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Impact of motivational interviewing as a follow-up to an exercise intervention among women with or at risk for metabolic syndrome: A randomized controlled trial

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Abstract

Objectives: Women have a higher prevalence of metabolic syndrome than their male counterparts, and interventions should target women with or at risk for metabolic syndrome. The objective of this study was to compare two intervention strategies on long-term outcomes following the completion of an exercise intervention.

Methods: Twenty-six women (M age = 43.35 ± 9.03) with at least one risk factor for metabolic syndrome were randomized into either a motivational interviewing group (n = 10) or self-regulation-based mobile messaging control group (n = 16) as a 12-week follow-up to a 10-week, 30-session exercise intervention. Outcomes of interest were body fat percentage, bone mineral density, waist circumference, systolic blood pressure, diastolic blood pressure, triglycerides, high-density cholesterol, and fasting blood glucose.

Results: Mixed ANOVAs revealed a significant effect for group × time for body fat percentage $F(1, 24) = 8.30$, $p = 0.01$, $\eta_p^2 = 0.26$, bone mineral density $F(1, 24) = 6.68$, $p = 0.02$, $\eta_p^2 = 0.22$, waist circumference $F(1, 24) = 10.35$, $p = 0.01$, $\eta_p^2 = 0.30$, triglycerides $F(1, 24) = 5.06$, $p = 0.03$, $\eta_p^2 = 0.17$, and systolic blood pressure $F(1, 24) = 5.39$, $p = 0.03$, $\eta_p^2 = 0.18$ all in favor of the motivational interviewing group after 12 weeks when compared to the self-regulation-based mobile messaging group. No significant effect for group × time was noted for diastolic blood pressure $p = 0.36$, $\eta_p^2 = 0.04$, high-density cholesterol $p = 0.08$, $\eta_p^2 = 0.12$, or fasting blood glucose $p = 0.85$, $\eta_p^2 = 0.01$ when comparing the motivational interviewing and self-regulation-based mobile messaging groups.

Conclusions: Motivational interviewing may be a more impactful solution to extend the effects of exercise intervention studies compared to a self-regulation-based mobile messaging control group. Future interventions should focus on increasing sample size, utilizing more objective measures of body composition, utilizing booster sessions, and increasing the length of follow-up periods.

Keywords

Body composition, bone health, diabetes/endocrinology, randomized trial, women's health

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Introduction

Metabolic syndrome occurs when a person has three or more risk factors including elevated waist circumference (WC), triglycerides (TG), systolic blood pressure (SBP), diastolic blood pressure (DBP), fasting blood glucose (FBG), and low high-density lipoproteins (HDL).[1,2] Metabolic syndrome is associated with numerous health concerns, including an increased risk for stroke (the fifth leading cause of death in the United States) and heart disease (the leading cause of death in the United States).[3] Furthermore, it appears evident

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that metabolic syndrome is taking a toll on the world's economy. It is estimated that the cost of the included risk factors of metabolic syndrome is in the trillions of dollars on a global scale.[4]

Among the US adults, the rate of metabolic syndrome increased from 25.3% in 1988–1994 to 34.2% in 2007–2012 with women showing a higher prevalence of metabolic syndrome (34.9%) compared to men (33.4%).[5] This same survey showed that the component with the most significant increase over time has been WC (among men: from 23.6% in 1988–1994% to 42.6% in 2007–2012; among women: from 38.2% to 60.9%) signaling that central obesity is a major issue among adult women. Interventions that target this growing health condition with specific attention focused on females are needed.

Recent meta-analysis/systematic reviews of exercise and dietary interventions to address metabolic syndrome have been conducted and have found lifestyle interventions to be effective in treating metabolic syndrome by improving all risk factors associated with metabolic syndrome.[6–9] Both exercise and dietary intake have been shown to improve metabolic syndrome independently and through combined usage. While exercise and healthy dietary habits have consistently been shown to improve various metabolic markers, adherence to these behaviors is low. Most adults do not meet physical activity (PA) recommendations,[10] and women engage in less PA than men.[11] According to a national survey, most women are also not meeting current dietary intake guidelines, with women of all ages on average consuming more saturated fat, sodium, added sugar, and fewer vegetables and fruits when compared to the guidelines.[12] Methods that increase adherence to these various health behaviors are needed. An additional issue that seems mostly unaddressed in the literature is more long-termed adherence to lifestyle interventions. Most of the interventions included in recent meta-analyses/systematic reviews are short-term in nature.[6–9] In fact, one meta-analysis only found one intervention that included a follow-up period longer than 1 year in duration and has called for more information on maintenance of lifestyle interventions.[9] Another review among lifestyle interventions for metabolic syndrome found that the largest area for improvement in the literature was longer-term maintenance after a short-term program.[13] One intervention within this review found that multiple follow-up boosters were effective in maintenance.[14] Another review for lifestyle modification interventions for metabolic syndrome concluded that patient motivation was the key factor in adherence to behaviors that can treat metabolic syndrome and the authors suggested that perhaps the best strategy moving forward should include tailoring to the participant's needs and preferences.[15]

One method that can fulfill these gaps in the literature is motivational interviewing (MI). MI is an empathetic and person-centered communication skill set that includes elicitation of change talk, autonomy and self-efficacy support, a compassionate and nonjudgmental approach, among others.[16] MI has demonstrated success in several areas related to metabolic syndrome including type 2 diabetes management,[17] weight management for overweight children,[18] overweight adults in primary care,[19] and overweight women.[20] Because of its person-centered, tailored approach, MI is complex and requires evidence-based training to achieve a beginner-level proficiency (90% MI adherent). In addition to training, optimal methods in a study based on MI intervention must include implementation of MI intervention fidelity assessment to examine the consistency of MI in study encounters to make claims for validity for the MI basis of the intervention.

MI has been used to address both PA and dietary habits and has demonstrated initial potential in long-term weight maintenance as a follow-up to an obesity treatment program.[21] MI has also been utilized on a few occasions for PA, nutrition, and/or weight loss among women with or at risk for metabolic syndrome.[22–24] To our knowledge, MI has yet to be utilized as a follow-up to a structured exercise program among women with or at risk for metabolic syndrome. Therefore, the purpose of this study is to compare an MI intervention to a self-regulation-based mobile messaging intervention (SRM) as a follow-up to an exercise training program for various outcomes (BF%, BMD, WC, TG, SBP, DBP, FBG, and HDL). The SRM group was chosen as the control group because self-regulation is a key mediator in behavior change in women,[25–27] and an SRM group has been utilized in a previous intervention for PA promotion with success.[25] Excessive weight is intertwined with metabolic syndrome and is a massive problem in the United States, but weight regain after weight loss also presents a problem. Despite many lifestyle interventions being effective in clinical weight loss, 40%–65% of participants do not maintain clinical weight loss.[28] This influenced our decision to create this study comparing these two groups to detail the impact on the maintenance of various outcomes related to anthropometric status and metabolic markers after an exercise trial.

Methods

Nature of the study

The design of this intervention was a 12-week, randomized controlled trial (RCT) that served as a follow-up to a separate exercise intervention. The two groups were MI and SRM groups (which served as the control group). The objective of this study was to detail whether there were any significant differences between these two unique groups in various quantitative outcomes related to anthropometrics and metabolic syndrome markers after an exercise trial. A full-board research protocol document was submitted to the Institutional Review Board for Research Involving Human Subjects (IRB) under protocol number 18-323AR1809 for this intervention. The registered clinical trial number for this RCT is NCT04751240. A CONSORT 2010 checklist of information to include when

reporting a randomised trial has been provided in the supplementary materials. All data were collected within a laboratory at a university in the southeastern portion of the United States. Although separate from this RCT, it is important to note all participants were previously enrolled in a 10-week, sprint interval training/weight-lifting program. The exercise program targeted women with at least one risk factor for metabolic syndrome and consisted of 30 supervised exercise sessions (three times a week for 10 weeks) that combined sprint interval training on the treadmill with resistance training. At the end of the prior exercise program, participants were randomized to receive either monthly MI sessions or weekly SRM based on social cognitive theory constructs for an additional 3 months. The 3-month follow-up period was chosen as a result of resources available to carry out the intervention. Randomization occurred by a flip of a coin by a research assistant with heads resulting in randomization into the MI group and tails resulting in randomization into the SRM group. The same research assistant enrolled the participant and allocated them to the respective group after the coin-flip. All measures were assessed prior to randomization and at the end of the study 12 weeks later. An a priori sample size was computed using G-power[29] and estimated at 68 (34 per group). It is important to note this calculation utilized an effect size of 0.51 that was found in a meta-analysis for interventions using MI for weight loss in RCTs among overweight or obese patients and none of the included studies were used as an adjunct to an exercise program.[19] Less than 68 participants were recruited for the initial study and the decision was made to conduct the follow-up intervention regardless of sample size due to the lack of interventions utilizing MI as a follow-up to an exercise intervention among women with/at-risk for metabolic syndrome as the knowledge gained would still be useful. No changes to protocol, eligibility criteria, etc., after the onset of the study.

Participants

Female participants were initially recruited for the exercise protocol by health fairs, word of mouth, e-mail, flyers, and social networks from a community in the southeastern portion of the United States located near a university in the spring of 2019. Participants were then recruited to join this follow-up intervention after the completion of the exercise intervention in the summer of 2019. Prior to randomization, all participants completed the informed consent process for both participation and publication via written informed consent. The initial inclusion criteria for the prior exercise protocol were: (1) between the age of 25 and 55; (2) met at least one of the criteria for clinical metabolic syndrome based on the 2009 Joint Interim Statement of the International Diabetes Federation Task Force on Epidemiology and Prevention[30] found in Table 1; (3) aside from risk factors for metabolic syndrome, healthy as determined by the Physical Activity Readiness Questionnaire plus (PAR-Q+)[31]; (4) not pregnant; and (5) not currently engaged in any structured PA program. The PAR-Q+ that was utilized has been provided in the supplementary materials. For this follow-up intervention, the inclusion criteria were (1) completed post-testing of the prior exercise intervention and (2) not pregnant.

Table 1. Criteria for metabolic syndrome for the US women.

Measure	Variable cutoff
WC	⩾88 cm
TG	⩾150 mg/dL or on drug treatment for elevated TG
Blood pressure	⩾130 mmHg SBP or ⩾85 mmHg DBP or on antihypertensive drug treatment
FBG	⩾100 mg/dL or on drug treatment for elevated glucose
HDL	⩽50 mg/dL or on drug treatment for reduced HDL

DBP: diastolic blood pressure; FBG: fasting blood glucose; HDL: high-density cholesterol; SBP: systolic blood pressure; TG: triglycerides; WC: waist circumference.

MI group

Participants receiving MI sessions were scheduled to attend monthly sessions for 3 months (three sessions in total over 12 weeks). All sessions were delivered in-person and one-on-one by an MI-trained, exercise physiologist. These sessions lasted 20–30 min and covered multiple topics centering on PA and eating habits. Strategies utilized included: asking open-ended questions, using reflections and empathic responding, rolling with resistance, exploring ambivalence, and using agenda-setting to support autonomy, among other common MI strategies.[16] Examples of these stratigies have been provided in the supplementary materials.

MI training and fidelity

The interviewer in this intervention underwent extensive evidence-based MI training over 16 weeks before implementation. The training included origins and philosophy of MI, MI conceptual development, watching and critiquing example videos, several applied exercises, and multiple rounds of small group role-play with feedback and coaching from peers and an MI expert. This training has a 20-year history and was developed and evolved in accordance with training practices noted in systematic reviews of MI training studies.[32,33]

Fidelity assessment for MI adherence was employed to establish the validity of MI as the basis for the intervention. All interviews were audio-recorded and coded for fidelity utilizing the measure, Motivational Interviewing Skills in Health Care Encounters (MISHCE), which was developed based on the MI training model used in this study.[34] The MISHCE was first used post-training to assess interventionist baseline MI proficiency in an 8-min simulated encounter with a trained standardized patient. The first use of the MISHCE within the study was to provide initial feedback

during the first month of interviews; the first five participant encounters were coded, and feedback was then provided to the interventionist to promote self-awareness of strengths and areas for improvement. In addition, a random sample (20%) of the encounter recordings across the study was assessed for MI fidelity by an MI expert experienced with using the MISHCE. According to MI scholars (Miller, Moyers, and others), achieving at least 90% MI consistency is a key threshold to strive for in intervention studies.[35]

SRM group

Participants in the SRM (which served as the control group in this study) group received text messages and emails on a weekly basis that contained information and videos, based on self-regulation for 3 months (12 weeks). These weekly messages and videos focused on increasing self-regulation skills (time management, self-monitoring, reinforcements, social support, goal setting, dietary, and overcoming barriers). This protocol follows a similar structure to previous research.[25–27,36] Throughout the intervention, 12 text messages (once per week) and 6 e-mails (once every 2 weeks) were sent. The texts and emails were standardized and did not differ based on goals or initial measurement. Participants could respond to the texts and emails and ask for further information and/or clarification.

Body composition

All outcomes were assessed by researchers blind to group allocation. No changes to outcomes were made after the onset of the study. The iDexa was utilized to measure body composition among the participants. Participants were scanned in a fasted state (no nutritional intake for 8 h) by trained personnel. The iDexa utilizes dual-energy X-ray absorptiometry which provides accurate data related to body composition in terms of fat mass, lean mass, bone mineral density (BMD).[37,38] Specifically, variables of interest for this study included body fat percentage (BF%) and BMD (g/cm^2). Previous interventions have a detailed precision error for total body mass 0.9%, total body lean mass 0.4%–0.5%, total bone mineral content 0.6%, fat mass 0.7%–0.8%, and BF% 0.6%–0.9%.[39–41] While WC is a measure of anthropometrics and included in the metabolic risk factors, it does not take into consideration factors such as bone density or muscle mass. As this intervention took place after an intensive exercise intervention, which included resistance exercise, it was important to detail any changes in these variables after the follow-up. BF% is important as it is influenced by both fat mass and lean mass, and the impact of either of these may not be detected by WC alone. It has also been demonstrated that metabolic syndrome may have a positive relationship with BMD (metabolic syndrome prevalence may be associated with higher BMD).[42,43] This may arise due to a typically higher weight, which may mechanically put more load on the bone. While a positive in terms of overall health status, as metabolic syndrome risk factors decrease, it is unknown whether this could have a negative impact on BMD.

Metabolic markers

Fasting capillary blood was drawn after an 8-h fast and was assayed for FBG, HDL, and TG by a trained phlebotomist. Participants were asked to sit comfortably in the blood collection chair for blood to be drawn (5 μL) from a fingerstick using a 28-gauge lancet (Unistick 3 comfort, Owen Mumford, Marietta, GA) which was collected in a lithium heparin-coated capillary tube. This capillary tube transported blood to a cassette loaded into the Alere Cholestech LDX (Alere San Diego, Inc., San Diego, CA) for analysis.

Blood pressure

SBP and DBP were measured with a sphygmomanometer and blood pressure cuff (Welch Allyn Inc., Skaneateles, NY). Participants currently on blood pressure medication were asked to take their medication after blood pressure was measured on that day.

Waist circumference

Waist circumference was measured at the top of the right iliac crest and placing a Gulick tension rod measuring tape in a horizontal plane around the abdomen and level of the iliac crest. Measurements were made at the end of a normal expiration.[44]

Statistical analysis

Mixed ANOVAs assessed for statistically significant differences in variables. The mixed ANOVA allows for testing at the interaction of a between-subjects factor (MI versus SRM in the present study) and a within-subjects factor (pre- and post-test in the present study). In the present study, the post-testing of the previous exercise intervention is being considered "pretesting." Post-testing took place 3 months later. Although the sample size under analysis was smaller than is typically expected in an ANOVA design, it was still the appropriate choice as the model's statistical assumptions were met.[45] G*power indicated a required sample size of 68. Probability values of $p < 0.05$ were considered significant.

Results

A total of 41 subjects completed the prior exercise program and were asked to participate in this follow-up RCT; 36 agreed to participate and were randomized to either MI or SRM groups. Table 2 describes the 36 subjects in detail. There were no baseline differences between groups after

Table 2. Means, percentages, and SD for baseline demographic characteristics.

Variable	MI (n = 16)	SRM (n = 20)	Total (n = 36)
Age	44.30 (9.34)	41.98 (8.33)	43.01 (9.37)
WC (cm)	106.22 (16.89)	105.32 (15.67)	105.72 (16.13)
SBP (mmHg)	126.76 (15.91)	125.66 (12.23)	126.15 (13.79)
DBP (mmHg)	79.22 (7.23)	78.96 (6.86)	79.08 (7.04)
TG (mg/dL)	106.97 (45.89)	109.88 (44.78)	108.59 (44.95)
FBG (mg/dL)	90.78 (8.43)	89.76 (8.35)	90.21 (8.39)
HDL (mg/dL)	53.47 (17.81)	50.66 (16.79)	51.91 (17.11)
% White	56.25%	65.00%	61.11%
% Black	37.50%	25.00%	30.56%
% Hispanic	6.25%	10.00%	8.33%

DBP: diastolic blood pressure; FBG: fasting blood glucose; HDL: high-density cholesterol; MI: motivational interviewing; SBP: systolic blood pressure; SD: standard deviation; TG: triglycerides; SRM: self-regulation messaging; WC: waist circumference.

randomization based on the outcomes of interest or demographic information. Five subjects dropped out before receiving their first dose of intervention (three participants cited lack of time for the intervention and two participants declined to respond), while another five subjects failed to attend post-testing (all five declined to respond). In total, 26 subjects were included in the data analysis. No adverse events occurred during the intervention. Figure 1 describes the CONSORT flow diagram.

Body composition

Table 3 displays mean values of outcomes from pre to post for both groups. A significant effect for group × time was noted for BF% $F(1, 24) = 8.30$, $p = 0.01$, $\eta_p^2 = 0.26$. The MI group had a decrease in BF% ($M = -1.5\%$) compared to the increase within the SRM group ($M = 1.47\%$). A significant effect for group × time was noted for BMD, $F(1, 24) = 6.68$, $p = 0.02$, $\eta_p^2 = 0.22$. The MI group had no change, while the SRM group had a decrease ($M = -0.07\,g/cm^2$).

Metabolic markers

A significant effect for group × time was noted for WC, $F(1, 24) = 10.35$, $p = 0.01$, $\eta_p^2 = 0.30$. The MI group had a reduction in WC ($M = -2.07$ cm), while the SRM group had an increase ($M = 3.16$ cm). A significant effect for group × time was noted for TG, $F(1, 24) = 5.06$, $p = 0.03$, $\eta_p^2 = 0.17$. The MI group had a decrease ($M = -7.4$ mg/dL), while the SRM group had an increase ($M = 26.5$ mg/dL). A significant effect for group × time was found for SBP, $F(1, 24) = 5.39$, $p = 0.03$, $\eta_p^2 = 0.18$. The MI group had a reduction in SBP ($M = -4$ mmHg), while the SRM group had an increase ($M = 2.12$ mmHg). No significant effect for group × time was noted for DBP $F(1, 24) = 0.87$, $p = 0.36$, $\eta_p^2 = 0.04$, HDL $F(1, 24) = 3.35$, $p = 0.08$, $\eta_p^2 = 0.12$, or FBG $F(1, 24) = .04$, $p = 0.85$, $\eta_p^2 = 0.01$. Observed power failed to reach 0.80 in all but one (WC = 0.87) of the variables for group × time interaction with a range of 0.79 and 0.05.

Attendance

In the MI group, 86.67% of the sessions were attended. All subjects that attended post-testing, participated in at least two of the three MI sessions. In the SRM group, 85.93% of the weekly text messages were responded, while 52.08% of the biweekly emails were responded too by the participants.

Motivational interviewing fidelity assessment

The initial MI fidelity assessment which was conducted right after the training included the use of the MISHCE for MI expert evaluation of the interventionist's MI consistency in an 8-min recorded encounter with a trained, standardized patient. The interventionist was 97.2% MI consistent in that encounter. For the random sample of encounters, the sample was stratified by encounters in approximately the first half of the study and encounters in the second half of the study. The mean fidelity score (percentage of MI consistency) for the first half sample was 93.45% and was 96.65% for the second half sample; the total fidelity for the entire sample was 95.2%, which is 5.20% higher than the previously noted 90% threshold established by MI assessment scholars. None of the sessions were rated at below 90% MI consistent, with 92.3% being the lowest individual score and 96.98% being the highest.

Discussion

This RCT lends itself to the small base of literature for use of MI for PA, nutrition, and/or weight loss among women that have or are at risk for metabolic syndrome.[22–24] Blackford et al.[22] found a significant improvement in moderate PA, fiber intake, fat intake, and vegetable intake among the MI group compared to a control. Another study found significant improvements in weekly PA and percentage of participants with metabolic syndrome in the telephone MI group compared to a usual care control.[23] One last study found that a computer program based on motivational theories including MI found significantly more cases of participants losing at least 5% of their body weight compared to a control.[24] With this RCT, we have demonstrated significant effectiveness of MI when compared to an SRM group in regards to body composition and several metabolic markers. Our intervention does appear to be the first case of MI being used as a follow-up intervention among those with/at risk for metabolic syndrome and perhaps indicates potential for sustainability after more intensive programs. Future studies should validate these findings.

This RCT acted upon many of the findings laid out by authors conducting reviews for lifestyle modification among

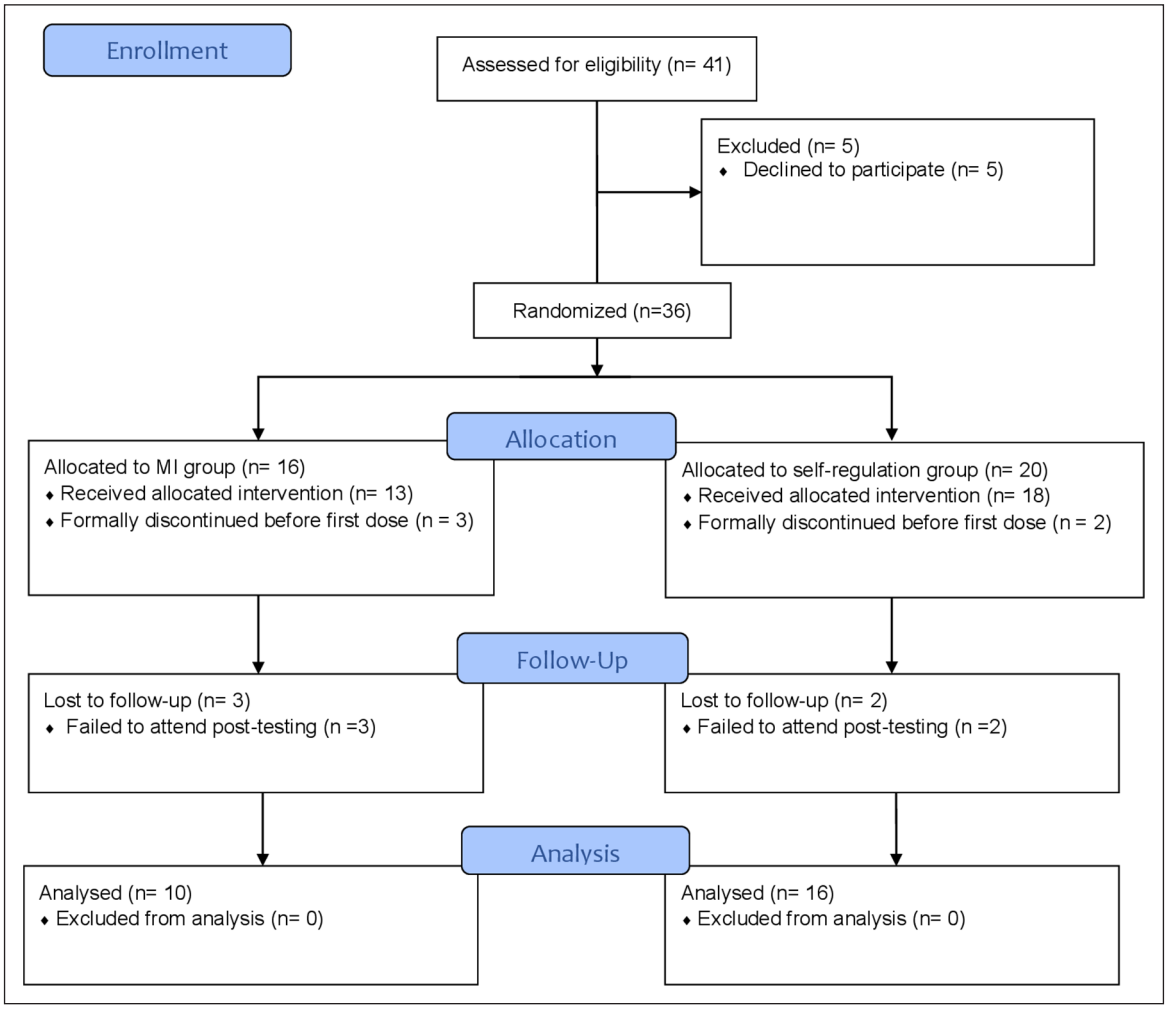

Figure 1. A CONSORT 2010 flow diagram.

Table 3. Mean (SD) values for body composition and metabolic markers by treatment condition.

Variable	MI Pre	MI Post	SRM Pre	SRM Post	p	Effect size (η_p^2)
Body composition						
BF %	42.27 (12.04)	40.77 (10.92)	43.29 (10.42)	44.76 (11.20)	0.01*	0.26
BMD	1.21 (.13)	1.21 (.11)	1.27 (.12)	1.20 (.10)	0.03*	0.18
Metabolic markers						
WC	105.30 (17.11)	103.23 (16.74)	104.18 (15.67)	107.35 (16.14)	0.01*	0.30
SBP	127.80 (16.37)	123.80 (11.76)	124.88 (11.62)	127.00 (15.09)	0.03*	0.18
DBP	78.40 (7.59)	77.00 (6.68)	78.38 (6.21)	79.25 (7.69)	0.36	0.04
TG	106.50 (45.61)	99.10 (45.73)	111.75 (44.63)	138.25 (44.14)	0.03*	0.17
FBG	90.30 (8.51)	90.50 (4.33)	89.13 (8.40)	89.87 (7.18)	0.85	0.01
HDL	54.10 (19.89)	45.70 (21.47)	49.87 (15.58)	48.50 (12.65)	0.08	0.12

DBP: diastolic blood pressure; FBG: fasting blood glucose; HDL: high-density cholesterol; MI: motivational interviewing; SBP: systolic blood pressure; SD: standard deviation; TG: triglycerides; SRM: self-regulation messaging; WC: waist circumference.
*A significant change ($p < 0.05$).

those with metabolic syndrome.[13,15] This intervention utilized follow-up booster sessions for maintenance after a short-term, intensive exercise program, which addressed gaps and suggestions made by one review.[13] The MI group also focused heavily on the participant's motivations and tailored each session based on the participant's desires, which

also acted upon findings from the literature,[15] whereas the SRM group provided general nontailored information. Based on the results from this study, there may be potential for MI to help sustain effects following an intensive exercise intervention regarding body composition and metabolic markers when compared to an SRM group, though future researchers should continue to investigate this.

This study adds to the growing literature for weight management-based MI among adults. Two meta-analyses of RCTs measured anthropometric changes after MI interventions. One meta-analysis found MI groups lost 1.47 kg more in weight and 0.25 kg/m^2 more in BMI than control groups.[19] Another meta-analysis specifically focusing on women, found MI groups lost 1.36 kg more in weight and 1.22 kg/m^2 more in BMI more than control groups.[20] Within the current intervention, females in the MI group had a difference of about −3 BF% and −5.23 cm in WC when compared to the SRM group. This adds to the growing evidence base demonstrating the potential of MI and weight management. It is also evident that weight and BMI are the most common anthropometric measures for MI interventions and have been specifically mentioned as a limitation of the current literature.[20] Only one prior MI intervention utilizing the iDexa exists to our knowledge and was conducted among college students during the COVID-19 pandemic.[46] Suire et al.[20] found a significant difference of 2.43 BF% in favor of the MI, which is comparable to the 3% difference found in the current study. Suire et al.[20] also found a nonsignificant difference of 0.01 g/cm^2 in BMD between groups, which is less than the significant difference of 0.07 g/cm^2 found in the current study. When comparing these results, it is important to mention the prior intervention by Suire et al.[20] utilized six MI sessions over 6 months and was the only aspect of the intervention. The current intervention employed three MI sessions over 3 months and was used as a follow-up to an intensive, exercise intervention. While these interventions are unique in nature, they both demonstrate the potential of MI for body composition outcomes. Future interventions that utilize technology like the iDexa are needed to validate these findings as neither weight nor BMI provides information regarding body composition.

When comparing this intervention to the MI weight management literature, there are differences worth stating. This research acted upon gaps in the literature identified in previous research,[18–20] which was the lack of training and fidelity information. This information is imperative to establish future standards for ensuring that MI was delivered at an adherence threshold determined to be effective by MI experts. As per fidelity scores, MI adherence was upheld during the intervention, supporting claims for validity that MI was the core component of this intervention that impacted the outcomes as described. Future interventions should report both detailed training information and fidelity results to strengthen MI interventions and provide a base of evidence. Using the most recent meta-analysis/systematic review for weight management-based MI among women, more successful interventions had five sessions of MI, whereas studies that were not as successful had an average of three sessions.[20] Another review found interventions that employed at least three sessions, lasting 4–5 h tended to be more impactful.[47] The literature could be improved by further investigation on dosage so that a standard can be established for future interventions. The current intervention utilized three sessions over 3 months and found significantly improved outcomes compared to the SRM group. While much more research is needed, this may point to fewer sessions being needed in follow-up interventions, though the context is unique in this study and generalizations are limited. The attrition rate within this intervention (28%) was larger than expected when using the average attrition rate of about 20% within the literature.[19] This is especially true for the MI group where there was a 37.5% attrition rate compared to the 20% attrition rate of the SRM group. This may point to a weakness of MI for follow-up interventions or perhaps a key difference between a more demanding onsite method (MI group) and a less demanding remote method (SRM) though future research is needed. It is unknown if additional measures are needed to prevent large attrition for follow-up MI interventions.

Limitations

Perhaps, the largest limitation of this study was the small sample size. With 26 subjects in total, the power of almost all interactions is low. Related to this limitation is the attrition rate. It is also worth mentioning that the attrition rate for the MI group was much higher compared to the SRM group. Future studies should include strategies for recruiting and retaining participants over the course of a study. In future interventions, a larger and more diverse sample size should be sought and maintained so that stronger generalizations can be made. Incentives have been utilized in weight-loss interventions to increase adherence with success[48] and have been utilized in conjunction with MI[49] though more research is needed. Our low sample size also ensured the lack of an analysis based on dose. Future studies should include dosage in the analysis to make inferences regarding dosage impact on outcomes, especially in follow-up interventions. Finally, measures of PA and nutrition were not collected during this intervention as we focused attention on body composition and metabolic markers. Future studies should include measures of behaviors related to anthropometric status as more information is needed on why MI interventions may lead to improved anthropometric outcomes.

Conclusion

MI demonstrated potential in body composition maintenance when compared to an SRM intervention among women with or at risk for metabolic syndrome. This adds to the growing

literature base demonstrating the positive impacts of MI on weight management. Future studies would enhance the literature by focusing on increasing and diversifying the sample, conducting analyses based on dosage, measuring behaviors related to weight management utilizing MI for booster sessions after exercise programs, and investigating longer follow-up periods.

Declaration of conflicting interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Dr Kavookjian reports that she is on the Merck Speakers Bureau for nonproduct 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.

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Ethical approval

A full-board research protocol document was submitted to the Institutional Review Board for Research Involving Human Subjects (IRB) under protocol number 18-323AR1809 for this intervention.

Informed consent

Prior to randomization, all participants completed the informed consent process for both participation and publication via written informed consent.

Trial registration

The registered clinical trial number for this study is NCT04751240.

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Supplemental material

Supplemental material for this article is available online.

References

1. Mayo Clinic. Metabolic Syndrome. https://www.mayoclinic.org/diseases-conditions/metabolic-syndrome/symptoms-causes/syc-20351916 (accessed 28 June 2021).
2. National Heart, Lung, and Blood Institute. Metabolic Syndrome. https://www.nhlbi.nih.gov/health-topics/metabolic-syndrome (accessed 28 June 2021).
3. Kochanek KD, Murphy SL, Xu J, et al. Deaths: final data for 2017. *Natl Vital Stat Rep* 2019; 68(9): 1–77.
4. Saklayen MG. The global epidemic of the metabolic syndrome. *Curr Hypertens Rep* 2018; 20(2): 1–8.
5. Moore JX, Chaudhary N and Akinyemiju T. Metabolic syndrome prevalence by race/ethnicity and sex in the United States, National Health and Nutrition Examination Survey, 1988–2012. *Prev Chronic Dis* 2017; 14: 160287.
6. Ostman C, Smart NA, Morcos D, et al. The effect of exercise training on clinical outcomes in patients with the metabolic syndrome: a systematic review and meta-analysis. *Cardiovasc Diabetol* 2017; 16(1): 110.
7. Wewege MA, Thom JM, Rye KA, et al. Aerobic, resistance or combined training: a systematic review and meta-analysis of exercise to reduce cardiovascular risk in adults with metabolic syndrome. *Atherosclerosis* 2018; 274: 162–171.
8. Lee G, Choi HY and Yang SJ. Effects of dietary and physical activity interventions on metabolic syndrome: a meta-analysis. *J Korean Acad Nurs* 2015; 45(4): 483–494.
9. van Namen M, Prendergast L and Peiris C. Supervised lifestyle intervention for people with metabolic syndrome improves outcomes and reduces individual risk factors of metabolic syndrome: a systematic review and meta-analysis. *Metabolism* 2019; 101: 153988.
10. Piercy KL, Troiano RP, Ballard RM, et al. The physical activity guidelines for Americans. *JAMA* 2018; 320(19): 2020–2028.
11. World Health Organization. Physical Activity Women. https://www.who.int/dietphysicalactivity/factsheet_women/en/ (accessed 3 December 2020).
12. NHANES. What we eat in America, 2017–2018, individuals 2 years and over (excluding breast-fed children), day 1. https://www.ars.usda.gov/nea/bhnrc/fsrg (accessed 28 June 2021).
13. Fappa E, Yannakoulia M, Pitsavos C, et al. Lifestyle intervention in the management of metabolic syndrome: could we improve adherence issues. *Nutrition* 2008; 24(3): 286–291.
14. Muzio F, Mondazzi L, Sommariva D, et al. Long-term effects of low-calorie diet on the metabolic syndrome in obese nondiabetic patients. *Diabetes Care* 2005; 28(6): 1485–1486.
15. Bassi N, Karagodin I, Wang S, et al. Lifestyle modification for metabolic syndrome: a systematic review. *Am J Med* 2014; 127(12): 1242.e1.
16. Miller WR and Rollnick S. *Motivational interviewing: helping people change*. New York, NY: Guilford Press, 2012.
17. Thepwongsa I, Muthukumar R and Kessomboon P. Motivational interviewing by general practitioners for Type 2 diabetes patients: a systematic review. *Fam Pract* 2017; 34(4): 376–383.
18. Suire KB, Kavookjian J and Wadsworth DD. Motivational interviewing for overweight children: a systematic review. *Pediatrics* 2020; 146(5): e20200193.
19. Armstrong M, Mottershead T, Ronksley P, et al. 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): 709–723.
20. Suire KB, Kavookjian J, Feiss R, et al. Motivational interviewing for weight management among women: a meta-analysis and systematic review of RCTs. *Int J Behav Med* 2021; 28(4): 403–416.
21. 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 (Lond)* 2011; 35(2): 259–269.
22. Blackford K, Jancey J, Lee AH, et al. Effects of a home-based intervention on diet and physical activity behaviours for rural adults with or at risk of metabolic syndrome: a randomised controlled trial. *Int J Behav Nutr Phys Act* 2016; 13(1): 13.

23. Lin CH, Chiang SL, Heitkemper MM, et al. Effects of telephone-based motivational interviewing in lifestyle modification program on reducing metabolic risks in middle-aged and older women with metabolic syndrome: a randomized controlled trial. *Int J Nurs Stud* 2016; 60: 12–23.
24. Christian JG, Byers TE, Christian KK, et al. A computer support program that helps clinicians provide patients with metabolic syndrome tailored counseling to promote weight loss. *J Am Diet Assoc* 2011; 111(1): 75–83.
25. Gell NM and Wadsworth DD. The use of text messaging to promote physical activity in working women: a randomized controlled trial. *J Phys Act Health* 2015; 12(6): 756–763.
26. Gell NM and Wadsworth DD. How do they do it: working women meeting physical activity recommendations. *Am J Health Behav* 2014; 38(2): 208–217.
27. Wadsworth DD and Hallam JS. Effect of a web site intervention on physical activity of college females. *Am J Health Behav* 2010; 34(1): 60–69.
28. Jensen MD, Ryan DH, Apovian CM, et al. AHA/ACC/TOS guideline for the management of overweight and obesity in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society. *Circulation* 2014; 129: S102–S138.
29. Faul F, Erdfelder E, Lang AG, et al. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods* 2007; 39(2): 175–191.
30. Alberti KG, Eckel RH, Grundy SM, et al. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. *Circulation* 2009; 120(16): 1640–1645.
31. Warburton DE, Jamnik VK, Bredin SS, et al. The physical activity readiness questionnaire for everyone (PAR-Q+) and electronic physical activity readiness medical examination (ePARmed-X+). *Health Fit J Can* 2011; 4(2): 3–17.
32. Madson MB, Loignon AC and Lane C. Training in motivational interviewing: a systematic review. *J Subst Abuse Treat* 2009; 36(1): 101–109.
33. Söderlund LL, Madson MB, Rubak S, et al. A systematic review of motivational interviewing training for general health care practitioners. *Patient Educ Couns* 2011; 84(1): 16–26.
34. Petrova T, Kavookjian J, Madson MB, et al. Motivational Interviewing Skills in Health Care Encounters (MISHCE): development and psychometric testing of an assessment tool. *Res Soc Adm Pharm* 2005; 11(5): 696–707.
35. Moyers TB, Martin T, Manuel JK, et al. *Revised global scales: motivational interviewing treatment integrity 3.0 (MITI 3.0)*. Albuquerque, NM: University of New Mexico, CASAA, 2007.
36. Rodriguez-Hernandez MG and Wadsworth D. A walking intervention for sedentary employees: effects on self-regulation and self-efficacy. *Pensar En Movimiento: Cienc Ejer Fis Salud* 2020; 18(1): 1–17.
37. Svendsen OL, Haarbo J, Hassager C, et al. Accuracy of measurements of body composition by dual-energy X-ray absorptiometry in vivo. *Am J Clin Nutr* 1993; 57(5): 605–608.
38. 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 (1985)* 1999; 87(4): 1513–1520.
39. Hind K, Oldroyd B and Truscott JG. In vivo precision of the GE Lunar iDXA densitometer for the measurement of total body composition and fat distribution in adults. *Eur J Clin Nutr* 2011; 65(1): 140–142.
40. Rezzi S, Ginty F, Beaumont, et al. Body composition precision with the Lunar iDXA. *J Clin Densitom* 2009; 3(12): 402.
41. Rothney MP, Martin FP, Xia Y, et al. Precision of GE Lunar iDXA for the measurement of total and regional body composition in nonobese adults. *J Clin Densitom* 2012; 15(4): 399–404.
42. Xue P, Gao P and Li Y. The association between metabolic syndrome and bone mineral density: a meta-analysis. *Endocrine* 2012; 42(3): 546–554.
43. Chin KY, Chan CY, Subramaniam S, et al. Positive association between metabolic syndrome and bone mineral density among Malaysians. *Int J Med Sci* 2020; 17(16): 2585–2593.
44. Grundy SM. Metabolic syndrome scientific statement by the American Heart Association and the National Heart, Lung, and Blood Institute. *Arterioscler Thromb Vasc Biol* 2005; 25: 2243–2244.
45. Strunk KK and Mwavita M. *Design and analysis in educational research: ANOVA designs in SPSS*. London: Routledge, 2020.
46. Suire K. *Motivational interviewing for weight management among college students. PhD Dissertation, Auburn University*, Auburn, AL, 2021, https://etd.auburn.edu//handle/10415/7881
47. Morton K, Beauchamp M, Prothero A, et al. The effectiveness of motivational interviewing for health behaviour change in primary care settings: a systematic review. *Health Psychol Rev* 2015; 9(2): 205–223.
48. John LK, Loewenstein G, Troxel AB, et al. Financial incentives for extended weight loss: a randomized, controlled trial. *J Gen Intern Med* 2011; 26(6): 621–626.
49. Foster C, McDonald S, Frize G, et al. "Payment by Results"—financial incentives and motivational interviewing, adherence interventions in young adults with perinatally acquired HIV-1 infection: a pilot program. *AIDS Patient Care STDS* 2014; 28(1): 28–32.