzulka R, Timperley JG. Implementing lifestyle change through phone-based motivational interviewing in rural-based women with previous gestational diabetes mellitus. Health Promot J Austr. 2012;23(1):5–9.
41. Saffari M, Pakpour AH, Mohammadi-Zeidi I, Samadi M, Chen H. Long-term effect of motivational interviewing on dietary intake and weight loss in Iranian obese/overweight women. HPP. 2014;4(2):206.
42. Smith DE, Heckemeyer CM, Kratt PP, Mason DA. Motivational interviewing to improve adherence to a behavioral weight-control program for older obese women with NIDDM: a pilot study. Diabetes Care. 1997;20(1):52–4.
43. Webber KH, Gabriele JM, Tate DF, Dignan MB. The effect of a motivational intervention on weight loss is moderated by level of baseline controlled motivation. IJBNPA. 2010;7(1):4.
44. West DS, DiLillo V, Bursac Z, Gore SA, Greene PG. Motivational interviewing improves weight loss in women with type 2 diabetes. Diabetes Care. 2007;30(5):1081–7.
45. Williams L, Hollis JL, Collins CE, Morgan P. Can a relatively low-intensity intervention by health professionals prevent weight

gain in mid-age women? 12-month outcomes of the 40-Something randomised controlled trial. Nutr Diabetes. 2014;4(5):e116.
46. Faul F, Erdfelder E, Lang AG, Buchner A. G* Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences.
47. *Behav Res Methods*. 2007;39(2):175–91.
48. Svendsen OL, Haarbo J, Hassager C, Christiansen C. Accuracy of measurements of body composition by dual-energy x-ray absorptiometry in vivo. Am J Clin Nutr. 1993;57(5):605–8.
49. Visser M, Fuerst T, Lang T, et al. Validity of fan-beam dual-energy X-ray absorptiometry for measuring fat-free mass and leg muscle mass. J Appl Physiol. 1999;87(4):1513–20.
50. Apodaca TR, Longabaugh R. Mechanisms of change in motivational interviewing: a review and preliminary evaluation of the evidence. Addiction. 2009;104(5):705–15.
51. Copeland L, McNamara R, Kelson M, Simpson S. Mechanisms of change within motivational interviewing in relation to health behaviors outcomes: a systematic review. Patient Educ Couns. 2015;98(4):401–11.
52. Miller WR, Rollnick S. Meeting in the middle: motivational interviewing and self-determination theory. IJBNPA. 2012;9(1):25.
53. Vansteenkiste M, Sheldon KM. There's nothing more practical than a good theory: Integrating motivational interviewing and self-determination theory. Br J Soc Clin Psychol. 2006;45(1):63–82.
54. Markland D, Ryan RM, Tobin VJ, Rollnick S. Motivational interviewing and self–determination theory. J Soc Clin Psychol. 2005;24(6):811–31.
55. Deci EL, Ryan RM. Self-determination theory: a macrotheory of human motivation, development, and health. Can Psychol. 2008;49(3):182.
56. Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol. 2000;55(1):68.
57. Gourlan M, Sarrazin P, Trouilloud D. Motivational interviewing as a way to promote physical activity in obese adolescents: a randomised-controlled trial using self-determination theory as an explanatory framework. Psychol Health. 2013;28(11):1265–86.
58. Friederichs SA, Oenema A, Bolman C, Lechner L. Long term effects of self-determination theory and motivational interviewing in a web-based physical activity intervention: randomized controlled trial. IJBNPA. 2015;12(1):101.