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Review

Motivational interviewing and outcomes in adults with type 2 diabetes: A systematic review

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ABSTRACT

Objectives: The management of type 2 diabetes (T2D) requires complex behavior changes and treatment regimens to achieve optimal outcomes. Interventions including motivational interviewing (MI) have been explored to help patients achieve behavior change and outcomes; this study aimed to explore evidence and gaps in the literature for MI interventions and outcomes in adults with T2D.
Methods: A modified Cochrane method structured the search strategy among databases including MEDLINE, CINAHL, PsycINFO, and others. Inclusion criteria included randomized controlled trials that assessed the effects of MI on behavior changeoutcomes and resultant clinical outcomes in adults with T2D.
Results: Of the initial 159 studies identified, 14 were eligible for retention. Behavior targets in the retained studies included dietary changes, physical activity, smoking cessation, and alcohol reduction. MI had significant impact on some dietary behaviors and on weight loss. MI intervention structures were heterogeneous across studies; fidelity assessment was infrequent.
Conclusion: The effects of MI interventions on outcomes in T2D showed promising results for dietary behaviors. Clinical change outcomes from MI-based interventions were most favorable for weight management in T2D.
Practice implications: Behavior-specific MI interventions may positively influence study outcomes. Assessment of MI intervention fidelity will enhance treatment integrity and claims for validity.

Contents

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1. Introduction

The treatment and management of diabetes mellitus is a continued life experience that requires the development of behavioral self-management to achieve optimal outcomes. The International Diabetes Federation (IDF) estimates that 387 million people worldwide are living with diabetes with 4.9 million deaths attributed to diabetes in 2014 [1]. The Centers for Disease Control and Prevention (CDC) indicates the U.S. prevalence of diabetes is at 9.3%. About 90–95% of these cases are diagnosed as type 2 diabetes (T2D) [2]. Suboptimal diabetes self-management increases the risk of diabetes-related complications [3,4]. As such, a substantial number of people living with diabetes are at risk for hyperlipidemia, hypertension, and macro vascular complications [5]. Diabetes treatment and care are associated with considerably higher lifetime treatment costs, particularly when treatment involves poor adherence to self-management behaviors [3,6]. The rising prevalence of T2D and its expensive risks and complications signal the need for interventions that promote positive changes to patient health behaviors in the self-management of T2D, particularly given the complex and multiple behavior changes needed to manage T2D.

The American Association of Diabetes Educators (AADE) identifies seven key behaviors in the management of diabetes. These include medication taking, healthy eating, physical activity, blood glucose monitoring, diabetes self-care-related problem solving, reduction of acute and chronic complication risk, and healthy coping [7]. Other self-care behaviors that are important in general health are also important with diabetes (e.g., smoking cessation, reducing alcohol intake, eye and foot exams, etc). Various intervention types have been utilized to support healthy behaviors in diabetes management and range from patient education to behavior modification strategies [7–10]. Motivational Interviewing (MI) has received significant attention in research and in practice in recent years since the evidence base for its positive impact has grown. MI is a patient-centered communication skills set aimed at evoking the intrinsic motivation of the individual to develop the behavior changes needed to manage T2D [11,12]. The effectiveness and clinical utility of MI in promoting health behaviors have been documented in diverse health conditions and populations and with many different target behaviors [13–15].

MI is designed to elicit the inner motivation of the individual by using the communication styles of guiding, following, and directing. It is a patient-centered communication skills set that involves, among other things, open-ended questions, reflective listening, and support for patient autonomy and self-efficacy. The state of ambivalence in a person often complicates behavior changes for the individual [12]. To overcome ambivalence, MI employs communication principles such as expressing empathy, rolling with resistance/avoiding argumentation, developing discrepancy, and supporting self-efficacy along with strategies for eliciting change talk [12].

Recent American Diabetes Association (ADA) treatment guidelines (2014) specifically recommend patient-centered communication as an intervention strategy for lifestyle behavior changes in the management of diabetes [13]. MI has been applied exclusively or as an add-on strategy in various diabetes interventions aimed at improving treatment outcomes for people living with diabetes [14]. Studies of MI-based interventions aimed at diabetes self-management behavior change have sometimes yielded inconsistent results for the impact of MI, with inadequate MI training and/or the presence of heterogeneous study designs and measures often cited as reasons for the differences in study findings [15–18]. It is also important to note that MI is a multi-dimensional intervention that is also patient-centered and will never look exactly the same as if following a script or protocol because of its very nature. There will always be some variability in the content of patient-centered interventions if they are truly patient-centered and this makes the training, implementation, and measurement of MI very challenging.

Because of these multi-faceted characteristics of both T2D and MI, and the challenges these present in comparing studies within a body of evidence for behavior change with either, it would be useful to conduct a systematic review of rigorous, controlled study designs to report evidence and gaps in the literature examining MI compared to control for its impact on targeted behavioral and resultant clinical outcomes in the management of a complex chronic disease requiring focus on multiple behavior changes within a complex array of psychosocial and medical history factors that uniquely impact decision-making about behavior change. There is not published a recent systematic review of MI in T2D that focuses only on T2D and includes only rigorous study designs with the intention of reporting evidence and gaps in the literature. Therefore, the objective of this review is to examine empirical evidence for the impact of MI on behavior change and resultant clinical outcomes in adults with T2D; this will be done by describing evidence and gaps in the literature to inform practitioners and researchers about the state of MI use and impact in adult T2D behavior change interventions.

2. Methods

2.1. Inclusion criteria

This study employed a modified Cochrane method of systematic review. In contrast to a typical Cochrane review which compares specific outcomes surrounding a narrowly defined research question between two interventions in a specific population, 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 in adults with T2D.

The selection criteria for eligible studies were based on the PICOS format (Participants, Intervention, Comparators, Outcomes, and Study design) recommended by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) guideline. The inclusion criteria for retaining studies were:

- Population: adults (18 years and older) with T2D.
- Intervention: motivational interviewing (MI) based intervention.
- Comparators: usual care or a non-MI intervention.

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- Outcomes: assessment of changes in relevant health behaviors for diabetes management and any targeted clinical outcomes.
- Study design: randomized controlled trials (RCTs).

Retained studies only included RCTs that assessed the effects of MI-based interventions on behavior changes and resultant clinical outcomes of adults with T2D. In addition, cross sectional studies, literature reviews, preventive studies in pre-diabetes, and studies of gestational or type 1 diabetes were excluded.

2.2. Search strategy and review process

A systematic search of the literature was performed to identify all studies published in the English language through October 2014 that investigated the effects of MI or MI-based interventions on outcomes for T2D. The electronic database search was conducted among relevant databases, including Medline, CINAHL, PsycINFO, PsycARTICLES, Academic Search Premier, Alt Health Watch, Health Source: Consumer Edition, and Health Source: nursing/academic edition. Additional articles were found by manual searching of reference lists of relevant published papers, reviews, and published MI books, including the bibliography of the Motivational Interviewing Network of Trainers.

Search terms or combinations included: "motivational interviewing," "MI," "type 2 diabetes," "diabetes mellitus," "non-insulin dependent diabetes mellitus," "adult onset diabetes," "outcomes," "health outcomes," and "behavioral outcomes."

2.3. Data extraction and review of studies

The database retrieval process for eligible studies was initially performed by one researcher, and independently assessed by both authors at each search and review tier of the process. A study with differing retention/rejection opinion was settled to consensus by a critical evaluation of the study based on the review eligibility criteria. A standardized data extraction form was used to extract relevant information from all full-text studies reviewed. The following information was included: first author's name, study design, characteristics of the study sample, study setting, intervention methodology, study duration and number of follow-ups, training/fidelity assessment, behavioral outcome targets, and clinical outcome targets.

2.4. Assessment of methodological quality

It is important to evaluate the methodological quality of retained studies in a systematic review. All included studies were analyzed for methodological rigor in order to support summative conclusions from the results. Study quality assessment was conducted using the Cochrane method for assessing methodological quality; the Cochrane method assesses the risk of bias in several characteristics of the design of retained studies [19]. Bias domains evaluated per study included participant recruitment/selection, allocation, blinding, attrition, reporting, and other potential threats to validity. Two researchers rated each of the domains as having high, low, or unclear risk based on methods and analyses reported in the study; differing ratings were discussed to consensus.

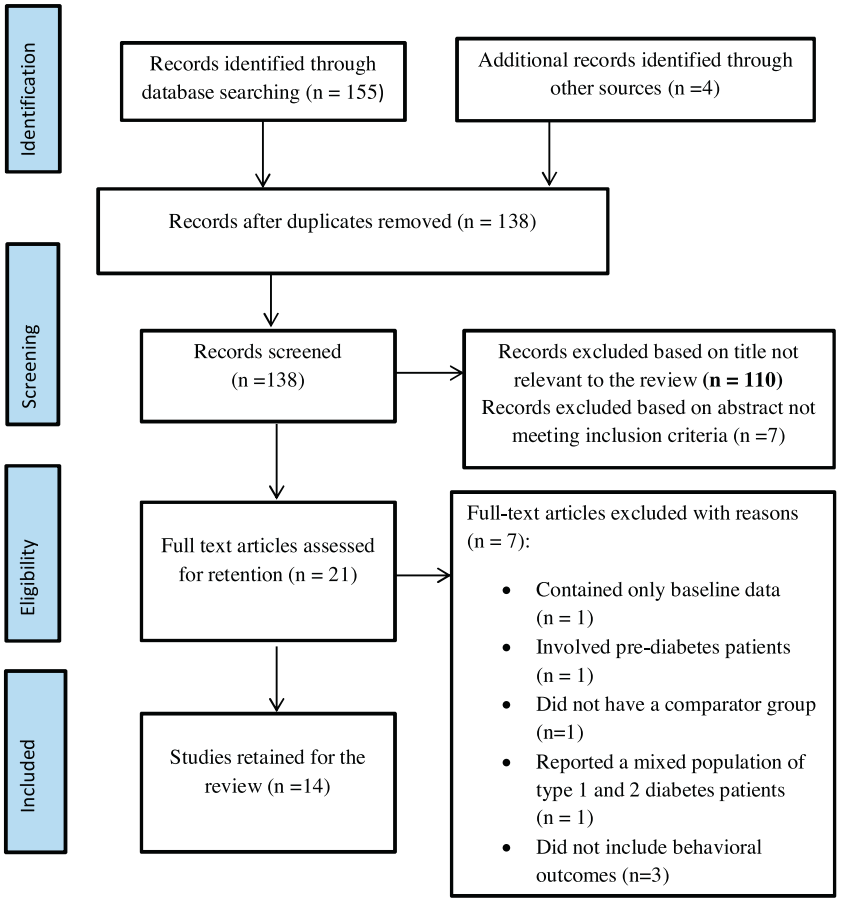

Fig. 1. PRISMA flow diagram of study retention process for the systematic review.

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3. Results

3.1. Retaining studies for review

The detailed literature search process and rejection rationale are illustrated in the PRISMA flow diagram in Fig. 1. The initial search revealed 155 citations from the databases and four citations from manual searching of reference lists from other relevant sources. After removing duplicates, 138 studies were retained for further screening. The next tier involved analysis of titles and elimination of those that were not relevant ($n = 110$). Abstracts were then screened and were excluded ($n = 7$) if they did not meet the inclusion criteria for this review as specified in the PRISMA diagram.

The seven full-text reviewed papers were excluded for the following reasons: one contained only baseline data, one assessed diabetes prevention and reducing risk in patients with pre-diabetes, one did not have a comparator group, one reported for a combined population of type 1 and 2 diabetes patients, and three did not measure behavioral outcomes. The remaining 14 studies were retained for the review [18,20–32]. All retained studies were randomized controlled trials. The characteristics of retained studies, their settings, and their MI-related methods are summarized in Table 1.

3.2. Methodological quality assessment

Table 2 reports the methodological quality of the 14 retained studies based on the Cochrane method for assessing risk of bias in randomized controlled trials [19]. Methodological strengths of the retained studies include that they were all randomized and controlled and sample sizes ranged from 22 participants to 940. Each bias domain was judged based on the Cochrane criteria for low, high, or unclear. Reporting bias had the lowest bias while a judgment of unclear was given to some studies for selection bias and blinding. All the studies reported randomization of participants and/or interventionists; however, the randomization method was described in only eight of the studies . Methods included computerized randomization scheme [20,22,23,26,30], closed envelope procedure [18], drawing of lots [16], and block randomization [25].

3.3. Motivational interviewing intervention structures

The MI sessions per behavior target were structured to include MI as part of the behavior-specific intervention strategy (e.g., physical activity counseling/goal setting using an MI-based messaging strategy and way of being) or the intervention itself

Table 1
Randomized controlled trials evaluating MI in T2D.

Source	Design, Settings	Sample	Method	Duration (months)	Clinical indicators	Behavioral targets
Wattanakorn et al. Thailand, 2013 [20]	RCT; single site	76 obese T2DM patients.	I: MI—based eating behavior modification program (EBMP) C: DM health education	13 weeks	BMI, waist circumference, blood glucose levels	Diet, physical activity
Jansink et al. Netherlands, 2013 [31]	RCT; multi site	940 uncontrolled and overweight T2DM patients	I: MI-based lifestyle counseling C: usual care	14	HbA1C, BP, BMI, and cholesterol levels.	Diet, alcohol, physical activity
Gabbay et al. USA, 2013 [28]	RCT; multi site	545 high-risk (A1C >8.5%) T2DM patients	I: MI-based behavior change counselling C: usual care	24	HbA1C, BP, and LDL	Self-management behaviors
Chen et al. Taiwan, 2012 [27]	RCT; single site	250 T2DM patients	I: MI (45–60 min) + hospital based educational sessions + "Diabetics Club" C: hospital based educational sessions + "Diabetics Club"	3	HbA1C	Self-management behaviors
Rubak et al. Denmark, 2011 [32]	RCT; multi site	628 newly diagnosed T2DM patients	I: MI-based DM counseling C: usual DM counseling	12	HbA1C, BP, BMI, and cholesterol levels.	Physical activity, smoking
Heinrich et al. Netherlands, 2010 [23]	RCT; multi site	584 T2DM patients	I: MI based counseling C: counseling based on usual care	24	HbA1C, BP, BMI, cholesterol and triglycerides	Diet (fat, vegetable & fruits), smoking, and physical activity
Welch et al. USA, 2010 [24]	RCT; single site	234 poorly controlled (A1C >7.5%) T2DM patients	Grp 1: DSME alone Grp 2: DSME + DM self-management barriers report Grp 3: MI Grp 4: MI + DM self-management barriers	6	HbA1C	Self-management behaviors
Osborn et al. USA, 2010 [26]	RCT; single site	118 T2DM patients	I: MI-based information-motivation-behavioral (IMB) skills intervention C: usual care	3	HbA1C	Diet, physical activity
Brug et al. Netherlands, 2007 [29]	RCT; multi site	209 newly diagnosed T2DM patients	I: MI counseling sessions C: usual care	NA	HbA1C, BMI, waist circumference	Diet (Saturated fat, fruit, vegetable intake)
West et al. USA, 2007 [18]	RCT; single site	217 overweight and uncontrolled (AIC >12%) female T2DM patients	I: MI + weight management program C: weight management program	18	HbA1C, BMI, and weight change	
Hokanson et al. USA, 2006 [22]	RCT; single site	114 patients with T2DM	I: MI-based counselling for smoking cessation + diabetes education C: diabetes education	6	HbA1C, BP, and weight reduction	Smoking cessation
Clark et al. UK, 2004 [30]	RCT; single site	100 overweight T2DM patients	I: MI-based personalized program C: usual care	12	HbA1C, BMI, LDL, HDL, triglycerides, and waist circumference	Diet, physical activity
Pill et al. UK, 1998 [25]	RCT; multi site	252 T2DM patients	I: MI-based DM counseling C: usual DM counseling	16	Glycemic control (% GHb), BMI, blood pressure	Smoking, and alcohol
Smith et al. USA, 1997 [21]	RCT; multi site	22 obese female T2DM patients	I: MI + behavioral weight control program C: Behavioral weight control program alone	4	Glycemic control (% GHb) and weight loss	Diet, physical activity

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Table 2
Risk of bias assessment for included studies (Cochrane method).

Source	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Reporting bias	Other bias
[20]	+	+	?	?	+	–	+
[31]	?	?	?	?	–	+	+
[28]	?	?	?	?	+	+	+
[27]	+	+	+	+	+	+	+
[32]	+	+	–	–	+	+	+
[23]	+	+	+	+	+	+	+
[24]	?	?	?	?	–	+	+
[26]	+	+	+	+	+	+	+
[29]	?	?	+	+	+	+	+
[18]	+	+	+	+	+	+	+
[22]	+	+	?	?	–	+	+
[30]	+	+	+	+	+	+	+
[25]	+	+	+	+	–	+	+
[21]	?	?	+	+	–	+	+

'+': low risk of bias in study design, '–': high risk of bias in study design, '?': unclear or insufficient detail.

was designed based on the principles of MI (e.g., MI-based counseling that was not specifically structured around the particular behavior target goal setting). Intervention sessions were delivered by trained medical professionals including one or combined of general practitioner physicians ($n = 2$), psychologists ($n = 2$), physician assistants ($n = 1$), nurses ($n = 6$), diabetes educators ($n = 1$), dieticians ($n = 1$), and unspecified ($n = 2$). Among those studies achieving significant impact of the MI intervention on a behavior target, six used MI-trained nurses, three used clinical psychologists, one was a diabetes educator, one was a dietician, one was a medical assistant. Intervention design could be broadly categorized into three types: (1) MI-based tailored intervention (tailored to patient preferences per behavior target), (2) MI counseling only, and (3) MI added to diabetes education or usual care.

As seen in Table 1, studies had varying length and frequency of MI delivery episodes. Length of MI encounter ranged from 30 to 90 min, with frequency of MI sessions ranging from one to five times during a study period. An individual face-to-face ($n = 11$) or group ($n = 1$) delivery of MI was applied for one or more MI sessions, while this information was not provided by two studies; some studies ($n = 3$) included telephone follow-up session(s). The 14 studies had been carried out in a variety of outpatient settings such as primary care clinics, doctor's offices, and community health facilities.

3.4. Motivational interviewing training and intervention fidelity assessments

Reporting a description of the training of interventionists is important to understanding the validity of the intervention. In addition, fidelity to the intended intervention should be assessed, particularly when the intervention involves a complex skills set and way of being, like MI. Among the 14 retained articles, eight described MI training procedures and duration. Areas of focus specified for MI trainings included exploration of patient ambivalence, reflective listening, asking open-ended questions, and agenda-setting. Training period durations ranged from 10 to 80 h among the eight studies reporting training details [22–26,28,31,32]. Five studies did not detail the training of interventionists, but simply stated that they were MI trained [18,20,21,27,29]. One study did not include any references to training details or duration [30]. Among the eight studies showing any significant impact of the MI group, only two [26,28] described details of their training (40–80 h curricula).

Intervention fidelity assessment is important to determine whether the interventionist's delivery was actually MI-consistent. Six studies directly reported how ongoing intervention fidelity was assessed; namely, that assessment was conducted by recording MI sessions and analyzing them for MI consistency [18,23,24,28,29,31]. The recordings were either audiotapes or videotapes of intervention sessions which were coded and evaluated by MI experts for feedback purposes. Three studies reported specific measures used in measuring MI fidelity assessments [24,28,29]. Measures included in these intervention fidelity assessments were the Motivational Interviewing Treatment Integrity (MITI), the Motivational Interviewing Treatment Code (MISC), and the Behavior Change Counseling Index (BECCI), which is primarily a global communication/counseling assessment instrument that also includes some of the MI principles and/or strategies. The remaining studies reported no methods for assessment of MI intervention fidelity.

3.5. Behavior change outcomes

Table 3 summarizes the results and significance testing of target behavioral and clinical outcomes for the fourteen retained studies. As shown in Table 3, the most frequently targeted self-management behaviors included one or both of the lifestyle changes related to healthy eating ($n = 7$) or being active ($n = 6$). Some studies included smoking cessation and/or alcohol reduction ($n = 4$) in diabetes patients. All behavior measures used self-reporting. Most of the studies ($n = 11$) used measures that were specific to the targeted health behaviors being studied. Three of the fourteen studies applied a compound measure that reported behavioral outcomes as a global "self-management behaviors" concept that reported a single, global score for the aggregate (multiple behaviors perception in one measure) outcomes that were self-reported.

Five of the seven studies that assessed eating changes reported significant group differences between the MI intervention group and usual care group. Two of the five studies showing significant group differences assessed specific target eating behaviors including reduction of saturated fat intake or increased fruit or vegetable intake [23,29]. Brug, et al. reported a significant difference in reduction of saturated fat intake for the MI group compared to the usual care group; however, fruit and vegetable intake had non-significant results in both groups. Among the three studies that reported a global measure for diabetes self-management behaviors, only Chen, et al. reported a significant difference

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Table 3
Behavioral and clinical outcomes based on tests of significance between the MI and control group.

Source	Behavioral targets					Clinical targets					
	Healthy eating	Physical activity	Alcohol reduction	Smoking cessation	Self-management behaviors	A1C/ glycemic levels	BP	BMI	Weight reduction	Waist circumference	Cholesterol levels
Wattanakorn et al. Thailand, 2013 [20]	Sig	NS				Sig		Sig			
Jansink et al. Netherlands, 2013 [31]	NS	NS	NS			NS	NS	NS			NS
Gabbay et al. USA, 2013 [28]					NS	NS	Sig[b]				NS
Chen et al. Taiwan, 2012 [27]					Sig	Sig					
Rubak et al. Denmark, 2011 [32]		NS		NS		NS	NS	NS			NS
Heinrich et al. Netherlands, 2010 [23]	NS					NS	NS	NS			NS
Welch et al. USA, 2010 [24]					NS	NS					
Osborn et al. USA, 2010 [26]	Sig	NS				NS					
Brug et al. Netherlands, 2007 [29]	Sig[a]					NS		NS		NS	
West et al. USA, 2007 [18]						Sig[c]			Sig		
Hokanson et al. USA, 2006 [22]				NS		NS	NS	NS			
Clark et al. UK, 2004 [30]	Sig	NS				NS		NS		NS	NS
Pill et al. UK, 1998 [25]			NS	NS		NS	NS	NS			
Smith et al. USA, 1997 [21]	NS	NS				Sig			NS		

Sig = significant at $p < 0.05$; NS = not significant at $p < 0.05$.
[a] Reduced saturated fat.
[b] Systolic blood pressure.
[c] 6 months follow-up.

for the MI group compared to control [24,27,28]. No significant differences were reported for the MI group versus the usual care group for physical activity, smoking cessation, and alcohol reduction in the studies that examined these behaviors ($n = 7$).

3.6. Clinical outcomes

Target clinical outcomes included in retained studies were glycemic control ($n = 14$), blood pressure (n = 6), waist circumference ($n = 2$), BMI ($n = 8$), weight loss ($n = 2$), and cholesterol ($n = 5$). Clinical variables were measured using recommended methods relevant to the particular clinical indicators. Smoking cessation and alcohol use were measured with self-reporting as noted above. Self-report was also compared with a biochemical test in some studies for smoking [22,23,31,32]. The type of biochemical test used was not specified.

All retained studies measured blood glucose levels; the methods used were A1C ($n = 13$) and peripheralglucose measured with a glucometer ($n = 1$). A significant difference for the MI group compared to control was reported in three of the thirteen studies that measured A1C and in the study that measured peripheral glucose measured with a glucometer. Moreover, two studies reported a reduction in A1C, but it was not significant [18,21]. In addition, Hokanson et al. reported A1C level reductions to below the 7.0% guideline for both the intervention and control groups after the intervention.

Significant weight loss in the MI group compared to the control group was reported by West and colleagues [18]. Another study with duration of 18 months reported significant weight loss in the MI group compared to the control at the 6 months follow-up, but not at the end of the study [21]. Wattanakorn et al. found a significant reduction in BMI for the MI group [20]; while Chen et al. reported similar findings for systolic blood pressure [27]. Non-significant differences between the MI intervention group and the control/usual care group were reported for other anthropometric and clinical outcomes such as waist circumference and cholesterol.

4. Discussion and conclusion

4.1. Discussion

This systematic review culminated in an examination of fourteen randomized controlled trials assessing MI as an intervention for targeted self-management behavior changes in adult patients with T2D. Positive behavior change and resultant clinical outcome effects for the MI intervention group were observed in four of seven studies that targeted dietary changes, one of two for weight loss interventions, four of fourteen for glycemic control, and one of eight studies for body mass index. Systolic blood pressure reduction was also significant in one study among studies assessing blood pressure. Three studies reported self-management behaviors as a global behavior summary score and one of these was significant for the MI group. MI did not show a statistically significant effect on physical activity, alcohol reduction, and smoking cessation behavior changes in any of the studies retained in this review; clinical outcomes from behavior changes were not significantly changed forwaist circumference and cholesterol. The behavior change category targeted most focused on various eating behaviors and a majority of these had significant changes in the MI group. This supports the potential for MI as an intervention for diet modification in T2D patients; however, conclusions should be drawn with caution due to heterogeneity in study designs, settings, and intervention type.

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Most of the retained studies focused on health behaviors that directly impact T2D glycemic control outcomes; however, four studies evaluated the effectiveness of MI on substance abuse/addiction behaviors like alcohol intake and/or cigarette smoking [22,25,31,32]. These behaviors are frequently addressed in diabetes self-management because of their contribution to increased risk of cardiovascular comorbidities or events. The studies in this review that targeted alcohol reduction and smoking cessation did not report significant results for the MI group compared to control/usual care. These findings for the targeted addiction behaviors were not congruent with original work with MI that impacted addictive behaviors [33–35]. A possible factor could be the addition of these challenging addictive behavior changes to the already complex set of diabetes self-management behaviors required for glycemic control. The reduction of habituated, physiologically addictive behaviors is complex and can be considered a big change for which many patients may not have the motivation or self-efficacy to achieve [36].

It is important to note that medication taking behavior was not evaluated as a target behavior in any of the retained MI-based intervention studies. Medication adherence rates have been reported as poor in chronic disease management including diabetes and since medication taking is a diabetes self-management behavior that is particularly impactful on glycemic control, further research in this realm is warranted [37,38]. One study not retained in this review was the Discussions on Taking Medications (Dotx.MED) diabetes pilot program conducted by the American Pharmacists Association. Data were collected from ten varied pharmacy practice sites across the US on the impact of MI-trained pharmacists and pharmacy residents on medication adherence in non-adherent patients (proportion of days covered). The pharmacists had brief MI-based conversations with patients each month for six months when the patient returned to the pharmacy for his or her medication refill. Results were modestly, but significantly impactful on the target behavior of adherence with diabetes medication-taking [39].

4.1.1. Limitations

The care settings in the retained studies were all outpatient sites, which is similar to the majority of real world encounters for behavior change interventions. Some of the retained studies were multi-site trials and while this is an opportunity to collect additional and comparative data, using multiple sites adds variability that impacts outcomes and could produce challenges to intervention fidelity among interventionists because of the varying nature of sites. External validity is limited due to the unique characteristics of the study populations. Potential bias could exist in this summary due to the exclusion of some studies based on the review inclusion criteria, unpublished manuscripts, and potentially eligible publications in other languages. Another potential source of bias is the heterogeneous designs, methods and measures used in retained studies. MI implementation was variable and 57% of retained studies did not document ongoing intervention fidelity measures. Measures of behavioral outcomes, patient baseline control level, and patient recruitment also varied significantly and impact outcomes and comparisons. In addition, as an MI originator recently reported in reflecting back on a few decades of MI, adequate training and practice is a key to skills development. His recommendation was that at a minimum, persons require at least two days of training with multiple opportunities to role-play with MI expert feedback and that follow-up training and/or practice is critical for reinforcing skills development and progression [40,41]. MI impact is not seen or is not significant in a study, it is often found that the study reported minimal training of interventionists in MI or did not report training in the article. Health literacy was not addressed within the retained studies; in addition, other outcomes of interest like humanistic outcomes (i.e., satisfaction, quality of life) and financial outcomes (e.g., return on investment) were also not targeted within the studies retained in this review and should be considered as areas for future research with MI as an intervention for behavior change in adults with T2D.

4.1.2. Comparison to other studies

The results of this review contribute to the body of literature that supports MI as an evidence-based, patient-centered communication skill set that is promising, when appropriately trained and applied, in addressing ambivalence. Some findings in this review are similar those from other reviews on the effects of MI in changing health behaviors [14,41,42]. It is important to note that, as in other studies, a common thread suggests that higher frequency of MI-based encounters are associated with more significant improvements in patient target outcomes [40,43]. This is congruent with recent commentaries by Miller, an MI originator [40,43].

As noted in the previous section, the quality of MI training received by interventionists has also been implicated as a factor that influences rigor of outcomes in MI studies [32,44,45]. Madson et al. concluded in their review of MI training that a lack of standard measures for MI assessments on knowledge, attitudes, and self-confidence contributes to challenges in comparing studies and validating MI-based interventions and their impact [45,46]. Measures used in evaluating MI proficiency and MI intervention fidelity should be implemented and reported in studies to support claims for validity of the actual intervention as being MI-consistent. MI training delivered by one trainer has been indicated as a possible influence on uptake of MI strategies by interventionists [32]. This could influence outcomes based on the methods emphasized by the trainer.

Copeland and colleagues examined possible mediators for MI outcomes in a previous general review of the mechanisms of MI in interventions [47]. MI spirit and change talk had been indicated as mediators for favorable outcomes [47]. A mediation analysis showed a positive association where an effective MI spirit increased change talk and behavior change was found in participants who engaged more frequently in change talk [47,48]. The lack of significant results in some behavioral outcomes such as physical activity and addiction could possibly be associated with a lack of these mediators and or study design and methods concerns noted previously.

Mulimba and Byron-Daniel recently published a review of MI in the diabetes literature published up through March, 2010 [49]. The inclusion criteria included type 1 or 2 diabetes and included less rigorous study designs than this review. Eight studies were retained and the authors found minimal impact of MI on diabetes outcomes. Some of the studies retained in that review were rejected for this review due to less rigorous study designs and measures. It is clear that studying a complex intervention set like MI requires rigorous methods for training, implementation, and assessment.

4.2. Practice implications and future directions

Results among retained studies suggest that MI, when appropriately trained and applied, has potential to impact changes in health behaviors, thereby, improving outcomes. The treatment and management of T2D requires sustained change for self-management behaviors such as healthy eating, being active, medication taking, and blood glucose monitoring. Patients who adhere with recommended regimens often have better disease prognosis and reduced risk of microvascular and macrovascular complications. Assessment of patient understanding and behavioral and motivational readiness is important to helping a provider

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make patient-centered decisions about directions to take in guiding a patient on goal setting for behavior change.

For the outcomes targeted among retained studies in this review, the behavioral change needed for addictive behaviors such as smoking and alcohol use requires behavior-specific interventions for favorable results. A focus of MI suggests that building self-efficacy for change can be achieved by goal-setting where incremental changes are the focus for those who may be resistant or ambivalent for the change (e.g., initial focus on cutting back on cigarettes smoked in a day rather than quitting altogether). In addition, the studies that did show significant impact on behavior change for the MI group versus control were often those which focused on a singular behavior (e.g., dietary intake), which has important implications for research and practice. Focus on many changes at once for a complex chronic disease like diabetes may prove overwhelming for individuals. A premise of MI includes the support of self-efficacy and one means of supporting confidence for change is to focus on incremental change [50]. This includes setting goals within behaviors that start with small changes with a plan for progression, which can also have implications for advising patients to focus on one behavior at a time if their self-efficacy for major change is low or the complexity of change is beyond their health literacy level.

The heterogeneous nature of MI interventions creates a significant challenge for comparing methods and outcomes across studies, and certainly does not reveal a "gold standard" for MI intervention study design. This is true of behavioral interventions in general. In addition, the way behavior change/achievement was measured across studies varied significantly, limiting meaningful comparisons. This is problematic across behavioral interventions research, with theory-based, established measures often producing more valid results, but not always being a standard of measure in practice settings beyond a research study. This is also problematic because often studies do not measure behavior change to a defined, specific behavior for a participant to respond for in self-report. The use of global measures to summarize diabetes self-management behaviors does not capture the adherence or change on any particular behavior. Participants may be adherent with one behavior but unsuccessful in another, and the changes could be significant if measured individually.

Another important research design factor to consider is the presence of motivation and incentives/compensation that will help attract more poorly controlled patients to a study in order to be able to show impact of an intervention. Smith and colleagues reported higher dropout rate among younger and poorer controlled participants [21]. Participant motivation has been indicated as a potential mediator for outcomes in MI interventions [47]. One retained study had provided compensation up to $65 for travel expenses [26]. Future studies may benefit from strategies to recruit participants with poorer disease control, since patients who are already adherent or well-controlled tend to show less impact from an intervention, because there is less room for significant improvement in the target outcome. This may have contributed to insignificant findings in some of the studies retained in this review and elsewhere.

Adequate training in MI has been implicated as a favorable factor in outcomes from MI interventions. Miller described the importance of adequate MI training and trainee feedback as factors in achieving competence with MI skills [51]. Most studies retained in this review did not adequately report training of the MI interventionists and MI intervention fidelity assessments. This calls into question the validity of those interventions since it has not been substantiated that what was actually done in the encounter was MI-consistent. Retained studies that evaluated intervention fidelity utilized the method of pre and post-assessments and/or MI expert evaluation of sample(s) of audio or video recorded intervention encounters with study participants. Providers who hope to impact outcomes of adult patients with T2D should consider extensive healthcare-based training that includes at least two days, MI expert feedback, and includes opportunities for follow-up training and/or practice. Future studies should at the very least conduct a pre and post-assessment of trainee knowledge, attitudes, and skills for MI and at best could employ intervention fidelity assessments in the study design to ensure that the intervention delivered was MI-consistent [44,46,52].

4.3. Conclusion

This review reports the evidence and gaps in the literature for the effectiveness of MI for helping patients change health behaviors in the unique patient population of adults living with T2D. Among targeted behavioral outcomes, the most frequent category of impacted behavior change included dietary changes. The resulting clinical outcome of weight reductionwas successful in one of the two retained studies evaluating this clinical target. Heterogeneity of measures and methods makes it difficult to compare the evidence and identify best-practice strategies, but one factor that was found among most of the studies showing MI impact had to do with frequency of encounters; the more MI encounters a patient experienced, the more likely he or she was to change behavior and achieve improved outcomes. Further research is needed due to the variability across studies for MI implementation and outcomes measurement. Overall, findings from this review support the potential effectiveness of MI-based interventions in patients living with T2D when optimally applied by trained interventionists.

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Conflict of interest

None.

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