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A Meta-Analysis of Motivational Interviewing Interventions for Pediatric Health Behavior Change

Laurie A. Gayes and Ric G. Steele
University of Kansas

Objective: Motivational interviewing (MI) is an empirically supported intervention that has shown effectiveness in moving people toward positive lifestyle choices. Although originally designed for adult substance users, MI has since expanded to other health concerns with a range of client age groups. The present study investigated the overall effectiveness of MI in the context of child and adolescent health behavior change and health outcomes. ***Method:*** A literature search using PsycINFO, PubMed, Google-Scholar, and Social Work Abstracts was performed. Thirty-seven empirical studies were included in this meta-analysis, encompassing 8 health domains. ***Results:*** The overall effect size (Hedges's *g*) of MI in this population as compared to both other active treatments and no treatment was $g = 0.282$ (95% CI [0.242, 0.323], $SE = 0.021$), slightly higher than a small effect size and also slightly higher than what has been typically found in the substance literature. Effect sizes varied by health condition such that the health domains with the largest overall effect sizes were Type 1 diabetes, asthma, and calcium intake. ***Conclusions:*** The effectiveness of MI in pediatric domains was moderated by factors such as practitioner background, health domain, and the family member who participated. Unexpectedly, number of MI sessions and follow-up length were not significant moderators. MI seems to be most effective when both parent and child participate in sessions and when the cultural background of the practitioner matches the family. Overall, these findings indicate that MI is an effective and appropriate intervention for targeting child health behavior changes.

Keywords: motivational interviewing, pediatric psychology, meta-analysis

Motivational interviewing (MI) is an empirically supported intervention that has shown promise in improving a range of health outcomes in a relatively brief amount of time (Lundahl, Kunz, Brownell, Tollefson, & Burke, 2010). Described by its founders as being "a client-centered, directive method for enhancing intrinsic motivation to change by exploring and resolving ambivalence" (Miller & Rollnick, 2002, p. 25), MI was developed by Miller and Rollnick in the 1980s as an alternative to traditional methods of treating substance abuse in adults (Miller & Rose, 2009). Over the last 30 years, MI has become an established treatment for adult substance abuse and has emerged as a promising method for treating a variety of behaviorally based health conditions and for a range of age groups (Miller & Rollnick, 2002).

In the adult population, several recent meta-analyses have examined the efficacy of MI for the treatment of a range of physical and mental health outcomes, including substance abuse, physical health conditions (e.g., adherence to medical treatment, weight loss, physical activity), and social or psychosocial outcomes related to physical illnesses (e.g., symptoms of eating disorders, improved health-related quality of life; Carey, Scott-Sheldon, Carey, & DeMartini, 2007; DiRosa, 2010; Heckman, Egleston, & Hofmann, 2010; Hettema & Hendricks, 2010; Knight, McGowan, Dickens, & Bundy, 2006; Lundahl et al., 2010; Rubak, Sandbaek, Lauritzen, & Christensen, 2005). Overall, results indicate that MI yields small to medium effect sizes across most outcome conditions. The largest and most comprehensive meta-analysis to date (Lundahl et al., 2010) found an overall average effect size (Hedges's *g*) of 0.22 and reported that the range of effect sizes for individual studies extended from −1.40 to 2.06.

Despite the fact that MI requires a somewhat sophisticated level of insight and discussion, there are multiple indications that this method may be well suited to children and adolescents. Ambivalence is common during this time, so normalizing both the resistance and desire to change may reduce frustration in both the youth and the clinician (Mehlenbeck & Wember, 2008). Also, MI's encouragement of *self-directed* change is likely to be appealing for youth (Baer & Peterson, 2002). Nevertheless, the evidence base for MI as an appropriate and effective intervention with children and adolescents is only emerging.

As in the adult literature, the majority of research into MI as an intervention among youth has been conducted in the substance abuse area. Two recent systematic reviews have suggested that MI is effective with adolescent substance abusers (Tevyaw & Monti, 2004; Wachtel & Staniford, 2010). To date, only one rigorous meta-analysis has been conducted on MI interventions for children and adolescents. Jensen et al. (2011) analyzed 21 studies of MI interventions for adolescent substance use and reported a small but significant mean effect size ($d = 0.17$) that persisted over time, consistent with what has been found in the adult literature (Carey

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Laurie A. Gayes and Ric G. Steele, Clinical Child Psychology Program, University of Kansas.

Correspondence concerning this article should be addressed to Ric G. Steele, Clinical Child Psychology Program, University of Kansas, 2010 Dole Human Development Center, 1000 Sunnyside Avenue, Lawrence, KS 66045-7555. E-mail: rsteele@ku.edu

et al., 2007; Hettema, Steele, & Miller, 2005; Lundahl et al., 2010; Vasilaki, Hosier, & Cox, 2006). Jensen and colleagues noted that the majority of studies involved only one session of MI, although the mean number of intervention sessions was four. Follow-up periods ranged from 1 month to 24 months. MI was most often the sole treatment but was also frequently combined with cognitive-behavioral therapy. Interventionists had a wide variety of backgrounds and education levels, and few studies reported treatment fidelity or counselor training.

Outside of substance use, MI has been applied to a range of child health domains, including diabetes, obesity and diet change, dental care, and reducing secondhand smoke in the homes of children with asthma (Erickson, Gerstle, & Feldstein, 2005; Suarez & Mullins, 2008). In their systematic review of these studies, Suarez and Mullins (2008) reported that the majority (i.e., seven of nine) randomized control trials identified yielded positive findings of MI groups over comparison groups, and Erickson and colleagues (2005) reported empirical support for MI for children's dietary control but noted a lack of sufficient evidence at that time to support MI in other areas. Other researchers have likewise reported that the research in pediatric health-risk behavior areas has been limited in quantity and quality but have noted that preliminary results are promising (Suarez & Mullins, 2008; Wachtel & Staniford, 2010). Erickson and colleagues said that MI is most promising in health care settings, but no systematic quantitative evaluation has been conducted to confirm this assertion.

A notable gap in the literature is the lack of a meta-analytic evaluation of MI as applied to health behavior change beyond substance abuse in children and youth. Thus, the primary aim of the present investigation is to summarize the current literature evaluating the use of MI for child health behaviors, quantifying the effectiveness of MI as compared to both active and passive control conditions. In doing so, this study provides direction for future research and assists practitioners in applying MI methods most appropriately to their child and adolescent populations. Based on the existing literature, it is hypothesized that MI interventions for pediatric health behaviors will be associated with small to medium overall effect sizes.

The second aim of the current study is to explain any variation in the existing MI literature by examining potential moderators of the effects of MI on child and adolescent health behaviors. As suggested by the range of effect sizes noted above, numerous meta-analyses of MI intervention studies indicate that effect sizes have varied (i.e., were moderated) by a number of factors, including comparison group, target health domain, dosage of treatment, treatment characteristics, participant characteristics, and practitioner characteristics (Burke, Arkowitz, & Menchola, 2003; Dunn, DeRoo, & Rivara, 2001; Hettema & Hendricks, 2010; Lundahl et al., 2010; Rubak et al., 2005; Vasilaki et al., 2006).

Importantly, the literature suggests that (among adults) MI yields favorable outcomes across all health domains studied, but results regarding relative efficacy across specific domains are mixed (Dunn et al., 2001; Lundahl et al., 2010). For example, Lundahl et al. (2010) reported the largest effect sizes for smoking cessation and gambling interventions and significantly smaller effect sizes for change in emotional well-being and eating disorder interventions. In contrast, Dunn and colleagues (2001) reported larger effect sizes in diet and exercise studies and smaller effect sizes among MI interventions to affect smoking cessation. Likewise, several studies have documented a dose–response of MI, with greater effect sizes being associated with greater numbers of sessions (Burke et al., 2003; Lundahl et al., 2010; Rubak et al., 2005; Vasilaki et al., 2006), although Hettema and Hendricks (2010) found that briefer sessions (less than 1 hour) delivered a more long-term impact than longer sessions.

Participant characteristics, such as age and ethnicity, also appear to moderate the impact of MI, although the direction is not consistent. Older participants tended to demonstrate better outcomes than younger participants but only when MI was compared to treatment as usual (Lundahl et al., 2010). In contrast, Hettema and Hendricks (2010) found that studies with adolescent samples (under age 18) had significant combined effect sizes at both short-term and long-term follow-up points ($d = 0.15$ and $d = 0.11$), while in adult samples, the effect sizes were not significant. Participants of minority ethnic/racial groups (Hettema et al., 2005; Lundahl et al., 2010) and international participants (Hettema & Hendricks, 2010) have demonstrated larger effect sizes than Caucasian American participants, but the data on MI with minority groups are still limited.

Few moderators of the efficacy of MI have been analyzed in the child literature thus far, and knowledge of the situations and participants that would be most likely to benefit from MI is greatly needed (Erickson et al., 2005; Resnicow, Davis, & Rollnick, 2006; Suarez & Mullins, 2008). Jensen and colleagues (2011) found that studies conducted on alcohol, tobacco, and drug interventions yielded relatively homogeneous effects (i.e., yielded a nonsignificant Q statistic). They also demonstrated that effects were maintained over time, although effect sizes calculated less than 6 months after treatment were relatively larger than those calculated 6 months after treatment.

Based on the available literature, the present study examines study rigor and design, treatment characteristics, participant characteristics, and provider characteristics as moderators of effect size in planned comparisons. It is hypothesized that MI will yield larger effect sizes when compared to passive control groups than active treatments, that greater time spent in treatment will be associated with larger effect sizes, and that effects will diminish over time but remain significant. Exploratory analyses will also determine whether MI performs differently alone versus in conjunction with another treatment and whether effect size varies across health populations.

Method

Literature Search

Comprehensive literature searches using psychological, medical, and general databases (PsycINFO, PUBMED/MEDLINE, Social Work Abstracts, and GoogleScholar) were used to identify interventions that reported using motivational interventions to change health behavior in youth. Searches were conducted in the Fall of 2012 using abbreviated and full keywords such as (motivation* enhancement OR interview*) AND (child OR adolescent OR youth). Furthermore, backward searching of reference lists of review articles and primary articles yielded additional relevant articles. *Dissertation Abstracts International* was also searched to gather nonpublished data. The bibliography list available on the official MI website administered by the

Motivational Interviewing Network of Trainers (www.motivationalinterview.org) also was searched for additional relevant articles. Researchers who authored more than one included study were contacted individually to inquire if they had relevant unpublished data that they would be willing to share. After duplicates were excluded, this literature searched produced 408 articles that were screened for inclusion.

Inclusion/Exclusion Criteria

All 408 article abstracts and articles were screened for potential inclusion in the study. Studies were retained at this point if they (a) involved MI or motivational enhancement therapy, (b) involved an intervention using either comparison/treatment groups or pretest–posttest assessment, (c) used participants who were youth with an average age of ≤18 years or parents of children in this age group, (d) reported target outcomes of pediatric health promotion, (e) were reported in English, and (f) reported enough information about results to calculate an effect size for the outcomes. Studies were excluded if mental health or substance abuse were the main health outcomes. Articles were retained for further review if they described procedures using the phrases *motivational interviewing* or *motivational enhancement therapy*, but not ambiguous phrases such as *motivational components*. Studies were included if MI was the sole treatment or if it was included in conjunction with another treatment. Health domains were not identified a priori; any nonaddiction pediatric health domain was included. Articles were analyzed for potential inclusion by two trained research assistants and the first author. Any disagreement was reconciled by discussion with the author until agreement was obtained.

Coding of Studies

Included articles were coded for study and participant characteristics by two independent research assistants as well as by the first author. Any discrepancies identified were clarified by the author. Study characteristics that were coded included health outcome, groups compared (treatment vs. control), methodology, sample size, mean age, participant ethnicity, whether MI stood alone or was used with another treatment, number of sessions, duration of treatment, follow-up times, fidelity assessment, and study rigor. Study rigor was quantified based on study characteristics including reporting data on demographics, sample size, objectively measuring outcomes, assessing fidelity, and so on, based on the 18-point rating scale used by Lundahl and colleagues (2010.) This scale was selected because it has been used in a similar meta-analysis and was the most comprehensive tool for the purpose identified. Effect sizes were calculated from differences in outcome variables between the intervention group and the control group or between pre- and postintervention assessments. Raters achieved 96% reliability with each other prior to clarification.

Studies were categorized across several dimensions for categorical moderator analyses. Some of these dimensions require description. Interventionist profession was determined using the descriptive data presented in the study. Studies were included in the *master's and doctoral level category* if these degrees were mentioned in the description of the interventionists. Studies were included in the *professional category* if no master's or doctoral degree was mentioned but interventionists were described as health professionals (e.g., nurses, nutritionists, etc.). Studies were included in the *community health worker* category if no health profession or educational degree was described but interventionists were described as being community members, health educators, health coaches, and so on. If no descriptions were provided about the interventionists, the study was put in the *no data* category.

Regarding type of outcome, outcomes were considered physical if the measurement tool was directly measuring a marker of physical health (e.g., body mass index [BMI], hemoglobin A_{1C}, number of days breastfeeding, number of days with asthma symptoms, etc.). Outcomes were considered psychosocial if the tool was measuring a psychological factor related to health (e.g., motivation, self-efficacy, quality of life, self-concept, perceived barriers to change, etc.).

Studies were considered to utilize a passive control group if the comparison group received no treatment (i.e., wait-list control), was the baseline measurement for the intervention group, or received some form of treatment as usual. Active control groups utilized an active form of treatment above and beyond treatment as usual (e.g., health education group, exercise group, problem-solving skills group, etc.).

Statistical Approach

Descriptive statistics of the studies included in the meta-analysis are presented, including range of health conditions, comparison groups, randomization procedures, follow-up length, fidelity to treatment, number of sessions, types of participants, and background of interventionist.

Effect sizes were calculated to measure the direction and magnitude of pediatric health behavior change as a result of MI interventions. These effect sizes were represented using Hedges's *g*. Hedges's *g* was used rather than Cohen's *d* because it yields more accurate results for studies with smaller sample sizes (Card, 2012). For studies that represented effect sizes using other metrics, data were converted to *g* using standard procedures as recommended by Card (2012) and based on the metric of the results of primary studies (e.g., from means and standard deviations, chi-square contingency table, significance test, odds ratio, etc.). Studies reporting only a significant statistical association were assumed to be $p = .05$ unless otherwise stated and were assigned the minimum *g* that would yield that level of significance. Likewise, if a study reported nonsignificance but did not report a specific *p* value, the study was assigned a $g = 0.00$. These methods represent a conservative measurement of overall effect size and thus may underrepresent the true effect size (Card, 2012).

Effect sizes were combined using a sample-size weighted approach, where individual studies were weighted according to their amount of standard error, giving more weight to studies with larger sample sizes (Card, 2012). Multiple effect sizes from a single study were averaged to yield a single effect size per study to avoid violation of assumptions of independence. A weighted mean effect size was then calculated to combine weighted effect sizes from all studies. Confidence intervals were constructed for each study, and intervals that did not contain zero were considered statistically significant whereas intervals that contained zero were considered not significant.

The Q statistic was calculated (with a fixed-effects model; Card 2012) to determine the degree of heterogeneity in effect sizes (Card, 2012). If heterogeneity was found, then moderators of amount of time in treatment, type of comparison group, health domain, study quality, and the presence of other additive treatment components were analyzed, as these are variables that have been relevant in the adult literature.

To assess for possible publication bias, a fail-safe *N* calculation and a funnel plot depiction were provided. The fail-safe *N* calculation indicated the number of excluded studies averaging an effect size of zero that would have to exist in order for the overall effect size to be lowered to zero. A funnel plot is a scatterplot of effect sizes relative to sample sizes. A funnel shape of data points indicates a relative absence of publication bias (Card, 2012).

Results

Description of Studies

The literature search returned 37 studies that were eligible for inclusion based on stated criteria for this meta-analysis (see Figure 1). The majority of studies were excluded for not conducting an intervention using MI (107 studies) and for not providing the data necessary to calculate an effect size (109 studies; e.g., feasibility studies, qualitative studies, etc.). Studies were also excluded based on not using a comparison group or providing pretest–posttest measurements (four studies), not having youth participants (43 studies), not targeting health promotion (five studies), not reporting in English (two studies), and reporting on mental health or substance abuse outcomes (53 studies).

Across the 37 included studies, 393 effect sizes were calculated. To prevent violations of independence, multiple effect sizes within the same study were averaged to create a single effect size per study. Not surprisingly, due to the large number of studies included in this analysis, the literature represents considerable diversity across study characteristics. Table 1 provides information about the characteristics of these studies.

Study design characteristics. The majority of the studies were published in the last 5 years, with the earliest study having been published in 2001, indicating that research in this field is rather new and growing rapidly.

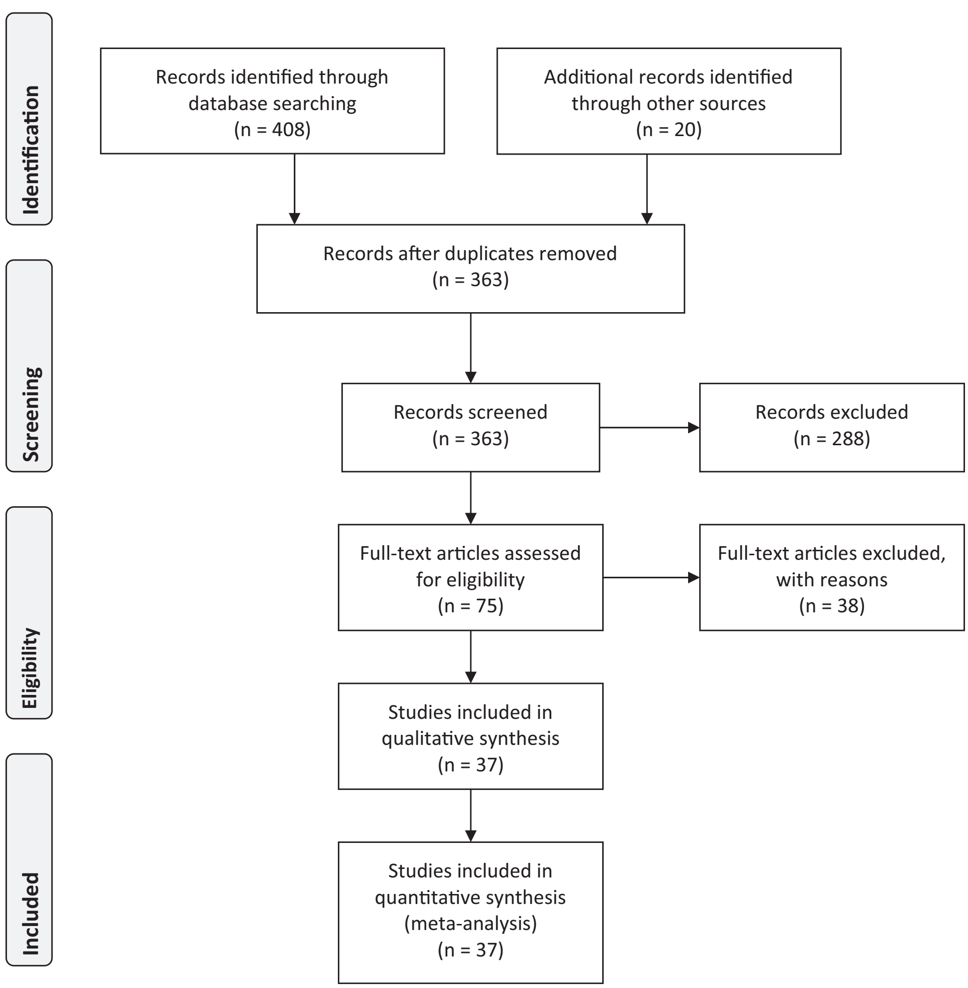

Figure 1. PRISMA 2009 flow diagram for included studies.

Table 1
Selected Study Characteristics and Average Study Effect Sizes

Study	Total sample size (*N*)	Study effect size (95% CI)	Participant	Average child age (years)	Health concern	Education level of interventionist	Group or individual	% of sample non-Caucasian	Number of MI sessions	Follow-up period (months)
Ball et al. (2011)	20	0.632 (−0.266, 1.530)	Child	15.60	Obesity	HS	Both	7	16	1
Barkin et al. (2008)	3,284	0.332 (0.267, 0.397)	Parent	6.50	Accident prevention	MA	Group	30	5	24
Barnet et al. (2009)	235	0.357 (0.034, 0.679)	Child	17.00	Infant health	HS	Group	97	9	11
Black et al. (2010)	235	0.067 (−0.224, 0.358)	Child	13.30	Obesity	BA	Group	97	12	1
Borrelli, McQuaid, Novak, & Hammond (2010)	133	0.074 (−0.337, 0.486)	Parent	—	Asthma	MA	Group	97	2	1
Cain, Gradisar, & Moesely (2011)	104	0.119 (−0.278, 0.516)	Child	16.20	Sleep	MA	Individual	—	4	1
Chan et al. (2005)	80	0.177 (−0.262, 0.617)	Parent	—	Smoking cessation for parents of sick children (asthma group)	BA	Group	100	1	6
Channon et al. (2007)	22	0.353 (−0.230, 0.936)	Both	15.80	Type 1 diabetes	MA	Individual	0	9	2
Channon, Smith, & Gregory (2003)	60	2.300 (1.345, 3.254)	Child	15.00	Type 1 diabetes	BA	Group	—	4	2
Davis et al. (2011)	38	0.453 (−0.342, 1.247)	Child	16.00	Obesity	—	Both	100	4	4
Flattum, Friend, Story, & Neumark-Sztainer (2011)	182	1.738 (0.987, 2.489)	Child	15.70	Obesity	—	Individual	75	7	0
Freudenthal & Bowen (2010)	72	0.139 (−0.303, 0.571)	Parent	—	Dental health	—	Group	—	1	9
Halterman, Riekert, et al. (2011)	28	0.570 (0.083, 1.137)	Child	13.60	Asthma	BA	Group	91	3	4
Halterman, Szilagyi, et al. (2011)	530	0.610 (0.395, 0.745)	Both	7.10	Asthma	BA	Group	100	1	24
Harrison, Benton, Everson-Stewart, & Weinstein (2007)	240	0.404 (0.128, 0.681)	Parent	1.00	Dental health	HS	Group	100	1	6
Ismail, Ondersma, Jedele, Little, & Lepkowski (2011)	599	0.076 (−0.069, 0.221)	Parent	4.00	Dental health	MA	Both	100	1	3
MacDonell, Brogan, Naar-King, Ellis, & Marshall (2012)	44	0.116 (−0.475, 0.708)	Both	15.10	Obesity	—	Group	100	4	0.5
Manarino (2007)	30	0.597 (0.079, 1.114)	Child	12.50	Calcium intake	MA	Individual	33	2	6
Naar-King, Outlaw, Green-Jones, Wright, & Parsons (2009)[a]	87	0.797 (0.350, 1.244)	Child	21.10	HIV/AIDS	HS and MA	Group	99	2	6
Naar-King, Parsons, et al. (2009)[a]	186	0.220 (−0.100, 0.539)	Child	20.50	HIV/AIDS	MA	Group	83	4	4
Naar-King, et al. (2006)[a]	51	0.576 (−0.100, 0.539)	Child	21.00	HIV/AIDS	MA	Group	97	4	9

(*table continues*)

Table 1 (*continued*)

Study	Total sample size (*N*)	Study effect size (95% CI)	Participant	Average child age (years)	Health concern	Education level of interventionist	Group or individual	% of sample non-Caucasian	Number of MI sessions	Follow-up period (months)
Neumark-Sztainer et al. (2010)	356	0.159 (−0.054, 0.372)	Child	15.80	Obesity	—	Both	56	6	12
Obarznek et al. (2001)	663	0.046 (−0.118, 0.209)	Child	9.00	Obesity	MA	Both	14	2	6
Olson, Gaffney, Lee, & Starr (2008)	284	0.183 (−0.100, 0.466)	Child	—	Obesity	BA	Group	4	1	6
Resnicow, Taylor, Baskin, & McCarty (2005)	123	0.013 (−0.356, 0.383)	Child	13.60	Obesity	BA	Individual	100	6	2
Riekert, Borrelli, Bilderback, & Rand (2011)	37	0.287 (−0.171, 0.745)	Child	12.50	Asthma	BA	Group	100	2	4.5
Robertson et al. (2011)	333	0.469 (0.216, 0.723)	Child	15.00	HIV/AIDS	—	Both	71	18	0
Schmiege, Broaddus, Levin, & Bryan (2009)	484	0.129 (−0.092, 0.351)	Child	15.80	HIV/AIDS	—	Individual	64	1	6
Schwartz et al. (2007)	91	0.275 (−0.346, 0.896)	Parent	5.30	Obesity	MA	Both	—	1.5	1
Seid et al. (2012)	26	0.781 (−0.019, 1.581)	Child	15.00	Asthma	MA	Group	89	2	6
Taveras, Blackburn, et al. (2011)	475	−0.002 (−0.189, 0.186)	Parent	4.50	Infant health	MA	Both	26	4	6
Taveras, Gortmaker, et al. (2011)	84	0.192 (0.004, 0.380)	Parent	0.25	Obesity	MA	Group	43	4	12
Viner, Christie, Taylor, & Hey (2003)	77	2.745 (2.082, 3.408)	Child	13.30	Type I diabetes	—	Individual	—	6	6
Wang et al. (2010)	44	−0.551 (−1.153, 0.051)	Child	15.00	Type 1 diabetes	—	Group	32	2	0
Weinstein, Harrison, & Benton (2006)	240	0.562 (0.282, 0.842)	Parent	1.00	Dental health	HS	Group	100	1	6
Wilhelm, Stephans, Hertzog, Rodehorst, & Gardner (2006)	73	0.222 (−0.239, 0.682)	Parent	0.25	Infant health	BA	Group	12	3	3
Wilson (2002)	53	0.400 (−0.242, 1.041)	Child	13.00	Obesity	—	Individual	100	12	1

Note. Dashes indicate that no data were reported. HS = high school; BA = bachelor's degree; MA = master's degree; MI = motivational interviewing.
[a] These studies were included even though the mean age was above 18 because a substantial percentage of the age range was within adolescence.

Health conditions. Across the 37 identified studies, eight health conditions were targeted for intervention. Of the included studies, 32.4% (*n* = 12) targeted pediatric obesity, 16.2% (*n* = 6) targeted asthma, 13.5% (*n* = 5) targeted HIV/AIDS, 10.8% (*n* = 4) targeted Type 1 diabetes, 8.1% (*n* = 3) targeted infant health, 10.8% (*n* = 4) targeted dental health, 2.7% (*n* = 1) targeted accident prevention, 2.7% (*n* = 1) targeted sleep, and 2.7% (*n* = 1) targeted calcium intake.

Comparison groups. The majority of studies (59%; *n* = 22) compared MI to a passive control group (e.g., wait-list control, baseline measures). In contrast, 35.1% (*n* = 13) of studies compared MI against another active treatment (e.g., moderate intensity version of the intervention, health education group, nutrition counseling group). Two studies (5.4%) compared MI to both an active and a passive control group.

Studies differed in the quality of randomization procedures. True randomization procedures were used in 54% of studies, matched groups or cluster randomization (e.g., by school, classroom, or medical practice) was used in 27% of studies, and comparison groups were not randomly assigned in 5% of studies (but groups were tested for pretreatment equivalence across several variables). Fourteen percent of studies compared the intervention group's posttreatment scores to its pretreatment scores.

About half of the studies (48.6%; *n* = 18) used MI as a stand-alone treatment, and the other half (51.4%; *n* = 19) incorporated MI along with another form of treatment (e.g., exercise program, health education, parenting skills training, dietary intervention).

Follow-up. Average follow-up length (measured as time since baseline) was 5.46 months (*SD* = 5.58), and follow-up ranged from no follow-up to 2 years.

Treatment fidelity. Fidelity to treatment was discussed in 40.5% (*n* = 15) of studies. However, results of objective fidelity measurements (i.e., scores on the Motivational Interviewing Treatment Integrity (MITI) code 3.0) were reported in only 13.5% (*n* = 5) of studies. When reported, fidelity to MI principles was generally high, with interventionists nearly always demonstrating proficiency in the domains of measurement (e.g., adherence to MI spirit, demonstration of empathy, open-ended questions, complex reflections).

Study rigor. Study rigor was measured using an 18-point methodological quality scale created by Lundahl and colleagues (2010). Results indicated that the average total score on this scale was 10.78, with a range of 6 to 15. Results included the following: Seventy percent of studies reported at least three demographic variables, 43% of studies had a follow-up measurement after the postintervention measurement, 24% of studies used blinded coders/data collectors, 70% of studies collected objective measurements, 16% of studies used a standardized intervention, and 89% of studies had over 20 participants per group. Seventy-three percent of studies presented enough information for an effect size to be calculated using means and standard deviations, which yields a more accurate effect-size calculation than using a test statistic. In 62% of studies, outcomes came from at least two sources (e.g., objective measurement and self-report, or both parent and child reports), while for 27% of studies, self-report was the only source of data, and for 11% of studies, just a collateral source was used (e.g., objective report or parent report).

Session characteristics. Both group and individual therapy sessions were utilized, with 56% (*n* = 21) of studies using group therapy MI sessions, 21.6% (*n* = 8) of studies using individual MI sessions, and 21.6% (*n* = 8) of studies incorporating both group and individual MI sessions. Average number of MI sessions was 4.53 (*SD* = 4.21).

Participant characteristics. The average number of participants per study was 262.24 (*SD* = 540.04), with a range from 20 participants to over 4,000 participants. Although the targeted outcomes were pediatric focused, studies differed on which family members participated in the intervention. Results indicated that in 62.2% (*n* = 23) of studies the child participated in MI sessions alone, in 29.7% (*n* = 11) of studies the parent participated alone, and in 8.1% (*n* = 3) of studies the parent and child both participated in MI sessions. The child was on average 12.01 years of age (*SD* = 6.04). Results also indicated that the average study's participants were 69.28% (*SD* = 6.04) non-Caucasian and 36.54% (*SD* = 24.86) male.

Interventionist characteristics. Interventionists had a wide range of backgrounds and education levels. Results demonstrated that 10.8% (*n* = 4) of studies used nonprofessional community members as interventionists, 27% (*n* = 10) of studies used professional interventionists but specific information about educational training was not mentioned (e.g., nurses, dieticians), and 35.1% (*n* = 13) used master's and doctoral level clinicians. Twenty-seven percent of studies (*n* = 10) did not give information about the interventionist.

Overall effect size. The overall effect size for MI interventions targeting pediatric health behavior change was statistically significant (*g* = 0.282, 95% CI [0.242, 0.323], *SE* = 0.021, *n* = 37). This finding is slightly larger than Cohen's classification of a small effect size (Cohen, 1988). In fact, only 2.7% of studies yielded a negative effect size, and the bottom 25% of studies ranged from a negative effect size to an effect size of just over 0.1, indicating that even the most ineffective studies were still largely more effective than the alternative. Almost all studies in this meta-analysis (95%) yielded improved outcomes as compared to the alternate group or to the baseline. The top 25% of studies yielded effect sizes of 0.57 and above, classified by Cohen as medium to large, indicating a sizable improvement over the comparison group. Individual studies contributed to the weighted overall effect size as depicted in Figure 2.

Given the range and diversity of study variables, this overall effect size likely is too broad to capture the many factors influencing study effect sizes. Not surprisingly, these studies yielded a significant Q statistic, indicating that the studies included in the meta-analysis displayed a more heterogeneous group of effect sizes than would be expected on the basis of chance alone (Q = 159.059, $p \leq .001$). This finding indicates that moderating variables, such as participant, session, and practitioner characteristics, are significantly influencing study effect sizes, and they are discussed below.

Moderator Analyses

Moderator variables were selected to reflect intervention characteristics (e.g., number of sessions, length of follow-up), practitioner characteristics (e.g., education level), and participant characteristics (e.g., age, participant) and are based on findings from

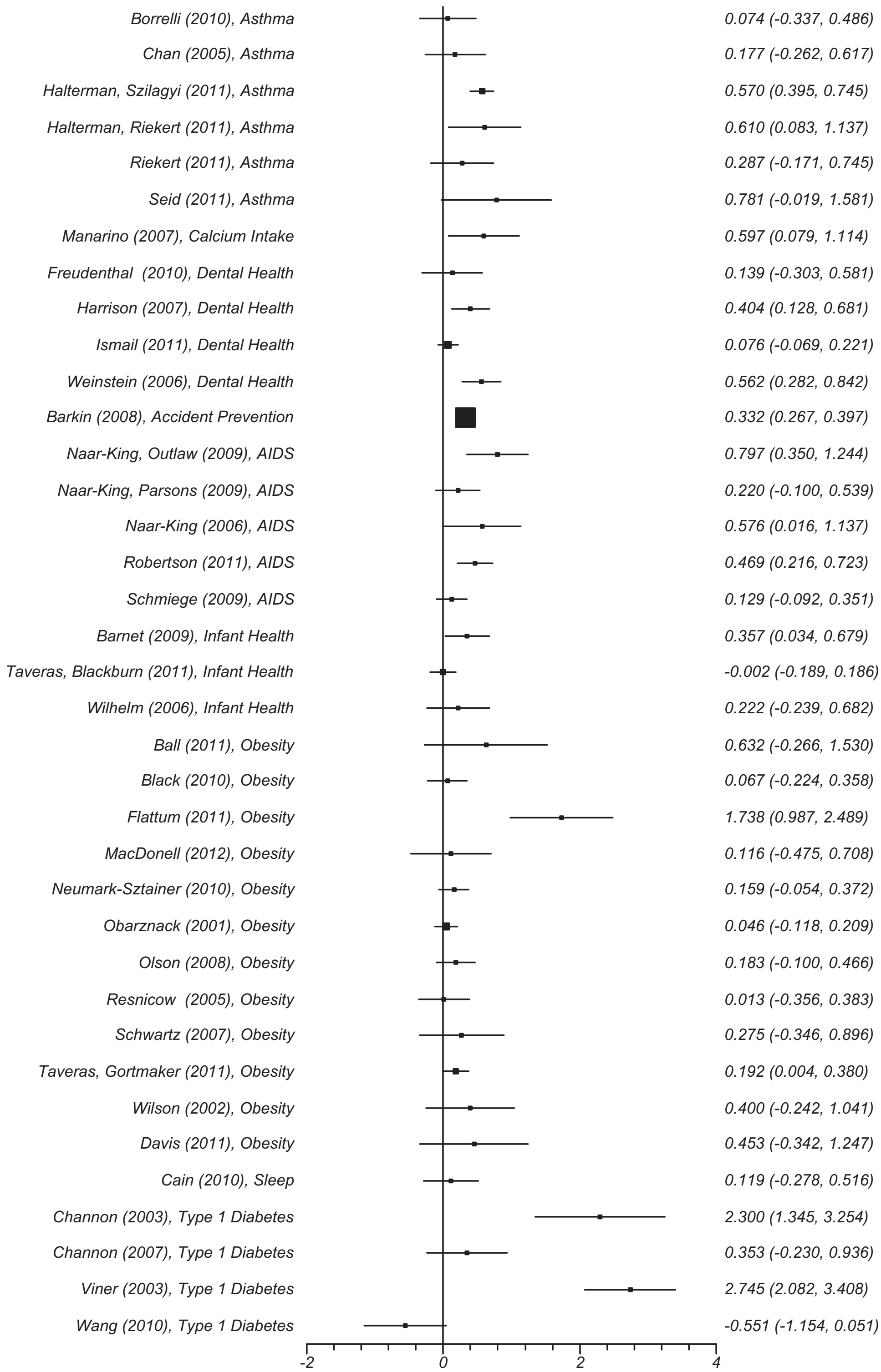

Figure 2. Forest plot of all included studies.

previous MI meta-analyses (e.g., Burke et al., 2003; Dunn et al., 2001; Hettema & Hendricks, 2010; Lundahl et al., 2010; Rubak et al., 2005; Vasilaki et al., 2006).

Continuous moderators. Continuous moderators analyzed in this meta-analysis were average child age, percentage male, percentage non-Caucasian, number of follow-up sessions, length of follow-up, and study quality. None of these continuous moderators yielded a sizable or statistically significant R^2 value. For number of sessions, 70% of studies utilized four or fewer sessions of MI, seemingly without a loss of impact.

Categorical moderators. Categorical moderators tested in this meta-analysis included provider education level, participant (i.e., child, parent, both), group/individual therapy, MI as standalone/component, type of control group, health domain, and fidelity to treatment (i.e., fidelity checked, fidelity not checked). Results are depicted in Table 2. Practitioner profession, participant, and fidelity to treatment were statistically significant moderators because they reduced the amount of between-groups variance to nonsignificant levels (see column 5, Table 2). The other categories were nonsignificant at the omnibus level, as they left variance unexplained, but groups within the category may still have accounted for significant variance. Results of categorical moderator analyses are also presented graphically in Figure 3.

Practitioner profession characteristics. Community health workers demonstrated the largest effect size (g = 0.491, 95% CI [0.334, 0.649]), followed by professional interventionists (e.g., nurses, nutritionists; g = 0.361, 95% CI [0.252, 0.470]), and interventionists with master's and doctorate degrees demonstrated the lowest effect size (g = 0.240, 95% CI [0.191, 0.289]). These results suggest that community health workers are statistically significantly more successful at eliciting client behavior change than interventionists with master's and doctorate degrees but not statistically distinct from professional interventionists.

Participant characteristics. Studies were partitioned based on whether they conducted MI with the child, with the parent, or with both the child and parent. Studies that conducted MI with both the child and parent yielded the largest effect sizes (g = 0.586, 95% CI [0.370, 0.752]), demonstrating that conducting MI with both parent and child is more effective than conducting MI with either parent or child individually.

Table 2
Summary Table of Categorical Moderator Analyses

Categorical moderator	Effect size (95% CI)	Q test of heterogeneity	Number of studies in group	Between-groups Q statistic
Interventionist profession				4.516
Community health worker	0.491 (0.334, 0.649)	3.094	4	
Professional	0.361 (0.252, 0.470)	32.496***	10	
Master's+	0.240 (0.191, 0.289)	30.825**	13	
No data	0.312 (0.198, 0.426)	80.748***	10	
Participant				13.825
Child	0.257 (0.185, 0.370)	104.742***	23	
Parent	0.266 (0.215, 0.317)	25.605*	11	
Both	0.586 (0.421, 0.752)	14.829***	3	
Group vs. individual therapy				22.037***
Group	0.336 (0.287, 0.385)	52.047***	21	
Individual	0.361 (0.074, 0.506)	72.431***	8	
Both	0.117 (0.037, 0.197)	12.364	8	
Alone vs. component				5.606*
Alone	0.324 (0.271, 0.377)	39.284**	18	
Component	0.224 (0.162, 0.287)	114.039***	19	
Outcome type[a]				5.418*
Physical	0.184 (0.168, 0.200)	4205.273***	261	
Psychosocial	0.221 (0.194, 0.248)	1994.482***	130	
Type of control group				57.486***
Active control	0.189 (0.099, 0.279)	23.013*	12	
Passive control	0.301 (0.257, 0.346)	78.431***	25	
Fidelity to treatment				2.403
Checked	0.217 (0.126, 0.308)	39.502***	15	
Not checked	0.298 (0.253, 0.343)	117.096***	22	
Health domain				46.165***
Accident prevention	0.293 (0.267, 0.397)		1	
Asthma	0.444 (0.454, 0.435)	10.544	7	
Calcium intake	0.597 (0.080, 1.114)		1	
Dental health	0.213 (0.207, 0.220)	11.366**	4	
HIV/AIDS	0.332 (0.323, 0.342)	9.718*	5	
Infant health	0.153 (0.136, 0.171)	2.979	3	
Obesity	0.150 (0.146, 0.154)	21.656*	12	
Sleep	0.119 (−0.278, 0.516)		1	
Type 1 diabetes	0.914 (0.858, 0.970)	63.668***	4	

Note. CI = confidence interval.
[a] Because an individual study often reported on multiple outcomes, all effect sizes were included in this analysis.
* $p < .05$. ** $p < .01$. *** $p < .001$.

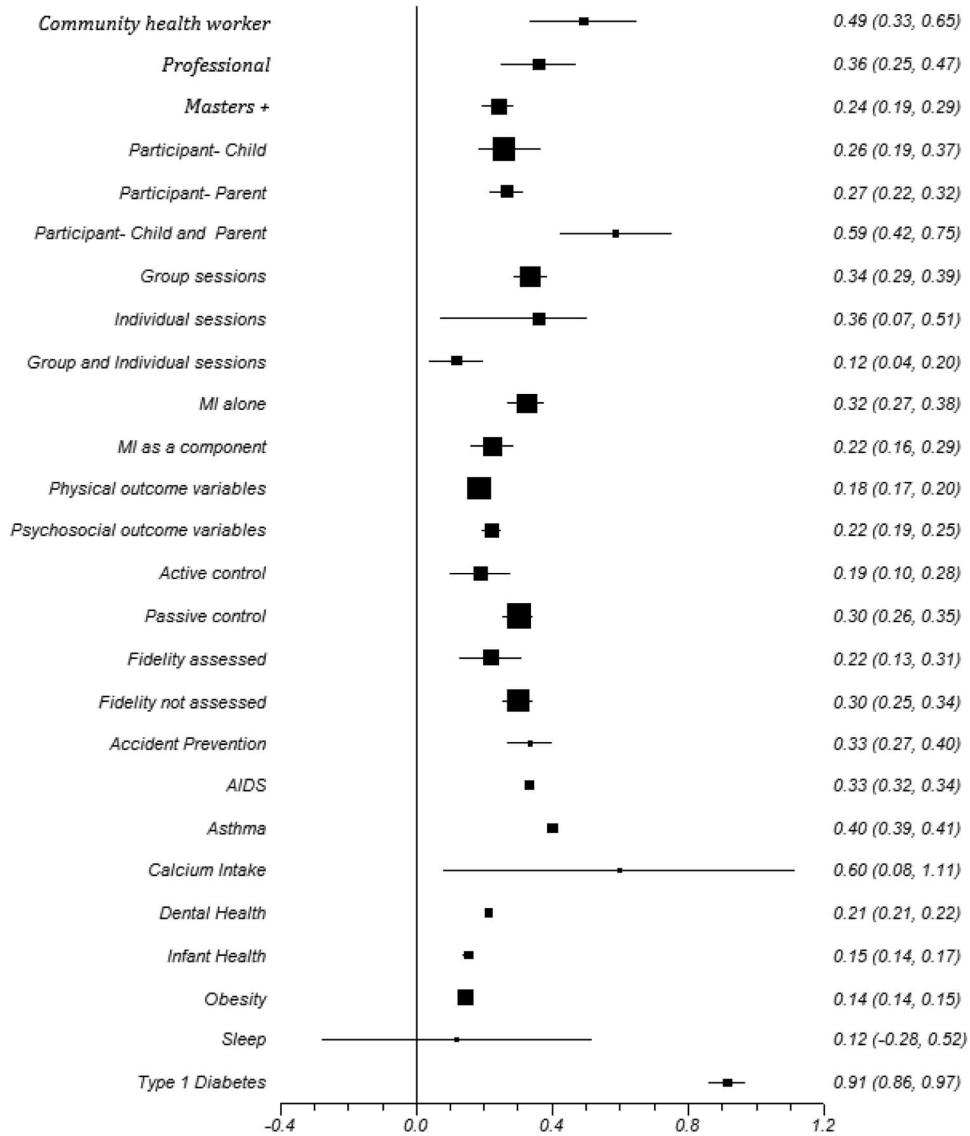

Figure 3. Forest plot of categorical moderators. MI = motivational interviewing.

Session characteristics. Both individual and group MI sessions appeared to be similarly effective; however, there was more variability among studies using individual sessions than in studies using group session studies (individual $g = 0.361$, 95% CI [0.074, 0.506]; group $g = 0.336$, 95% CI [0.287, 0.385]).

Study design characteristics. Studies of MI as a stand-alone treatment were not significantly different than studies that used MI with other treatment components, although MI alone tended to demonstrate greater effect sizes (alone $g = 0.324$, 95% CI [0.271, 0.377]; component $g = 0.224$, 95% CI [0.162, 0.287]). Psychosocial outcomes of studies tended to demonstrate larger effect sizes than physical outcomes of studies, but the results were not statistically significant (psychosocial $g = 0.221$, 95% CI [0.248, 0.194]; physical $g = 0.184$, 95% CI [0.168, 0.200]). Effect sizes varied by health domain such that the domains with the largest overall effect size were Type 1 diabetes ($g = 0.914$, 95% CI [0.858, 0.970]), calcium intake ($g = 0.597$, 95% CI [0.080, 1.114]), and asthma ($g = 0.444$, 95% CI [0.454, 0.435]). Studies that mentioned assessing fidelity to treatment were not distinct from studies that did not assess fidelity (checked $g = 0.217$, 95% CI [0.126, 0.308]; not checked $g = 0.298$, 95% CI [0.253, 0.343]). Finally, as expected, effect sizes tended to be greater when MI was compared to a passive control than to an active control (passive control $g = 0.301$, 95% CI [0.257, 0.346]; active control $g = 0.189$, 95% CI [0.099, 0.279]).

Fail-safe N calculation. Because studies with null findings are more likely to remain unpublished than studies with significant findings, there is a concern that the overall effect size of a meta-analysis may be an overly positive estimation of the true effect size in the population. In this study, a fail-safe *N* calculation demonstrated that approximately 1,555 studies with an effect size of zero would be required to bring the observed overall effect size to zero

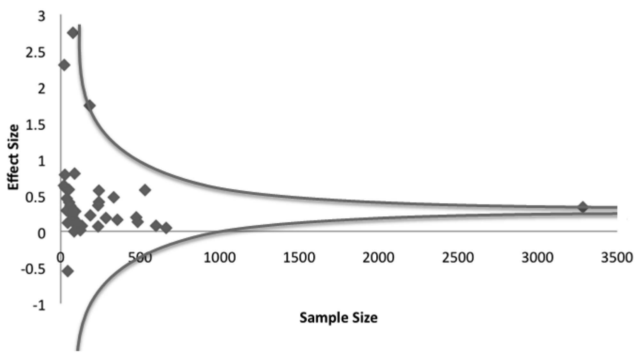

Figure 4. Funnel plot of study sample size and effect size.

(Rosenthal, 1979). Further evidence against publication bias is depicted in the funnel plot in Figure 4. A more-or-less funnel-shaped plot provides support that studies were not selectively published based on significance.

Discussion

MI is a clinical method intended to help clients make behavioral changes in their lives. Originally designed for adult substance users, it has since been adapted for use across a range of health behaviors and a diversity of clinical populations. This meta-analysis is the first to examine the effectiveness of MI for health behavior change in pediatric populations. Pediatric health domains currently utilizing MI vary widely and include asthma, HIV/AIDS, dental health, Type 1 diabetes, infant health, obesity, calcium intake, accident prevention, and sleep. Results from this meta-analysis suggest that MI produces a small but significant effect size across a range of child health behaviors ($g = 0.282$), indicating that overall, MI outperforms the alternative. Furthermore, effects of MI appear to be durable, as there was no evidence of a statistically significant decrease in effect size over follow-up time points, consistent with previous findings (e.g., Heckman et al., 2010; Jensen et al., 2011; Lundahl et al., 2010). Thus as a whole, the results suggest that MI is an effective and appropriate method to use for pediatric health behavior change.

These findings are consistent with previous meta-analyses demonstrating the effectiveness of MI to target substance use behavior change (e.g., Burke, Dunn, & Atkins, 2004; Jensen et al., 2011; Rubak et al., 2005), although the estimated effect size is slightly greater in the present study. Considering the inherent challenges of changing addictive behaviors, it may not be surprising that behavior change for other types of health behaviors may be more successful than substance use. For instance, changing addictive behaviors involves altering physiological addiction processes, whereas changing other health behaviors may not. People with problematic substance use may arrive to treatment due to a court order, which is unlikely for other health behavior change seekers. Socially, pediatric health behaviors may have more supportive systems in place that work to sustain change (e.g., families, schools, medical providers; Ellis et al., 2012). Similarly, substance use treatment may be more likely to target the adolescent alone, versus targeting the family as a whole in health behavior treatment. Finally, stigma around adolescent substance use has been found to be a significant barrier to treatment (Wisdom, Cavaleri, Gogel, & Nacht, 2011); perhaps there tends to be less stigma around health behaviors in youth, making it easier to seek support from others.

When comparing effectiveness across health domains, it is notable that all health domains that included more than one study yielded statistically significant positive effect sizes, largely consistent with previous research (e.g., Lundahl et al., 2010). The most studies have been conducted on obesity ($n = 12$, $g = 0.150$) and asthma ($n = 7$, $g = 0.444$), suggesting that these effect sizes are the most likely to be replicable. MI was most effective in asthma, calcium intake, and Type 1 diabetes domains, yielding medium–large effect sizes. Interventions targeting Type 1 diabetes behaviors yielded the largest overall effect size ($g = 0.914$). However, of the four studies in this domain, two studies yielded negative or nearly null effect sizes, and two studies yielded very large effect sizes (i.e., $g > 2.0$). This substantial discrepancy warrants caution and further investigation before MI is applied broadly to this population. Overall, MI appears to be applicable to a range of child health concerns and should continue to be applied and assessed with new populations.

Our results suggest that MI is efficacious for both physical and psychosocial health outcomes. This finding is encouraging because it demonstrates that not only does this method increase the psychosocial health variables that MI targets directly (e.g., motivation for change, self-efficacy for health behaviors) but MI also increases the health behaviors themselves *to the same extent,* which is often the ultimate goal of an intervention. This finding is consistent with the self-efficacy component of MI and client-centered approaches in general that the individual already has within him- or herself the ability to make positive changes (Miller & Rollnick, 2002).

Although consistent with previous meta-analyses (e.g., Jensen et al., 2011; Lundahl et al., 2010), it is still noteworthy to discuss our finding that a majority of practitioners did not possess the terminal degree in their field and that nonprofessional practitioners may demonstrate greater effectiveness as compared to their professional colleagues. These results suggest that community health workers may be most successful at using the MI method to encourage behavioral change with families, likely due to their unique understanding of cultural and community-specific concerns (Nemcek & Sabatier, 2003). While this meta-analysis did not specifically include community health workers from Latino communities, our findings are reminiscent of the concept of *Promotores de Salud*—community members who participate in health promotion initiatives (U.S. Department of Health and Human Services, Health Resources and Services Administration, Bureau of Health Professions, 2007) and have demonstrated success at increasing health awareness and promoting treatment in populations that would otherwise have limited access to health care (Stacciarini et al., 2012). These findings are consistent with Miller and Rollnick's (2002) assertion that the therapist's display of empathy and the quality of the therapeutic alliance are the most essential components of behavior change. However, because of the small number of studies using community health workers as providers, these results should be considered preliminary.

Similarly, matching cultural, community, and ethnic factors between the interventionist and the client is likely important. Since the average study had 70% of non-Caucasians participating and because master's and doctoral level interventionists were likely

Caucasian (Goodyear et al., 2008), it is probable that a cultural mismatch occurred, which potentially reduced the effectiveness of the therapeutic intervention. Future research should examine more specifically the role of profession or training and the role of ethnic and cultural background match in MI effectiveness.

Examination of several moderators of therapeutic effects provides guidance for the adaptation of MI specifically to child and adolescent patient populations. A promising finding is that MI is most effective when conducted with both parent and child and loses some effectiveness when conducted with either parent or child alone. This finding is consistent with the conceptual shift in pediatric psychology toward family-based lifestyle interventions that promote sustainable health behaviors for the whole family (e.g., Kitzmann et al., 2010). Obviously, in some circumstances (e.g., infant health concerns), MI with a single participant is appropriate and adequate. Given that our results in this area are based on only a small number of studies, these specific findings should be taken with some caution until further studies test replicability.

A surprising finding is that MI appeared to be most effective as a stand-alone treatment rather than as an adjunct to another form of treatment. This result is noteworthy considering that about half of the studies in this meta-analysis included MI as a component of broader treatment. It is possible that the nature of the condition explains this finding; outcomes that are harder to achieve (e.g., BMI reduction, hemoglobin A_{1C} reduction) may have been more likely to be targeted in multiple-component interventions. It could also be that if not handled thoughtfully, the more prescriptive interventions that accompanied client-centered MI (e.g., health education) actually reduced the effectiveness of MI by presenting potentially conflicting theoretical orientations.

Numerous moderators were nonsignificant with this population (e.g., gender, age of participant, ethnicity, study quality, number of sessions). Of these variables, gender has been consistently found to be unrelated to effect size (e.g., Hettema & Hendricks, 2010; Vasilaki et al., 2006), suggesting that future studies should not be concerned with this factor. However, other continuous moderators (e.g., age of participant, ethnicity, study quality, number of sessions) were not consistent with the previous MI literature and are worthy of continued examination. As discussed above, health behaviors may be easier and less complicated to change than addictive behaviors. It is also likely that these nonsignificant moderators represent different processes at work in children than among adults.

For instance, contrary to previous findings with adult populations (e.g., Lundahl et al., 2010; Rubak et al., 2005), we did not find evidence of a statistically significant dose effect, indicating that MI did not become more successful with more sessions. In fact, most studies used four or fewer sessions of MI, and brief treatments seemed to be just as effective as longer treatments. This finding is consistent with MI's original conceptualization as a brief intervention but suggests that MI may function differently here than with adults' substance use behaviors.

Thus, it is possible that these nonsignificant moderators represent different processes at work with children, perhaps due to younger age, the family context, shorter behavioral history, and potential range of support systems (e.g., school, sports, peers, etc.). Also possible is that these null findings are due to a lack of power in this analysis to detect small effects due to our sample size. As more studies are conducted with pediatric populations, the relevance of specific moderators and the mechanisms of how they impact effectiveness of MI will become clearer.

Finally, an area of concern for the field is the lack of attention to study quality and measurement of fidelity to treatment. The average study earned only slightly above half of the possible points for study quality, and more than half of the studies did not measure fidelity to treatment. Without serious attention paid to conducting highly rigorous studies that are adherent to the principles of MI, our conclusions remain limited. Similarly, future studies should consider measuring process variables to clarify mechanisms of change in MI interventions and should consider other aspects of quality assurance not measured by our rating system, such as details of training and presence of ongoing supervision. A better understanding of the MI change process would give guidance as to the key elements of MI interventions and lead to more consistently positive outcomes.

This meta-analysis has several limitations. While this analysis is the largest so far to examine MI in children, it did not contain enough studies to examine secondary moderators and was likely underpowered to detect small moderating effects. Also, due to the emerging nature of this field, this meta-analysis included studies of a range of quality (e.g., those that used pre–post design, had small samples, etc.). Furthermore, due to the broad scope of this analysis, effect sizes were calculated for a wide range of physical and psychosocial health outcomes. Finally, due to a limited statistical power and a lack of guidance from the literature, interactions were not tested at this time. While we believe these decisions were appropriate at this stage of this field's development, they limit our understanding of MI's effectiveness for any specific situation. Future meta-analyses might also consider calculating effect sizes related to target behavior as well as health domain (e.g., medication adherence, preventive care, dietary intake) in order to provide a more nuanced understanding of MI's effectiveness in pediatric populations. As more studies are conducted in this field, more detailed analyses can and should be undertaken.

In summary, the findings of this meta-analysis suggest that MI is an appropriate and effective method for pediatric populations across a range of health domains and appears to be particularly effective within the family context. MI participants show more substantial behavior changes as compared to both other active treatments and wait-list controls. That MI is at least as effective as other active treatments is exciting, especially considering that MI may offer several benefits as compared to traditional treatments. Our findings suggest that in pediatric populations, MI exerts its effects in a relatively brief period of time and can be delivered effectively by well-trained community health workers, reducing costs to the agency and client. Cost-effectiveness measurements could be included in future studies. However, less than half of the studies in this analysis evaluated MI against strong comparison groups. Future studies should continue to rigorously compare MI to other established treatments.

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