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Motivational interviewing with primary care populations: a systematic review and meta-analysis

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Date: Aug. 2014

From: Journal of Behavioral Medicine(Vol. 37, Issue 4)

Publisher: Springer

Document Type: Report

Length: 6,687 words

DOI: <http://dx.doi.org/10.1007/s10865-013-9527-4>

Abstract:

This meta-analysis synthesized the findings from randomized controlled trials (RCTs) of motivational interviewing (MI) for health behavior outcomes within primary care populations. Published and unpublished RCTs were identified using databases and online listservs. Studies were synthesized by outcome subgroup and meta-regression analyses were conducted to determine potential moderators accounting for heterogeneity within samples. Mean effect sizes ranged from .07 to .47; significant effect sizes were found for the adherence subgroup of studies ($p = .04$) and all outcomes combined ($p = .02$). Professional credentials of intervention deliverer were found to significantly moderate the association between MI and effect size in substance use subgroup ($p = .0005$) and all outcomes combined ($p = .004$). Mean effect sizes were largest in outcomes related to weight loss, blood pressure, and substance use. MI appears to be useful in clinical settings and as few as 1 MI session may be effective in enhancing readiness to change and action directed towards reaching health behavior-change goals.

Keywords Motivational interviewing * Primary care * Behavior change * Mental health * Interventions

Background

The interdisciplinary field of behavioral medicine, as defined by the Society of Behavioral Medicine, refers to the ongoing research and clinical care that seeks to prevent and treat barriers to physical health through the understanding of the biopsychosocial and behavioral underpinnings of health, wellness, and illness (Society of Behavioral Medicine, 2013). The up-and-coming field of primary care-mental health integration (PC-MHI) offers the unique opportunity to provide behavioral medicine interventions at the frontline of medical treatment. One of the leaders in the development of this field is the Veterans Health Administration (VHA) which began nationwide funding for PC-MHI programs in 2007 (Post & Van Stone, 2008). Within the VHA, these services have been thus far well utilized, evidencing a 95 % increase in mental health service use within primary care departments from 2008 to 2010. In this context, mental health service use may refer to the use of services for mood disorders, or psychological approaches to help with medical problems (Johnson-Lawrence et al., 2012).

Those providing services within these settings are met with a wide range of patient characteristics and medical and psychiatric disorders; as such, a multi-faceted approach to clinical care is necessary. In addition, given the time-limited course of treatment in these settings, evidence-based treatments are essential to ensuring effective treatments (Johnson-Lawrence et al., 2012). Research suggests that cognitive-behavioral therapy, problem-solving therapy, and interpersonal therapy are all techniques used within these settings. These forms of therapy have been applied to a wide range of medical conditions, such as diabetes

(Thorpe et al., 2013), obesity (Perri et al., 2001), insomnia (Savard et al., 2005), adjustment to cancer, low back pain (Malouff et al., 2007), as well as typical mental health conditions, such as depression (Cuijpers et al., 2011). Motivational interviewing (MI) is an additional form of therapy that originated out of substance abuse treatment and has gained notice as an effective treatment for eliciting behavior change (Rubak et al., 2005), an important aspect of most health-related targets (e.g., weight loss, increased exercise) found among primary care populations.

The most recent definition of MI given by its developers is: "a collaborative conversation style for strengthening a person's own motivation and commitment to change" (Miller & Rollnick, 2013, p. 12). As chronic "lifestyle-related" diseases steadily become the heaviest burden to modern Western medical systems, effective treatments focused on helping individuals change problematic behaviors are extremely necessary (Goodarz et al., 2009). MI takes a patient-centered approach that simultaneously acknowledges the patient's expertise into his or her own problems and empowers the patient to develop his or her own motivation. The therapeutic alliance within the MI framework is predominantly a partnership, rather than an expert/patient dynamic (Miller & Rollnick, 2013). MI has broadened in application over the past decade beyond the field of addiction, and research has begun to investigate its utility within health behavior topics, such as diabetes management and smoking cessation (Emmons & Rollnick, 2001). As behavioral medicine interventions have steadily grown within the field of primary care (Zivin et al., 2010), a role for MI techniques to be used by behavioral medicine providers, as well as general physicians and other professionals has emerged within primary care. Given the limited resources available within health care settings, it is important to ascertain the utility of these approaches within medical settings, and to determine if MI techniques are helpful with all or only some medical conditions that require behavior modification.

Objectives

To this end, the following research question was pursued using a systematic review and meta-analysis: is MI effective in improving behavior modification in patients seeking treatment for health conditions in primary care settings, as compared to treatment-as-usual or other interventions, in randomized controlled trials (RCTs)? MI in primary care has been addressed within a narrative review published in 2009 (Anstiss, 2009). Anstiss, (2009) presents a conceptual review of MI, as well as a discussion of the ways in which MI can be efficacious and advantageous to integrated primary care settings. However, in this review individual studies examining the effectiveness of MI in primary care settings are not addressed and there have been no published meta-analyses found addressing this topic.

Methods

Prior to database searching, eligibility criteria were established for the above research question. Studies were included if the study design stipulated that it was a RCT in which the experimental condition(s) used MI as a primary technique of the intervention. The experimental condition could be delivered by clinicians, doctors, nurses, or other trained professionals. Studies were included whether or not they included follow-up data. All publication dates were considered in the review; however, the review was limited to articles written or translated into English due to language limitations of the first author. MEDLINE, PsycInfo, and Cochrane Library Review databases were used to provide both medical and psychological searches of the literature. EBSCO Host, MEDLINE and PsycInfo were searched simultaneously with the following delimiters: motivational interviewing OR MI [Abstract] AND primary care [Abstract]. To minimize potential publication bias of the database searching, online listservs associated with the Society of Behavioral Medicine and the Motivational Interviewing Network of Trainers were also sent requests for published or unpublished manuscripts that may satisfy the above research question. Databases were last searched on November 1, 2012. PRISMA and QUOROM guidelines were consulted for the execution and reporting of this systematic review and meta-analysis (Moher et al., 1999, 2009).

Once identified through listserv responses and database searches, the studies were screened at the abstract and title level for eligibility for full-text screening. If through abstract review, a study appeared to be addressing a primary care-related patient issue with an MI intervention, it was retained for full-text screening. Studies were included if they used a RCT design in which participants were randomly assigned to participate in at least one experimental and one control condition. The experimental condition was required to consist of an intervention that used MI as the primary arm of the treatment; however, if the intervention was a dual-focused treatment (e.g., cognitive-behavioral therapy paired with MI), it was included. As such, if the experimental intervention was described as "using MI techniques" along with two or more other psychological techniques, it was excluded. The control condition was permitted to be treatment-as-usual, waitlist control, or another intervention. Participants were required to be recruited from a primary care setting, although, the intervention was not required to be delivered within the primary care setting. As such, studies were included if they used telephone-based or other forms of treatment intervention. If a study used computer-based therapies instead of a provider delivering the service it would have been excluded; however, there were no such studies found in the literature search. There were no exclusion criteria stipulated for the length of the intervention. The study was required to identify and measure a particular health-related outcome of interest that depended on the study population (e.g., medication adherence in diabetes management).

Data were extracted from articles independently by the first author using a piloted spreadsheet of pertinent variables, including experimental condition, delivery mode, and results. As this review focused on RCTs with group intervention versus control conditions, means, standard deviations, and p values were gathered for each group where reported. In trials involving dichotomous outcomes, Odds Ratios and 95 % confidence intervals were gathered, where reported. For those studies in which

pertinent outcome information was not reported, corresponding authors were contacted in an attempt to retrieve the data. Meta-analyses were executed using the methods outlined by Murray et al., (2012). These methods delineate the manner in which to conduct meta-analyses when reviewing studies that report multiple results that are not necessarily within the same construct (e.g., one study reporting changes in body weight, physical activity, and blood pressure). For meta-analysis, it is necessary to calculate one effect size per study. Given the heterogeneity of the outcomes of the reviewed studies, metaanalyses were completed first by subgroup of outcome (e.g., effect sizes for substance use). Following subgroup analyses, mixed effects meta-regression analyses were conducted to assess for significant moderator variables that would account for heterogeneity in subgroup analyses. These moderator analyses were conducted only for those subgroups that consisted of four or more studies (to provide sufficient degrees of freedom), and had statistically significant heterogeneity as signified by the Q-statistic of the meta-analysis. The meta-analyses were conducted using the inverse variance-weight approach referenced by Murray et al., (2012) and originally recommended by Lipsey and Wilson, (2001). Analyses were conducted using SPSS macros provided by David Wilson, Ph.D. through his website (Wilson, 2010). Effect sizes were calculated using the "practical meta-analysis effect size calculator", also available through Dr. Wilson's website. Random effects models were used due to the significant heterogeneity of study outcomes. Results are presented in Table 1.

Variables for assessment of risk of bias were gathered using the Cochrane criteria (Higgins et al., 2011) and results are presented in tabular form below (Table 2). The risk of publication bias was minimized through requests via online listservs; however, this risk likely remains in the current review. For the purpose of this review, the most appropriate variables will be presented in tables below.

Results

Through searching MEDLINE and PsycInfo via EBSCO Host and Cochrane Library Reviews, 272 articles were identified for initial screening. For article screening and exclusion process, please see the PRISMA Flow Chart (Fig. 1; Moher et al., 2009). Literature searching identified 12 studies that fulfilled the above inclusion criteria. Of these 12 studies, 9 evidenced positive results of MI, above and beyond control conditions. Two studies evidenced mixed results, and one did not find significant effects of MI. Half of the original 12 studies assessed the use of MI in relation to substance use; therefore, these studies remained in line with the original use of MI, only tailored to primary care populations. The other 6 studies addressed dietary and exercise-related goals, medication adherence, colorectal screening, and passive smoke exposure within households. Reduction in alcohol use was the primary focus of 3 studies. Details of these studies are summarized in Table 1.

Due to the heterogeneous nature of the study outcomes, a priori subgroups were established for the purpose of conducting meta-analyses. Three studies reported outcomes for diastolic and systolic blood pressure readings (Hardcastle et al., 2008; Hyman et al., 2007; Ogedegbe et al., 2008); the effect sizes from these outcomes were grouped together for one meta-analysis. Six studies reported on substance use outcomes (Beckham, 2007; Brown et al., 2007; D'Amico et al., 2008; Hyman et al., 2007; Mason et al., 2011; Soria et al., 2006). Two studies reported body weight reduction outcomes (Greaves et al., 2008; Hardcastle et al., 2008), while 3 studies reported physical activity results (Greaves et al., 2008; Hardcastle et al., 2008; Hyman et al., 2007). Each of these outcome subgroups was meta-analyzed separately. Finally, Menon et al., (2011) reported outcomes related to adherence to colorectal screening recommendations and Emmons et al., (2001) reported outcomes of adherence to passive household smoke exposure; these two studies were grouped together for adherence outcomes meta-analysis. No effect size was possible from results of Schaus et al., (2009) due to missing data. Potential moderators of total clinical contact (a variable calculated through reported average session number and length), professional qualifications of the deliverer of intervention, and age of participant were entered in mixed effects meta-regression analyses. Due to missing data, age was coded as a categorical variable. All studies reported whether the study focused on adolescents, adults, or both; however, 2 studies did not report the mean age of participants and corresponding authors were not responsive to or able to fulfill requests for data.

Included studies

In a trial of 897 individuals with at-risk drinking, a significant reduction in alcohol use was evidenced across both genders and both the experimental and control condition. MI was found to be associated with significant reductions in alcohol use above and beyond that seen cross-sectionally in men, but not in women. These investigators used 6 sessions of MI; however, sessions were conducted entirely over the telephone. Men receiving telephone-based MI sessions evidenced significantly reduced drinking days and amounts of alcohol consumed on the timeline follow-back questionnaire (TLFB) as compared to those men who received educational pamphlets in the control condition. While both groups of women evidenced reductions in alcohol consumption, no significant differences were found between groups (Brown et al., 2007). In a smaller study examining 26 individuals with hazardous drinking living in rural Idaho, 1 MI session from a nurse practitioner that lasted 45-60 min resulted in significantly reduced alcohol use on a piloted measure. This study also found that 1 MI session was associated with a significant reduction in gamma-glutamyltransferase (GGT) levels within the blood, a marker of alcohol consumption for the prior several weeks (Beckham, 2007; Conigrave et al., 2002; Daepfen et al., 1999). A third study looking primarily at alcohol use outcomes found that 2 MI counseling sessions that each lasted approximately 20 min evidenced significantly reduced alcohol use per week and per sitting, as well as reduced estimated blood alcohol concentration levels (as estimated from TLFB data using gender and weight) in college students with binge drinking patterns. These findings were found up through a 12-month follow-up period (Schaus et al., 2009).

D'Amico et al., (2008) investigated the effectiveness of one 15-20 min in-person MI session with a trained case manager, followed by one 10-min booster phone call, in a sample of 64 teens at high-risk of substance abuse in underserved community clinics of Los Angeles county. At 3 month follow-up, these participants reported significantly lower marijuana use, significantly lower intentions to use marijuana in the future, and lower perceptions of marijuana use in one's social circle, as compared to those in the control condition (usual care). Results were nonsignificant on alcohol use outcomes. These mixed findings were corroborated by the results of Mason et al., (2011) in which a sample of 28 female adolescents were not significantly different in self-reported frequency or amount of substance use as compared to the no treatment control condition. However, those receiving the intervention did report significantly less "trouble due to alcohol use," social stress, and substance use prior to sexual activities. These studies suggest that MI may have mixed utility with adolescent populations and may improve harm-reduction behaviors, but be less powerful in affecting substance, in particular alcohol, use amounts and frequency.

Emmons et al., (2001) targeted passive smoking household exposure in an effort to improve health outcomes among young children of smoking caregivers. In a sample of 279 low-income caregivers with a child 3 years or younger, participants were given one 30-45 min in-person session with a trained interventionist in the home, boosted by four 10-min follow-up telephone calls. At 6-month follow-up, participants in the experimental condition had significantly lower nicotine levels in the home as compared to the control group, which received self-help didactic materials. Nicotine levels were measured using objective house monitoring systems, which improves on traditional self-report measurement techniques. While these results were significant, the secondary outcome of smoking cessation was not significantly different between the two conditions, suggesting that targeting household smoke exposure did not generalize to smoking quitting behavior. Soria et al., (2006) targeted smoking cessation in a sample of 200 current smokers with three 20-min sessions conducted by family general practitioners in urban primary care centers in Spain. At 12 months, experimental condition participants were approximately 7 times more likely to quit smoking as compared to those who received the control condition, anti-smoking advice.

Smoking cessation rates were also targeted as an outcome in a study attempting to modify three outcomes: smoking cessation, physical activity, and reduced-sodium diet for hypertension. Hyman et al., (2007) used a unique study design to look at whether targeting behavior change simultaneously or sequentially would produce better treatment gains. This study was further strengthened through predominantly objective measurements of outcomes such as urine cotinine for smoking cessation, pedometer counts for physical activity, and blood samples for health indicators. Participants received three in-person sessions 6 months apart from trained health educators. Each in-person session was followed-up with an average of four 15-min phone calls. In one arm of the study, MI sessions were geared towards targeting all three outcomes at once ("simultaneous condition") and in the other experimental arm the MI sessions were "sequentially" oriented so that MI sessions were focused on one targeted outcome at a time. At 6-months, the participants in simultaneous and sequential conditions were significantly more likely to reduce sodium as compared to the usual care control group. No other primary outcomes were found to be significantly different between groups at 6 or 18-month follow-up. Perhaps among the target behaviors, salt reduction was the least complex, and as such, the most likely to be sustained.

Behavioral health outcomes of diet and exercise were targeted by two studies reviewed. Greaves et al., (2008) conducted the intervention with the largest dosage: up to 11 sessions of a combination of in-person and telephone contact. The median number of in-person contacts was 8 and the median number of telephone contacts was 1.5. The odds of reaching the primary outcome of 5 % weight loss at 6-months was nearly 4 times those of the control condition. The other primary outcome of reaching 150 min of moderate activity per week was not significantly different across groups. Hardcastle et al., (2008) conducted a trial in a sample of 334 adults with cardiovascular risk factors in which participants received up to 5 (mean sessions attended = 2.0) in-person, 20-30 min sessions from 1 Physical Activity Specialist or 1 Registered Dietician. The MI sessions focused on increasing physical activity and making dietary improvements in the support of healthy weight and blood pressure. Those receiving counseling showed significantly increased walking time and weight reduction as compared to the control group, although the groups did not significantly differ on moderate or vigorous levels of physical activity. While both groups significantly improved eating habits over time, the control group decreased dietary fat significantly more than did the experimental group. The above studies were unfortunately weakened by use of predominantly self-report measures of physical activity and food intake. Finally, another health indicator, hypertension, was targeted in a trial by Ogedegbe et al., (2008) in which 190 African American participants with uncontrolled hypertension in an urban primary care setting were randomized to receive usual care or four 30-40 min in-person sessions from trained research assistants regarding hypertensive medication adherence. Medication adherence was measured using electronic pill caps and blood pressure readings for 12 months. Over time, the usual care group evidenced a significant decline in medication adherence from baseline whereas the experimental group did not evidence this decline. Interestingly, despite these findings, all groups significantly decreased systolic and diastolic blood pressure readings over time with no significant differences between groups. As such, it would appear that MI improved the primary outcome as measured by electronic pill caps. However, the health indicator of blood pressure, which is likely the more significant clinical outcome, was not significantly affected by MI and significantly improved over time across both groups.

Menon et al., (2011) found that MI was not significantly different from control in improving colorectal screening rates. In contrast, the third arm of this study, Stage of Change matched tailored education (TE), was significantly different from control and improved colorectal screening rates. Interestingly, both protocols were delivered over the phone, with TE taking approximately 13 min over the phone as compared to approximately 21 min for the MI phone calls. A potential limitation of this comparison of interventions is that the TE intervention was developed with baseline data input into computers by the participants. In response to baseline data, the computer generated Stage of Change matched scripts that interventionists then read to the participants over the phone. In contrast, the MI interventionists did not use baseline data information in the delivery

of the intervention. However, MI is often formulated as a stage-matched approach, as well; therefore, contrasting TE and MI in this manner may not have been true to the typical formulation and delivery of MI (Miller & Rollnick, 2002).

Meta-analyses

Table 3 shows the results of the individual meta-analyses by subgroup. The effect size for adherence was significant ($p < .05$); this result is meaningful given that only 2 samples were available for meta-analysis in this subgroup. All other subgroup meta-analyses were nonsignificant ($p > .05$). Insufficient power may be the underlying cause for some of the lack of significance in results, as some studies had moderate mean effect sizes, but the total number of samples to meta-analyze was small. Blood pressure meta-analysis found a mean effect size of .38, although only 3 studies were used in this meta-analysis. Similarly, the meta-analysis of body weight reduction RCTs found a mean effect size of .47 that approached significance ($p = .07$), although only 2 samples were available for meta-analysis. The meta-analysis of all samples found an overall significant mean effect size of .18 ($p = .02$). The Q-statistic, which is the test of heterogeneity within samples, was significant for 3 subgroups: blood pressure, substance use, and body weight reduction. The overall meta-analysis of all outcomes was also found to have a significant Q-statistic.

Moderator analyses were undertaken to assess for possible underlying variables that may account for the heterogeneity within samples. Results are presented in Table 4. Unfortunately, the small number of samples available for the blood pressure ($k = 3$) and body weight reduction ($k = 2$) prohibited the use of meta-regression analyses due to insufficient degrees of freedom. Meta-regression analyses within the substance use samples found significant effects of the professional credentials of the deliverer ($p = .0005$). It appears that with increasing levels of professional credentials of the deliverer (e.g., from research assistant, to master's level counselor, to physician), effect sizes were seen to increase. The same result was found in the meta-regression of all samples ($p = .004$), suggesting a robust effect of provider qualifications. Total clinical contact was not found to significantly moderate the results ($p > .05$), nor did the age of the participant receiving the intervention ($p > .05$) in both meta-regression analyses.

Quality assessment

Study design and execution quality ranged across the 12 studies surveyed. Risk of bias assessment found that nearly all studies were potentially biased by a lack of allocation concealment and lack of blinding. Allocation concealment is difficult to execute in a RCT of treatment interventions with human populations; especially when informed consent stipulates the difference between the experimental and control conditions. As such, there is likely a ceiling effect in the minimization of bias possible among these types of studies. Improvements could have been made in increasing blinding as only two studies reported blinding assessors to outcomes (Greaves et al., 2008; Ogedegbe et al., 2008). Please see table 3 for full results.

Discussion

This review and meta-analysis investigated the effectiveness of MI in RCTs conducted with primary care populations. Notably, the majority of reviewed studies used MI to intervene on substance use issues, the behavioral target for which MI was originally developed. Of the 12 studies reviewed, 7 targeted a substance use-related outcome. The other five studies targeted diet and exercise, medication adherence, and colorectal screening. Across all 12 studies, 9 demonstrated that MI was more effective at achieving targeted outcomes than were control conditions (e.g., usual care, didactic pamphlets). These results spanned a wide range of behavioral outcomes, such as substance use (self-report and objective GGT levels), household passive smoke exposure, low-impact physical activity time, blood pressure, weight, and self-reported smoking cessation rate. Null or mixed findings were found in an investigation of MI as an effective intervention for colorectal screening (Menon et al., 2011), medication adherence (Ogedegbe et al., 2008), and adolescent substance use (although this may be better accounted for by lack of power, as mentioned above) (Mason et al., 2011). As such, MI has been found to be generally effective with primary care populations, although certain modes of delivery or targets may be better than others.

Interventions varied considerably across several dimensions, such as number and length of sessions, mode of delivery, and qualifications of provider. Five of the 12 reviewed studies used 1 session and 8 of the reviewed studies used 3 or fewer sessions. Therefore, larger numbers of sessions were the rarity among this set of studies. Three or fewer sessions were found to be effective in improvement in substance use (Beckham, 2007; D'Amico et al., 2008; Schaus et al., 2009; Soria et al., 2006), multiple behavior change (Hyman et al., 2007), and household smoke exposure (Emmons et al., 2001). A larger (between 4 and 11) number of sessions was used for diet and exercise (Greaves et al., 2008; Hardcastle et al., 2008), alcohol use (Brown et al., 2007), and medication adherence interventions (Ogedegbe et al., 2008). It is possible that certain behaviors (e.g., weight loss efforts) may need more than several sessions to improve findings. However, for some behavioral targets, the minimum effective dose may in fact be one session such as for alcohol abuse (Beckham, 2007) and passive smoke exposure (Emmons

et al., 2001). Metaregression found that total time of clinical contact was not a significant moderator of effect sizes among all outcomes and the substance use subgroup of studies. In addition, sessions need not necessarily be delivered in person. Seven of the 12 studies used telephone calls in the delivery of the intervention. Five of these studies used phone calls as "booster" or follow-up sessions; however, 2 studies used the telephone as the only mode of delivery of the intervention. Brown et al., (2007) found significant decreases in alcohol use using up to 6 telephone sessions; however, Menon et al., (2011) did not find MI to be effective when delivered in 1 session to improve colorectal screening. As such, it is possible that telephone-only interventions may need more than 1 session to reach effectiveness. The subtleties of this intervention will be important to target in future research, so as to best identify the minimum effective dose for motivating and enhancing behavior change.

Variety between studies was also evidenced in the qualifications of the individuals delivering the intervention. Three studies used physicians or nurse practitioners to deliver the intervention (Beckham 2007; Schaus et al., 2009; Soria et al., 2006). One study detailed that the intervention was delivered by a master's level therapist (Mason et al., 2011). The remaining 8 studies described the individuals providing the intervention in terms such as "health educator", "counselor", "interventionist", and "research assistant". Given the growing awareness of cost-effectiveness within health care settings, it is extremely important for the qualifications of interventionists to be well elucidated. In addition, delineating the particular training completed by interventionists is important information to disseminate. Of the 12 reviewed studies, 7 studies did not describe the MI-specific training given to providers, or described the training in terms that were not translatable to quantitative variables (e.g., "extensive training", "thorough review of materials"). Of the 5 studies that detailed training completed by providers, the training time ranged from 8 h to 4 weeks, suggesting a wide variety of training practices among studies. In addition, only 6 of the 12 reviewed studies discussed whether or not providers received supervision after didactic training was completed, leaving an important area of clinical training and care unaddressed. With clear information about the design and delivery of the protocol, a cost-effective version of this intervention may be increasingly feasible to disseminate to clinical practice. Meta-regression analyses found that the professional qualifications of the intervention provider were a significant moderator of the effect sizes. It is possible that MI is more potent when delivered by individuals with higher levels of professional training; however, with better description of interventionist's qualifications, these results would be better elucidated. In addition, better description of MI training provided to interventionists would improve the ability to differentiate between provider's educational attainment and degree of proficiency with MI. It is possible that higher educational attainment is confounded by other variables (e.g., trust in provider, authority of provider). Investigators would have better ability to more precisely isolate this variable with improved reporting standards regarding technique-specific training provided to interventionists.

Streamlining of reporting of measurement outcomes will also improve the ability to gather implications from investigations, as well as generalize across studies. The effectiveness of MI is being tested among a variety of populations and behavioral outcomes; as such, consistently reporting outcomes such as pre- and post-treatment means and standard deviations will greatly improve the ability to compare effect sizes across studies. These results were only reported in 6 of the reviewed manuscripts and the results were not reported for all targeted outcomes in each study. However, after authors were contacted for further information, effect sizes were able to be calculated for 11 of the included 12 studies. As such, full reporting of null and significant findings, particularly in tabular form, would help the literature to better identify the minimum effective dose, the minimum qualifications necessary for the dose to be effective, and the best behavioral outcomes to target with this intervention.

In addition, it is important to note that populations seen within primary care settings are potentially different from those that most often encounter mental health interventions, such as MI techniques. MI methods are firmly established within substance abuse treatment centers and other psychological service centers; however, many individuals presenting to primary care settings may have little to no experience with mental health professionals. As such, it is important to determine whether these approaches are helpful in this non-psychological setting. The above results suggest that among those presenting to standard primary care facilities, MI approaches are generally helpful in eliciting behavior change. Finally, MI techniques have been demonstrated to have a broad application. If these techniques are capable of generalizing across conditions (e.g., alcohol use, smoking cessation, weight loss), it is possible that training in these approaches will be a significant resource to addressing the multiple behavior change difficulties that are affecting the average modern primary care patient.

Future research studies would benefit from broadening methodologies beyond comparing MI to usual care. Two studies employed unique designs, such as comparing MI that targeted three behavioral outcomes at once (simultaneously) or sequentially over three visits (Hyman et al., 2007) or comparing MI to computer-generated, stage-matched TE (Menon et al., 2011). With these increases in study design sophistication, more detailed information can be learned about the effectiveness of MI as compared to other short-term interventions that may be delivered in primary care settings. This study had a number of limitations. First, publication and English language bias may have limited the number of available studies included in this review. In addition, the small number of available RCTs for review and meta-analysis may have led to underpowered study results. Given the heterogeneity of the study outcomes, subgroup meta-analyses were deemed appropriate; however, these subgroup analyses further limit the power to find significant results. As discussed above, our study findings are also limited in that we were able to assess for the effect of interventionist qualifications, but not the degree of training each interventionist received particularly in MI. Future research may help to better investigate whether there is a differential effect of provider's educational attainment and MI-specific proficiency.

In conclusion, MI was found to be effective in comparison to usual care for a number of different behavioral outcomes with

primary care populations. MI has been found to be effective in as little as one 15-20 min session with an individual with minimal training in MI techniques, although the exact qualifications and training necessary to deliver the intervention require better reporting and clarification by future investigators. Higher levels of professional training may be more efficacious when it comes to obtaining strong effects from brief MI interventions. MI has been found to be effective when delivered either entirely over the phone, or when "boosted" by intermittent phone calls after in-person meetings. As such, this intervention appears to be extremely flexible in its formulation and delivery with this population. Given this flexibility, the literature will be better served by greater clarity in reporting standards, both for protocols and providers, as well as clinical and behavioral outcomes.

DOI 10.1007/s10865-013-9527-4

Received: February 1, 2013/Accepted: July 20, 2013/Published online: August 11, 2013

Acknowledgments The authors would like to thank Linda Gallo, Ph.D., for her revisions of an earlier version of this manuscript.

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Table 1 Motivational interviewing used in primary care populations:
primary outcomes

Authors and Year; study n	Population	MI intervention; provider; control
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Beckham, 2007; n = 26	Low-income community health patients in rural Idaho with at-risk drinking; 97 % Caucasian, 3 % African American, 58 % women, M age NR	1 45-60 min in-person MI session by nurse practitioner (NP) versus no treatment
Brown et al., 2007; n = 897	Primary care patients in Wisconsin with at-risk drinking; 86 % Caucasian, 9.2 % African American, 6.5 % Other, 55 % women; M age NR	6 telephone-based MI sessions and mailed follow-up letters by trained counselor versus mailed didactic pamphlet
D'Amico et al., 2008; n = 64	Low-income community health adolescents with high-risk substance use in Los Angeles County; 85.7 % Hispanic, 9.5 % African American, 4.8 % Caucasian, 52 % women, M age = 16	1 15-20 min MI session and follow-up booster phone call by trained case manager versus usual care (UC)
Emmons et al., 2001; n = 279	Low-income caregivers of child(ren) 3 years or younger; 46 % Caucasian, 19 % African American, 21 % Hispanic, 14 % Other, 91.5 % women, M age = 28	1 30-45 min MI session and 4 follow-up telephone counseling calls by trained interventionist
Greaves et al., 2008; n = 141	Primary care patients with BMI [greater than or equal to] 28 in semi/rural UK; race/ethnicity NR, 64 % women, M age 53.9	Up to 11 MI sessions in-person and telephone by health promotion counselor from community versus UC plus didactic materials
Hardcastle et al., 2008; n = 334	Primary care patients with BMI >28, hypertension, or high cholesterol in the UK; race/ethnicity NR, 67 % women, M age 51.1	Up to 5 in-person 20-30 min, stage-matched MI sessions by physical activity specialist or registered dietician versus UC
Hyman et al., 2007; n = 289	African American primary care patients age 45-65 nonadherent to 3 behavioral health outcomes living in the US; 100 % African American, 67.3 % women, M age = 53.3	1 MI session every 3 months focusing either on all behavioral outcomes (SIM) or 1 at a time (SEQ) and telephone follow-up by health educator versus UC
Mason et al., 2011; n = 28	Primary care adolescent women in Philadelphia, PA with at-risk substance use; 82 % African American, 18 % mixed race, 100 % women, M age = 16	1 20-min MI session and social network counseling by master's level therapist
Menon et al., 2011; n = 515	Primary care patients not adherent to colorectal screening in Midwestern and Southeastern US; 72.4 % African American, 17.7 % Caucasian, 9.9 % Other, 29.3 % women, M age = 58.1	1 telephone-based MI session (M = 21 min) or baseline data-informed, stage-matched tailored education (M = 13 min) by trained interventionist versus UC

Ogedegbe et al., 2008; n = 190	African American primary care patients with uncontrolled hypertension in NYC; 100 % African American, 88 % women, M age = 54	4 in-person 30-40 min MI sessions by trained research assistant versus UC
Schaus et al., 2009; n = 363	College students with high-risk drinking at public Southeastern US university; 78 % Caucasian, 11 % Hispanic, 5 % African American, 6 % Other; 52 % women, M age = 20.6	2 in-person 20-min dual MI-CBT sessions by general physician or nurse practitioner versus didactic pamphlet
Soria et al., 2006; n = 200	Primary care patients who smoked cigarettes in urban Spain; race/ethnicity NR, 51.8 % women, M age = 38.6	3 in-person 20 min MI sessions by general physician versus anti-smoking advice
Authors and Year; study n	Outcome	Results
Beckham, 2007; n = 26	AUDIT, 6-week alcohol quantity-frequency form, gamma-glutamyltransferase (GGT) blood test	Experimental group reported less daily alcohol use at 6/weeks ([M.sub.1] = 1.95 [+ or /] NR, [M.sub.2] = 3.77 [+ or /] NR drinks/day, p = 0.03) and had significantly lower GGT levels ([M.sub.1], [M.sub.2] = NR, p = 0.03).
Brown et al., 2007; n = 897	Timeline Follow-back Questionnaire	All participants improved over time, with experimental group males evidencing significantly lower drinking days ([M.sub.1] = 4.3 [+ or /] 5.8, [M.sub.2] = 6.6 [+ or /] 7.2) and amounts ([M.sub.1] = 57.4 [+ or /] 105.4, [M.sub.2] = 71.5 [+ or /] 65.3 drinks/month) than control group males (p's < .001). Results were NS for women (p > .05).
D'Amico et al., 2008; n = 64	RAND Adolescent/Young Adult Panel Survey	Those who received intervention demonstrated significantly lower intentions to use marijuana ([M.sub.1] = 2.75 [+ or -] 1.16, [M.sub.2] = 2.18 [+ or -] 1.09, p = .004), reported number of marijuana uses ([M.sub.1] = 1.21 [+ or -] 1.06, [M.sub.2] = 0.61 [+ or -] 0.87, p = .005), and perceived prevalence of use ([M.sub.1] = 6.2 [+ or -] 3.1, [M.sub.2] = 4.1 [+ or -] 3.1, p = .004).

		or -] 2.57, [M.sub.2] = 4.91 [+ or -] 3.18, p = .004).
Emmons et al., 2001; n = 279	Nicotine concentration monitor results in [microg/[m.sup.3], smoking cessation rates	MI group had significantly lower nicotine levels in kitchen ([M.sub.1] = 2.6, [M.sub.2] = 6.9 [microg/[m.sup.3], p < .05) and TV room ([M.sub.1] = 2.3, [M.sub.2] = 3.5, [+ or /] NR [microg/[m.sup.3], p < .05) as compared to control group. No significant difference in cessation rates between groups.
Greaves et al., 2008; n = 141	Odds of achieving 5 % reduction in weight and/or 150 min moderate activity per week	Odds ratio of reaching weight-loss target = 3.96 for intervention group [95 % CI 1.4-11.4], no significant difference on physical activity target between control and intervention OR 1.6, [95 % CI 0.7-3.8]
Hardcastle et al., 2008; n = 334	Blood pressure, cholesterol, weight, self-reported physical activity, dietary intake	Counseling group significantly increased walking time ([M.sub.[DELTA]1] = 198 [+ or -] 63, [M.sub.[DELTA]2] = -145 [+ or -] 109 met-min-wk, p < .01) and BMI ([M.sub.[DELTA]1] = -0.21 [+ or -] 0.10, [M.sub.[DELTA]2] = 0.15 [+ or -] 0.10 points, p < .01). Both groups increased fruit and vegetable intake and decreased fat intake, however control group decreased fat significantly more than did counseling group (p < .001).
Hyman et al., 2007; n = 289	Urine cotinine (smoking), pedometer counts (physical activity), blood indicators for hypertension, urine sodium level (mEq/L)	At 6 months, for sodium reduction, SIM ([M.sub.SIM] = 169.2 [+ or -] 169.2) was better than UC ([M.sub.UC] = 189.3 [+ or -] 92.1, p = .01) and SEQ ([M.sub.SEQ] = 200.4 [+ or -] 94.8, p = .04). No significant effects on other outcomes at 6-or 18-months. SIM significantly improved readiness to change on smoking and PA (p's = .02; .03)
Mason et al.,	Substance use, Readiness Ruler, high-risk sexual	No significant difference between groups on social

2011; n = 28	behavior	network, days and number of times substances used (p > .05). Significant differences were found on readiness to receive counseling (p < .05). Significant differences were found on trouble due to alcohol use, using substances before sexual intercourse, social stress, and offers to use marijuana (p's < .05). ([M.sub.1], [M.sub.2], = NR).
Menon et al., 2011; n = 515	Colorectal screening (e.g., stool blood test, sigmoidoscopy, colonoscopy) within 12 months of intervention	MI was not associated with significant increase in screening. Tailored education was significantly better than usual care (OR 2.4, 95 % CI 1.4-4.0).
Ogedegbe et al., 2008; n = 190	Medication adherence (medication events monitoring system), blood pressure	MI group did not evidence predicted adherence decline over time (Predicted [[DELTA].sub.1] = 1.5 % [+ or -] .78; Predicted [[DELTA].sub.2] = -12.3 %, [+ or -] 3.7, p = .81). Blood pressure readings were NS between groups.
Schaus et al., 2009; n = 363	Time-line follow back questionnaire, healthy lifestyle questionnaire, blood alcohol concentration (BAC) estimated from TLFB	Intervention had significantly lower peak estimated BAC at 3 months ([M.sub.1] = .112 [+ or -] .007, [M.sub.2] = .142 [+ or -] .007, [P.sub.trend] = .006), typical BAC ([M.sub.1] = 0.57, [+ or -] .004, [M.sub.2] = 0.73 [+ or -] .004, [P.sub.trend] = .02), lower peak number of drinks in a sitting ([M.sub.1] = 6.87 [+ or -] .40, [M.sub.2] = 8.03 [+ or -] .38, [P.sub.trend] = .04), and reduced number drinks per week ([M.sub.1] = 7.33 [+ or -] .62, [M.sub.2] = 9.45 [+ or -] .72, [P.sub.trend] = .03). Results tended to wane at 12-months.
Soria et al., 2006; n = 200	Smoking cessation self-report, CO-oximetry	Patients evidenced a 6.9 times greater odds of quitting in MI group after 12 months (OR 6.91, 95 % CI 1.98-24.15) than in control group

CI confidence interval, UK United Kingdom, SIM simultaneous, SEQ sequential, PA physical activity, M mean, NR not reported, Mi mean experimental group, M2 mean control group, MDi mean change experimental group, MD2 mean change control group

Table 2 Cochrane collaboration risk of bias tool

Author	Sequence generation	Allocation concealment	Blinding
Beckham, 2007	+	-	-
Brown et al., 2007	+	-	-
D'Amico et al., 2008	-	-	-
Emmons et al., 2001	+	-	-
Greaves et al., 2008	?	-	+
Hardcastle et al., 2008	+	-	-
Hyman et al., 2007	-	-	-
Mason et al., 2011	+	-	-
Menon et al., 2011	+	-	-
Ogedegbe et al., 2008	+	-	+
Schaus et al., 2009	+	-	-
Soria et al., 2006	+	-	-

Author	Incomplete outcome data	Selective outcome reporting
Beckham, 2007	+	-
Brown et al., 2007	+	-
D'Amico et al., 2008	+	+
Emmons et al., 2001	+	+
Greaves et al., 2008	+	+
Hardcastle et al., 2008	+	+
Hyman et al., 2007	+	+
Mason et al., 2011	+	+
Menon et al., 2011	+	+
Ogedegbe et al., 2008	+	+
Schaus et al., 2009	+	+
Soria et al., 2006	+	-

+ Low risk of bias, - High risk of bias, ? Not enough information reported to estimate risk of bias

Table 3 Main effects of meta-analyses

Outcome group	Mean ES	Min ES	Max ES	[95 % CI]	p
Blood pressure	0.38	-.22	.275	[-.24, .31]	.79
Substance use	.22	-.36	1.01	[-.21, .65]	.31
Body weight reduction	.47	.23	.75	[-.04, .99]	.07
Physical activity	.07	.02	.25	[-.08, .21]	.37
Adherence	.19*	.11	.30	[.01, .37]	.04
All outcomes	.18*	-.36	1.01	[.03, .33]	.02

Outcome group	Q	k
Blood pressure	6.87 *	3
Substance use	49.36 **	6
Body weight reduction	6.49 *	2
Physical activity	1.46	3
Adherence	1.20	2
All outcomes	75.32 **	16

Results from random effects models. ES effect size, CI confidence interval, p p value, Q Q statistic for test of heterogeneity within samples, k number of samples

* p < .05, ** p < .01

Table 4 Possible moderators of associations between motivational interviewing and outcomes

Outcome group	Moderator	B	SE	[95 % CI]	p
Substance use	Total contact	-.0003	.001	[-.002, .002]	.76
	Deliverer	.31 ***	.09	[.14, .48]	.0005
	Age	.17	.21	[-.25, .59]	.42
All outcomes	Total contact	.0011	.0006	[-.0001, .002]	.08
	Deliverer	.26 **	.09	[.08, .44]	.004
	Age	.23	.22	[-.20, .65]	.29

Results from mixed effects models. B Regression beta, SE standard error, CI confidence interval, p: p value, ** p < .01, *** p < .001

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Source Citation

VanBuskirk, Katherine A., and Julie Loebach Wetherell. "Motivational interviewing with primary care populations: a systematic review and meta-analysis." *Journal of Behavioral Medicine*, vol. 37, no. 4, 2014, p. 768+. *Gale Academic OneFile Select*, https://link.gale.com/apps/doc/A380342150/EAIM?u=yorku_main&sid=EAIM&xid=8cdf30f1. Accessed 5 Nov. 2020.

Gale Document Number: GALE|A380342150