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# Motivational Interviewing for Parent-child Health Interventions: A Systematic Review and Meta-Analysis

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# Motivational Interviewing for Parent-child Health Interventions: A Systematic Review and Meta-Analysis

Belinda Borrelli, PhD[1] • Erin M. Tooley, PhD[2] • Lori A. J. Scott-Sheldon, PhD[3]

**Abstract:** ***Purpose:*** *Motivational interviewing (MI) is a patient-centered approach focusing on building intrinsic motivation for change. This paper presents a meta-analysis of parent-involved MI to improve pediatric health behavior and health outcomes.* ***Methods:*** *Study inclusion criteria: (1) examined modifiable pediatric health behaviors (< 18 years old); (2) used MI or motivational enhancement; (3) conducted a randomized controlled trial with a comparison group (non-MI control or active treatment group); (4) conducted the intervention with only a parent or both a parent and child; and (5) were written in English. Twenty-five studies (with 5,130 participants) were included and independently rated. Weighted mean effect sizes, using random-effects assumptions, were calculated.* ***Results:*** *Relative to comparison groups, MI was associated with significant improvements in health behaviors (e.g., oral health, diet, physical activity, reduced screen time, smoking cessation, reduced second hand smoke) and reduction in body mass index. Results suggest that MI may also outperform comparison groups in terms of dental caries, but more studies are needed. MI interventions were more successful at improving diets for Caucasians and when the intervention included more MI components.* ***Conclusions:*** *Our findings provide support for providing motivational interviewing to parents and children to improve pediatric health behaviors.* *(Pediatr Dent 2015;37(3):254-65) Received January 22, 2015 | Last Revision April 1, 2015 | Accepted April 10, 2015*

KEYWORDS: MOTIVATIONAL INTERVIEWING, META-ANALYSIS, ORAL HEALTH, PEDIATRICS, HEALTH BEHAVIORS

Motivational interviewing (**MI**) is a patient-centered treatment that focuses on building intrinsic motivation for change by exploring and resolving ambivalence.[1] MI is patient centered in that the provider attempts to understand the patient's expectations, beliefs, perspectives, and concerns about changing their health behaviors. Counseling techniques are calibrated to the patient's level of readiness to change, with educational approaches given only when the patient is ready and willing to hear the information, and provided in a collaborative, autonomy-promoting manner. Providing education to patients who are ambivalent about change has paradoxical effects, producing resistance to change.[2-4] MI is directive in that the conversation is structured to produce movement toward change. A comfortable and nonjudgmental atmosphere is created that allows the patient to talk about the pros and cons of changing, without coercion to change or premature suggestions of change options. The core of MI involves strengthening intrinsic motivation by discussing how change is consistent with the patient's own values and goals.[5] Patients are given the autonomy to make their own decisions about change, which has been shown to increase commitment to change.[3]

MI was first developed by William Miller in 1983 for the treatment of alcoholism; it was later expanded by Miller and Rollnick[1] to target a variety of mental health and physical conditions.[1,6] MI has been successfully used to promote healthy behaviors, such as exercise,[7] glycemic control,[8] oral health,[9,10] medication adherence,[11,12] and weight loss,[13] as well as reduce maladaptive behaviors such as smoking,[14,15] sexual risk behaviors,[16] and gambling.[17] Meta-analyses have shown that MI significantly outperforms controls (no treatment and waitlist), and treatments based on education, across a wide variety of health behaviors, including exercise, diet, weight loss, oral health, smoking, substance abuse, and safe-sex behaviors[15,18-21] One meta-analysis has shown that MI outperforms traditional advice-giving in approximately 80 percent of studies, with significant effects for body mass index (**BMI**), blood cholesterol, systolic blood pressure, and blood alcohol concentration.[22] If MI is used as a stand-alone treatment, positive effects are seen early and tend to diminish across a year of follow-up; however, when MI is used in conjunction with other treatments, the effect of MI is maintained or increased over time.[20]

Meta-analyses of the effect of MI on adolescent and young adult health behaviors have shown weaker effects for risky behaviors (e.g., alcohol use and abuse[23]) but more positive effects for health-promoting behaviors (e.g., weight, diet, sleep, and physical activity[24,25]). For example, in their meta-analysis of the effect of MI on eight different health promotion behaviors, Gayes and Steele[25] found that MI had an effect size (Hedges' g) of 0.28 when compared to other active treatments and to no treatment. Their results also suggest that interventions focused on parent-child dyads are more effective at improving pediatric health outcomes and behaviors than those focused on either the child or parent alone. However, this conclusion is tentative, as it is based on three studies and because parent-directed or parent-child dyad-directed interventions were not part of the inclusion criteria for this meta-analysis.

Family focused interventions have been found to be an effective means for enacting pediatric health behavior change across a wide range of behaviors.[26] One advantage of involving the parent in the intervention is that the intervention has greater potential to impact all of the children in the family, not just the index child.[24]

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Therefore, the purpose of this study was to conduct a meta-analysis to specifically examine the effect of parent-directed or parent-child dyad-directed motivational interviewing to improve pediatric health behaviors relative to controls. We examined effect sizes by type of health behavior and investigated several important predictors of the effect, identified a priori (e.g., child race/ethnicity, intervention setting, delivery method, dose, provision of feedback, intensity of MI, and degree of parental involvement).

## Methods

**Sample of studies and selection criteria.** Studies were retrieved from: (1) electronic reference databases (PubMED, PsycINFO, CINAHL, The Cochrane Library, ERIC, and Web of Science) using a Boolean search strategy with the following keywords: (motivational interviewing OR motivational enhancement therapy) AND (parent OR caregiver OR guardian OR mother OR father OR birth parent OR biological parent OR adoptive parent OR foster parent OR step parent) AND (intervention OR prevention OR education*); (2) reference sections of relevant review or published studies; and (3) sending manuscript requests to relevant authors. Two authors independently examined the full-text papers of relevant records obtained from the electronic database searches using our inclusion criteria.

To be included, studies had to: (1) sample parents of children and/or adolescents 18 years old or younger (participants); (2) implement an intervention that used MI or motivational enhancement that targeted either a parent or a parent-child dyad (interventions); (3) compare the intervention group to a control condition (e.g., assessment only, active comparison; comparisons); (4) examine modifiable health behaviors related to one of the leading health indicators specified in Healthy People 2020[27] (e.g., oral health, physical activity, diet and obesity, tobacco use, substance use, and responsible sexual behavior); (5) use a randomized controlled trial (RCT) design (study design); (6) be written in English; and (7) provide sufficient statistical information to calculate effect sizes.

Studies that fulfilled the selection criteria and were available by August 2014 were included. If an author reported insufficient statistical information, they were contacted for additional information. Two authors were contacted, but one was unable to provide the data by the date of data analysis (October 2014), resulting in the exclusion of a single study. (The number of studies is referred to as *k* throughout the manuscript).

**Overview of the data collection process.** Independent raters coded study information, participant characteristics, design and methodological features, treatment fidelity and methodological quality (**MQ**), and intervention content for the studies included in the meta-analysis. A coding protocol and form were developed to extract the aforementioned data from each individual study. Studies that reported intervention details or data from the same sample were linked together in the database and coded as a single study to avoid violating the assumption of independence. When a study used more than one comparison condition (e.g., usual care or usual care with reduced measurement[28]), the condition with the least intervention contact and the same assessment schedule was used as the comparison condition for ease of interpretation of treatment effects. (The magnitude of the effect sizes will be stronger when comparing an assessment only control versus an active comparison.[29])

**Study features coded.** Studies were coded for a number of characteristics, including sample characteristics, intervention setting, intervention dose, provider characteristics, target of intervention (parent only, parent-child dyad, child with ancillary parental involvement, group treatment), and MI components (see Table 2 for details).

**Methodological quality and treatment fidelity.** MQ was assessed using 14 items (e.g., random assignment, retention) adapted from validated measures[30-32]; and the total possible MQ score was 20 points. Treatment fidelity was assessed using a shortened, 15-item version of the validated treatment fidelity checklist developed by the National Institutes of Health (**NIH**) Treatment Fidelity Framework.[33,34] Items were scored as present (1) or absent (0). Studies that did not report the treatment fidelity item were also assigned a zero. Overall proportion of adherence to treatment fidelity was calculated by summing the total number of items coded as present by the total number of items considered applicable to the trial (Table 3).

**Study outcomes coded.** Estimates of effect sizes were calculated by one of this study's authors and verified by the first and/or second authors. Effect sizes were calculated from the information provided in the study or in a related study (i.e., when study outcomes were reported in multiple papers). Effect sizes were calculated for behavioral or biomedical health outcomes. Behavioral outcomes included: (1) oral health hygiene and maintenance behaviors (i.e., brushing, visiting the dentist, precavity checks, not sharing utensils); (2) overweight and obesity concerns (i.e., physical activity, healthy food servings, screen viewing access and time); (3) tobacco use (i.e., smoking cessation, environmental smoking restrictions); and (4) alcohol use. Biomedical outcomes included: (1) oral health (i.e., dental caries); (2) body composition (i.e., BMI, proportion of overweight or obese, waist circumference, proportion of body fat); and (3) tobacco exposure (i.e., secondhand smoking). Self-report and objective measures were used to evaluate the behavioral and biomedical outcomes.

**Hypothesized predictors.** Based on a priori hypotheses, several features of the studies were evaluated as potential predictors of the variation in the effect size distribution. Sample characteristics included parent and child race/ethnicity (Caucasian versus non-Caucasian). Intervention features included: (1) setting (clinical versus nonclinical); (2) delivery method (intervention delivered in person only versus any other method or combination of methods); (3) number of intervention sessions using MI; (4) treatment dose (total number of minutes of contact besides assessment) (5) the provision of personalized health-related feedback (versus no feedback); (6) number of MI components; (7) target of the intervention (e.g., whether studies with more parental involvement had better outcomes than those in which the parent had only ancillary involvement); and (8) provider type (whether interventions that were delivered by those with a professional terminal degree, with or without paraprofessional involvement, had better outcomes than those delivered by para-professionals alone, or lay providers alone).

**Effect size derivation.** Study effect sizes were calculated as the standardized mean difference between the treatment and comparison groups divided by the pooled standard deviation.[35] We used other statistical information, such as *t*- or *F*-values, when means and standard deviations were not available.[36] If a study reported dichotomous outcomes, we calculated an odds ratio and transformed it to *d* using the Cox transformation.[37] Effect sizes were adjusted for baseline differences when preintervention measures were available.[38] If no statistical information was available (and could not be obtained from the authors) and the study reported no significant between-group differences, we estimated that effect size to be zero.[36,39] Multiple effect sizes were calculated from individual studies when they reported more than one outcome of interest or assessed outcomes across multiple follow-ups. If a study contained multiple measures of the same outcome (e.g., nutrition measured using two items for fruit and vegetable servings), the effect sizes were averaged. All effect sizes were corrected for sample size bias.[40]

The effect sizes from the last study assessment (50 percent of the studies reported more than one follow-up) were used in the analyses because initial intervention effects tend to decay over time.[41] Using the last assessment as the point of analysis provides a stronger test of the robustness of the interventions. Positive effect sizes indicate that participants receiving the MI-based intervention indicated a greater health benefit (e.g., lower tobacco use, fewer dental caries) relative to comparison groups.

**Statistical analyses.** Weighted mean effect sizes ($d_+$) were calculated using random-effects procedures, such that individual studies' effect sizes were weighted by the inverse of their random-effects variance.[36] The homogeneity statistic, $Q$, was calculated for each health behavior or biomedical outcome. A significant $Q$ indicates a lack of homogeneity and an inference of heterogeneity. The $I^2$ index and the corresponding 95 percent confidence intervals (**CIs**) were also calculated to assess the extent to which outcomes were consistent across studies (homogeneous).[42,43] If the 95% CI around the $I^2$ index includes a zero, the hypothesis of homogeneity is confirmed.[42] To explain variability in effect sizes, meta-regression was conducted to determine the relationship between sample, methodological, or intervention characteristics and the magnitude of the effect sizes using a modified weighted regression analysis, with weights equivalent to the inverse of the variance for each effect size.[36,44] These analyses were conducted if the weighted mean effect size for a health behavior or biomedical outcome indicated significant heterogeneity and was reported in five or more studies. All analyses were conducted in Stata 13 (StataCorp LP, College Station, Texas, USA) using published macros.[36,45]

**Publication bias.** Publication bias (i.e., when studies with significant findings are published, whereas studies with nonsignificant findings remain unpublished; also known as the file-drawer effect)[46] was assessed by inspecting funnel plots[47] assessing the degree of funnel plot asymmetry using Begg's[48] and Egger's[49] methods and by determining the number of studies that could be missing using trim and fill procedures.[50]

## Results

**Study selection and reliability of coding.** A total of 25 studies were included in the meta-analysis (Figure 1). For the categorical dimensions, raters agreed on 74 percent of the judgments (mean Cohen's κ=0.47, indicating moderate agreement[51]). Reliability for the continuous variables was calculated using the intraclass correlation coefficient (**ICC**); and the mean ICC equaled 0.78 across categories. Coding disagreements were resolved through discussion or by a third rater when consensus could not be achieved. Details for each study are provided in Table 1.

**Study and sample characteristics.** Table 2 provides aggregate information on the sample and intervention characteristics

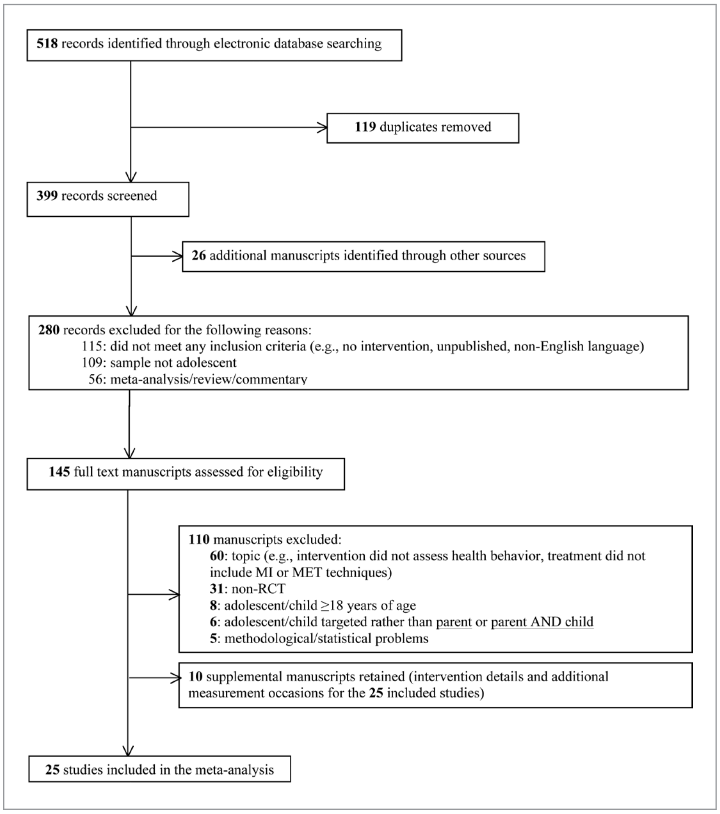


Figure 1. Selection process for study inclusion in the meta-analysis.

of the 25 studies included in the meta-analysis. Studies were published between 2001 and 2014, with a median publication date of 2011. Studies were typically conducted in the United States (72 percent) and in clinical settings (56 percent). Interventions focused on: (1) overweight and obesity (diet, weight, physical activity, and/or diabetes; 48 percent); (2) smoking and tobacco (cessation, secondhand smoke exposure; 32 percent); (3) oral health (e.g., dental caries, brushing; 16 percent); and (4) alcohol use (four percent). The median number of postinter-vention assessments was two (range = 1 to 3). The final postintervention assessment (used in the data analyses) occurred a median of 26 weeks (mean equals 38 weeks; ± standard deviation [**SD**] equals 35), but ranged from immediate post-intervention to 104 weeks. Our sample consisted of 5,130 parents (mean age=33 years, 93 percent female) or children (mean age=nine years, 56 percent female) with an average retention rate of 79 percent.

**MI intervention characteristics.** Interventions were typically delivered over multiple sessions, with a median of 26 minutes per session, by a single facilitator. MI was used in 74 percent (±0.36 SD) of the intervention sessions (median equals three sessions, range = 1 to 16), and 16 of the 25 studies used MI in 100 percent of their sessions. Interventions were typically delivered to a parent alone (52 percent), a child with ancillary parental involvement (12 percent), and parent-child dyads (eight percent); 28 percent of studies used a combination of these targets (e.g., parent-child dyads plus groups). All of the studies delivered MI in person for at least one session; approximately half were supplemented by telephone counseling and/or print. All 25 studies also stated that the intervention

Table 1. STUDY, SAMPLE, AND INTERVENTION DETAILS FOR THE 25 RANDOMIZED CONTROLLED TRIALS INCLUDED IN THE META-ANALYSIS*

| Study | N | Intervention composition | Child's age (mean yrs) | Child's ethnicity | Target | Study outcomes | Sessions (no.) | MI sessions (no.) | Total dose[c] | MI components (no.) |
|---|---|---|---|---|---|---|---|---|---|---|
| Ball et al.[60] | 31[a] | C/AP | 15 | 90% CA | Overweight and obesity | Body mass index (+)<br>Waist circumference (+) | 16 | 16 | 840 | 2 |
| Barkin et al.[61] | 72 | Dyad/GRP | 9 | 100% L | Overweight and obesity | Body mass index (+) | 6 | 6 | 345 | 0 |
| Black et al.[62] | 235 | C/AP | 13 | 100% AA | Overweight and obesity | Physical activity (-)<br>Nutrition (+)<br>Body mass index (+)<br>% overweight/obese (+) | 12 | 12 | NR | 2 |
| Borrelli et al.[14] | 133 | P | 7 | 100% L | Smoking and tobacco | Smoking cessation (+) | 4 | 2 | 166 | 11 |
| Brown et al.[63] | 191 | C/AP | 15 | 95% CA | Smoking and tobacco | Smoking cessation (+) | 5 | 2 | 150 | 3 |
| Colby et al.[64] | 162 | P/C | 16 | 72% CA | Smoking and tobacco | Smoking cessation (+) | 3 | 3 | 80 | 5 |
| Davoli et al.[65] | 372 | Dyad | 4 | NR | Overweight and obesity | Physical activity (+)<br>Screen viewing time (+)<br>Nutrition (+)<br>Body mass index (+)<br>% overweight/obese (+) | 5 | 5 | 225 | 4 |
| Eakin et al.[66] | 350 | P | 4 | 92% AA | Smoking and tobacco | Smoking cessation (+)<br>Smoking ban (+)<br>Secondhand smoking (NR) | 5 | 5 | 103 | 11 |
| Emmons et al.[67]<br>Linked studies[68] | 323 | P | NR | NR | Smoking and tobacco | Smoking cessation (NR)<br>Secondhand smoking (+) | 5 | 1 | 78 | 6 |
| Freudenthal and Brown[58] | 72 | P | 1 | NR | Oral health | Oral health management (+) | 3 | 1 | 55 | 8 |
| Haines et al.[69] | 121 | P | 4 | 51% L | Overweight and obesity | Screen viewing time (+)<br>Screen access (+)<br>Body mass index (+) | 8 | 8 | NR | 1 |
| Halterman et al.[70] | 530 | P | 7 | 63% AA | Smoking and tobacco | Secondhand smoking (+) | 3 | 3 | 50 | 11 |
| Harrison et al.[57]<br>Linked studies[71] | 272 | P | NR | 100% Cree | Oral health | Dental caries (+) | 7 | 7 | 158 | 2 |
| Harutunyan et al.[54] | 250 | Dyad | 4 | 100% Armenian | Smoking and tobacco | Smoking cessation (+)<br>Smoking ban (+)<br>Secondhand smoking (+) | 3 | 3 | 60 | 1 |
| Ismail et al.[53] | 1021 | P | 5 | 100% AA | Oral health | Nutrition (+)<br>Dental caries (NR)<br>Oral health management (+) | 1 | 1 | 55 | 7 |
| Linakis et al.[52] | 89 | Dyad | 13 | 71% CA | Alcohol | Alcohol use (-) | 3 | 3 | 43 | 6 |
| MacDonell et al.[72] | 49 | Dyad | 15 | 100% AA | Overweight and obesity | Physical activity (-)<br>Nutrition (+)<br>Body mass index (+) | 4 | 4 | 240 | 3 |
| Neumark-Sztainer et al.[73]<br>Linked studies[74-76] | 433 | C/AP/GRP | 16 | 28% AA | Overweight and obesity | Physical activity (+)<br>Screen viewing time (+)<br>Nutrition (+)<br>Body mass index (+) | 103 | 6 | NR | 7 |
| Resnicow et al.[77] | 147 | C/Dyad/GRP | 14 | 100% AA | Overweight and obesity | Body mass index (-)<br>Waist circumference (+) | 29 | 5 | NR | 5 |

*Table continues on next page*

Table 1. Continued

| Study | N | Intervention composition | Child's age (mean yrs) | Child's ethnicity | Target | Study outcomes | Sessions (no.) | MI sessions (no.) | Total dose[c] | MI components (no.) |
|---|---|---|---|---|---|---|---|---|---|---|
| Small et al.[78] | 67 | P | 6 | NR | Overweight and obesity | Body mass index (+)<br>Waist circumference (+) | 8 | 4 | 240 | 3 |
| Stotts et al.[28] | 104[b] | P | NR | NR | Smoking and tobacco | Smoking ban (+) | 2 | 2 | 75 | 5 |
| Taveras et al.[79] | 475 | P | 5 | 57% CA | Overweight and obesity | Screen viewing time (+)<br>Screen access (+)<br>Nutrition (+)<br>Body mass index (+) | 7 | 7 | 145 | 3 |
| Van Grieken et al.[80] Linked studies[81,82] | 637 | P | 6 | 78% Dutch | Overweight and obesity | Body mass index (-)<br>% overweight/obese (-)<br>Waist circumference (+)<br>Physical activity (+)<br>Nutrition (+)<br>Screen viewing time (+) | 3 | 3 | 180 | 0 |
| Van Wely et al.[83] Linked studies[84] | 50 | C/Dyad/GRP | 10 | 100% Dutch | Overweight and obesity | Physical activity (+) | 5 | 2 | NR | 2 |
| Weinstein et al.[10] Linked studies[9,85] | 240 | P | 11 | 100% Punjabi | Oral health | Dental caries (+) | 7 | 1 | 150 | 9 |

*N=number of consenting participants; C=child; P=parent; AP=ancillary parent; Dyad=parent-child dyad; GRP=group; CA=Caucasian; AA=African. American; L=Latino (a); MI=motivational interviewing; NR=not reported. A positive (+) or negative (-) sign after the study outcomes indicates the direction of the study-level effect size (i.e., treatment group improved or control group improved).

a The Youth Lifestyle Program (YLP) treatment condition is excluded because it did not use motivational interviewing techniques.

b The Usual Care—Reduced Measurement control condition is excluded because measures were unavailable for 1- and 3-month follow-up.

c Estimated number of minutes of intervention content excluding measurement.

content was tailored to the population, but only 64 percent (16/25) said they developed targeted intervention content from formative work.

Intervention content included: health-related education (100 percent); strategies to modify health behaviors (68 percent); and personalized risk assessments (44 percent). Most interventions provided general health-related materials (e.g., pamphlets; 76 percent) and/or boosters to enhance the intervention (88 percent). As shown in Table 2, the MI components used by more than half of the studies were collaboration ($k$=20), evocation ($k$=15), patient-centeredness ($k$=14), and autonomy ($k$=13). Studies, on average, described five MI components (±3.39 SD, range = zero to 11).

**Description of the comparison conditions.** Comparison conditions included assessment-only controls (28 percent) as well as active treatment comparisons (72 percent). The latter were typically delivered in a single session with a median of 13 minutes. Of the 18 studies with active controls, 13 provided content relevant to the target behavior (11 not time matched; two time-matched), two provided general health content (one not time matched; one time-matched), and three provided standard education only.

**Methodological quality and treatment fidelity.** Methodological quality of the studies ranged from nine to 17 (out of 20), with an average score of 14 (±1.96 SD). Overall, the studies satisfied an average of 70 percent (±0.10 SD) of the MQ criteria, indicating moderate to strong MQ. The total MQ score was not significantly correlated with any behavioral or biological outcome ($P$>.16).

The mean proportion adherence to treatment fidelity strategies was 40 percent (±19 SD). Most studies reported using theoretical models or clinical guidelines to guide their intervention (76 percent), but only a minority of studies assessed whether the provider acquired the intervention skills after training (20 percent) or included an assessment to examine whether the provider adhered to the intervention during the delivery (40 percent). Full details of the treatment fidelity strategies assessed appear in Table 3.

**Efficacy of the MI interventions compared with comparison groups by health outcome.** Table 4 provides the weighted mean effect sizes and homogeneity statistics by health-related behavioral and biomedical outcomes. Compared to comparison groups, participants who received an MI intervention reported improvements in their health-related behaviors at the final postintervention assessment. Parents in the MI intervention condition were more likely than comparison groups to report: increasing the oral health hygiene and management of their children ($d_+$=0.38, 95% CI =0.08, 0.68); increases in children's level of physical activity ($d_+$=0.15, 95% CI=0.03, 0.28); reductions in children's screen viewing time ($d_+$=0.16, 95% CI= 0.03, 0.29); less screen access for their children ($d_+$=0.19, 95% CI=0.02, 0.36); improvement in their children's

Table 2. DESCRIPTION OF STUDY, SAMPLE, AND INTERVENTION CHARACTERISTICS OF THE 25 INCLUDED STUDIES

| | |
|---|---|
| **Study characteristics** | |
| Publication year, median (range) | 2011 (2001-2014) |
| U.S. region: No. (%) | 18 (72) |
| **Research design and implementation** | |
| Intervention setting: No. (%) | |
| Clinical | 14 (56) |
| Nonclinical | 11 (44) |
| Target outcome, no. (%) | |
| Alcohol | 1 (4) |
| Oral health | 4 (16) |
| Overweight and obesity | 12 (48) |
| Smoking and tobacco | 8 (32) |
| Postintervention assessments, median (range) | 2 (1-3) |
| Methodological quality rating, median (range) | 14 (9-17) |
| **Sample characteristics** | |
| Sample size, initial/final | 6,513/5,130 |
| Child | |
| Age, M±(SD) | 9±(5) |
| Girls, M%±(SD) | 56±(18) |
| Race/ethnic, M%±(SD)‡ | |
| Caucasian | 25±(36) |
| African American | 36±(43) |
| Hispanic/Latino | 20±(34) |
| Asian | 2±(7) |
| Other | 37±(48) |
| Parent | |
| Age, M±(SD) | 33±(6) |
| Women, M%±(SD) | 93±(7) |
| Race/ethnic, M%±(SD)‡ | |
| Caucasian | 13±(24) |
| African American | 17±(33) |
| Hispanic/Latino | 27±(40) |
| Asian | <1±(<1) |
| Other | 54±(51) |
| **Intervention characteristics** | |
| Intervention dose, median (range) | |
| Sessions | 5 (1-103) |
| MI sessions | 3 (1-16) |
| Mins per session | 26 (14-60) |
| Intervention session participant, no. studies† | |
| Parent only | 15 |
| Child only | 3 |
| Parent-child dyad | 5 |
| Child with ancillary parent | 4 |
| Group | 3 |
| Other | 1 |
| Facilitators, median (range) | 1 (1-4) |
| Facilitators, no. studies† | |
| Peers | 2 |
| Paraprofessionals | 11 |
| Professional-in-training | 2 |
| Professionals | 16 |
| None/NR | 2 |

Table 2. Continued

| | |
|---|---|
| **Intervention characteristics (continued)** | |
| Delivery, no. studies† | |
| In-person | 25 |
| Facilitated by computer/technology | 4 |
| Electronic/postal mail | 6 |
| Print materials | 6 |
| Phone and/or pager | 14 |
| Intervention content tailored, no. (%) | 25 (100) |
| Intervention content targeted, no (%) | 16 (64) |
| Intervention content, no. (%)† | |
| Health information/education | 25 (100) |
| Personalized risk assessment | 11 (44) |
| Oral feedback | 4 (36) |
| Written feedback | 2 (18) |
| Both | 5 (45) |
| Moderation strategies provided | 17 (68) |
| Provided general health-related materials | 19 (76) |
| Boosters or other relevant materials | 22 (88) |
| MI components, no. (%)† | |
| Patient-centered | 14 (56) |
| Autonomy | 13 (52) |
| Expresses empathy | 9 (36) |
| Evocation | 15 (60) |
| Collaboration | 20 (80) |
| Open-ended questions | 8 (32) |
| Reflections | 9 (36) |
| Affirmation | 8 (32) |
| Permission | 8 (32) |
| Values clarification | 6 (24) |
| Decisional balance exercise | 7 (28) |
| Treatment fidelity, M%±(SD) | 40±(19) |
| **Control characteristics** | |
| Active control, no. (%) | 18 (72) |
| Control dose, median (range) | |
| Sessions | 2 (1-64) |
| Minutes per session | 13 (5-60) |
| Control session participant, no. studies† | |
| Parent only | 11 |
| Child only | 4 |
| Parent-child dyad | 4 |
| Group | 2 |
| Facilitators, median (range) | 1 (0-4) |
| Facilitators, no. studies† | |
| Peers | 1 |
| Paraprofessionals | 5 |
| Professionals | 7 |
| None/NR | 7 |
| Delivery, no. studies† | |
| In-person | 10 |
| Facilitated by computer/technology | 2 |
| Electronic/postal mail | 3 |
| Print materials | 7 |
| Phone and/or pager | 3 |

* M=mean; SD=standard deviation; NR=not reported.
† Multiple categories were possible.
‡ Complete or partial race/ethnic information was provided in a subset of studies for the child ($k$≤18) and/or the parent ($k$ ≤10).

diet ($d_+$=0.24, 95% CI=0.09, 0.39); quitting smoking ($d_+$=0.33, 95% CI=0.03, 0.68); and employing greater smoking restrictions ($d_+$=0.17, 95% CI=0.01, 0.34). Linakis et al.[52] met the inclusion criteria, but we could not calculate an overall weighted mean effect size, because it was the only study that measured alcohol use ($d$=0.91; 95% CI=0.45, 1.37).

In terms of biometric measures, children in the MI intervention conditions had a lower BMI at the final assessment ($d_+$=0.13, 95% CI=0.02, 0.25) versus children in the comparison groups. The weighted mean effect size for dental caries was not significant but included one study in which the effect size was estimated as zero.[53] Removing this study resulted in an overall weighted mean effect size for dental caries: $d_+$=0.36 (95% CI=0.18, 0.55); $k$=2, $Q$ [1]=0.24; heterogeneity was not significant. There were no differences between the MI intervention and comparison parents on the other biometric measures assessed (i.e., proportion of overweight/obese, waist circumference, proportion of body fat, or objectively measured secondhand smoke exposure).

Table 3. TREATMENT FIDELITY CHECKLIST

| Treatment fidelity categories | Treatment fidelity strategies | Proportion (%) |
|---|---|---|
| Treatment design | Mention of provider credentials | 72 |
| | Mention of a theoretical model or clinical guidelines on which the intervention is based | 76 |
| Training providers | Description of how providers were trained | 44 |
| | Standardized provider training | 60 |
| | Measured provider skill acquisition post-training | 20 |
| | Described how provider skills maintained over time | 56 |
| Delivery of treatment | Method used to ensure that the content of the intervention was being delivered as specified | 36 |
| | Method used to ensure that the dose of the intervention was being delivered as specified | 20 |
| | Included mechanisms to assess if the provider actually adhered to the intervention | 40 |
| | Assessment of nonspecific treatment effects | 12 |
| | Use of treatment manual | 56 |
| Receipt of treatment | Assessment of the degree to which the participants understood the intervention | 4 |
| | Specified strategies used to improve the participant comprehension of the intervention | 64 |
| Enactment of treatment skills | Assessed participant performance of the intervention skills in settings in which the skills might be applied | 20 |
| | Assessed strategy to improve participant performance of the intervention skills in settings in which the skills might be applied | 24 |

Homogeneity tests revealed significant heterogeneity for dental caries and the proportion of overweight/obese ($P$≥.001). Sources of heterogeneity could not be explored for these outcomes due to the limited number of studies assessing dental caries ($k$=3) and the proportion of overweight/obese ($k$=3). The hypothesis of homogeneity was supported for BMI and all behavioral outcomes, except for diet (i.e., healthy food consumption) and smoking cessation; meta-regression analyses were conducted for these two variables.

**Meta-regression analyses.** Meta-regression analyses were used to examine whether sample or intervention characteristics (determined a priori) related to the variability in the effect size distribution associated with diet (i.e., consumption) and smoking cessation rates.

**Diet.** MI interventions were more successful at improving diet when the study sampled more Caucasians (β=0.80, $P$=.051, $Q_{Residual}$ [1]=3.81) and the intervention included more MI components (β=0.81, $P$=.047, $Q_{Residual}$ [1]=3.93). The interventions were less successful at improving diet when the intervention was delivered in person (β = -0.80, $P$=.051, $Q_{Residual}$ [1] = 3.81); however, this finding may be spurious, as only a single study used delivery methods other than in person alone. No other intervention feature moderated the intervention impact on diet (i.e., food consumption).

**Smoking cessation.** Participants in the MI intervention were more successful at quitting smoking when the intervention with the total dose delivered (number of sessions times number of minutes) was less (β equals -0.38, $P$=.035, $Q_{Residual}$ [1]=4.43), used fewer MI components (β=-0.59, $P$<.001, $Q_{Residual}$ [1]=11.00), and had less parental involvement (β=-0.67, $P$<.001, $Q_{Residual}$ [1]=13.95). No other sample or intervention features moderated the intervention impact on smoking cessation. Supplemental analyses indicated that the meta-regression analyses were substantially influenced by a single study.[54] No significant predictors of smoking cessation were detected when the outlier was excluded.

**Publication bias.** We intended to assess funnel plot asymmetry and perform formal statistical tests for publication bias (i.e., Egger,[49] Begg[48]) but were unable to do so given the small number of studies available for each outcome (i.e., less than 10 studies).[55] Assessment of the funnel plot for BMI revealed no asymmetries that might be interpreted as publication bias. Results from Egger's[49] ($P$=.952) and Begg's[48] ($P$=.472) tests were non-significant. The funnel plot for BMI is presented in the supplemental digital content.

## Discussion

The aim of our meta-analysis was to evaluate the effect of parent-involved MI on modifiable pediatric health behaviors and biomedical outcomes. Our results showed that, relative to comparison groups, parent-involved MI was associated with significant improvements in health behaviors (oral health management, diet, physical activity, reduced screen time and access, smoking cessation, and household smoking restrictions) and biomedical outcomes (reduced BMI and dental caries). Because there were only two studies on dental caries with usable data, these results, while promising, should be interpreted with caution. We did not find an effect of parent-involved MI on other biomedical outcomes (proportion of overweight/obese, waist circumference, proportion of body fat, or objectively measured second hand smoke exposure). Our meta-analysis contributes to extant literature because of its evaluation of the:

(1) effect of parental involvement in pediatric health behavior change; (2) number and type of MI components included in the intervention; and (3) treatment fidelity in general and in relation to specific features important for the delivery of MI (e.g., type of training, acquisition of MI skills, maintenance of MI skills over time). We also used rigorous criteria to evaluate outcomes, such that only the final evaluation point was used to assess the effect of MI on outcomes.

We found a significant effect of MI on oral health behaviors and management (e.g., toothbrushing, visiting the dentist) versus comparison groups across the four studies that met inclusion criteria. While three of these studies also included dental caries as an outcome, only two had sufficient data to be included in the analyses. Consistent with meta-analytic methodology,[36] we conservatively estimated the effect of the study to be zero. When all three studies were included in analyses, there was no MI effect on reducing pediatric dental caries; however, when only the studies with data were included, there was a significant MI effect. Although this estimate is based on a moderate sample size (N equals 443), additional studies are needed to confirm this effect. Gao et al.[56] performed a systematic review of 16 randomized controlled trials that evaluated the effectiveness of MI compared with health education on oral health behaviors among adults and children. Among adults, they found that MI was associated with improved periodontic health in five of seven trials, but the five trials with positive effects had short-term outcomes (less than eight weeks), whereas the two trials with negative effects had longer-term outcomes.

In terms of preventing early childhood caries, Gao et al.'s review included four studies that targeted oral health in children; all were included in our meta-analysis.[10,53,57,58] Our meta-analyses supports their finding that MI is associated with improvements in pediatric oral health behavior; however, our finding should be interpreted with caution, as it is based on a small number of studies evaluating parent-based MI interventions. Additional studies of the effect of parent-based MI on oral health behaviors and outcomes are needed, particularly those that involve objective measures of caries. One such trial is underway (NIDCR U54 DEO192745), involving training of lay providers to deliver MI to low-income and ethnically diverse caregivers of zero- to five-year-olds to improve pediatric oral health. In this trial, both oral health behaviors and objectively measured caries are assessed longitudinally.

MI outperformed comparison treatments across all other health behaviors that were included in the articles in our meta-analysis, such as employing greater household smoking restrictions, quitting smoking, physical activity, screen viewing time and access, and diet. Effects ranged from small ($d_+$=0.17 for household smoking restrictions) to medium ($d_+$=0.38 for oral health behaviors). These results are conservative, as we used the final assessment point to estimate the effect of MI. Use of more proximal assessment points may have resulted in stronger effects. It was surprising that MI had a clearly significant effect on only one biomedical outcome (BMI) and a promising effect for another (dental caries). Meta-analyses of the effect of MI on physical health outcomes in adults have shown significant effects for BMI, HbA1c, blood cholesterol, and systolic blood pressure.[22]

Meta-regression analyses assessed whether sample or intervention characteristics were related to the variability of the effect size distribution for two outcomes that met the criteria for heterogeneity: diet and smoking cessation. MI interventions were more successful at improving diet when the study had a greater number of Caucasians in the sample. Our findings are in contrast to prior meta-analyses that found significantly larger effects of MI for minority versus nonminority populations.[20] Differences may be due to the isolation of specific health behaviors (i.e., diet) rather than combining all behavioral outcomes. Future research should evaluate whether parent-based MI interventions are more effective for minority versus nonminority populations. We also found that MI interventions were more successful at improving diet when the intervention included more MI components. Previous meta-analyses have not found a relationship between the intensity of MI and outcome; this may be due to the fact that effect sizes were computed across behaviors.[25] (Contemporary

Table 4. EFFICACY OF MOTIVATIONAL INTERVIEWING (MI) INTERVENTIONS RELATIVE TO CONTROL CONDITIONS*

| Outcome | N | k | d+ (95% CI) | Q | I² (95% CI) |
|---|---|---|---|---|---|
| **Behaviors** | | | | | |
| *Oral health* | | | | | |
| Hygiene/management | 667 | 2 | 0.38 (0.08, 0.68) | 1.75 | 43 (0, 84) |
| *Overweight/obesity* | | | | | |
| Physical activity | 1,223 | 6 | 0.15 (0.03, 0.28) | 5.97 | 16 (0, 61) |
| Screen viewing time | 1,554 | 5 | 0.16 (0.03, 0.29) | 6.52 | 39 (0, 77) |
| Screen viewing access | 549 | 2 | 0.19 (0.02, 0.36) | 0.78 | 0 |
| Diet | 2,231 | 7 | 0.24 (0.09, 0.39) | 17.88** | 66 (25, 85) |
| *Smoking/tobacco* | | | | | |
| Smoking cessation† | 1,153 | 6 | 0.33 (0.03, 0.63) | 31.17** | 84 (67, 92) |
| Smoking restrictions | 574 | 3 | 0.17 (0.01, 0.34) | 0.27 | 0 |
| **Biometric screening** | | | | | |
| *Oral health* | | | | | |
| Dental caries† | 1,045 | 3 | 0.23 (-0.05, 0.50) | 8.64** | 77 (25, 93) |
| *Overweight/obesity* | | | | | |
| Body mass index | 2,259 | 11 | 0.13 (0.01, 0.25) | 16.98 | 41 (0, 71) |
| Proportion of overweight/obese | 1,188 | 3 | 0.17 (-0.10, 0.44) | 9.80** | 80 (35, 94) |
| Waist circumference | 670 | 4 | 0.08 (-0.07, 0.23) | 0.39 | 0 |
| Proportion body fat | 642 | 3 | 0.10 (-0.12, 0.32) | 3.45 | 42 (0, 82) |
| *Smoking/tobacco* | | | | | |
| Secondhand smoking† | 1,226 | 4 | 0.05 (-0.06, 0.16) | 0.21 | 0 |

* CI=confidence interval. Weighted mean effect sizes (*d*+) are positive for differences that favor the treatment group relative to the control group. N=number of participants; k=number of studies; CI=confidence interval; Q=homogeneity statistic; I2=consistency of effect sizes.

** Heterogeneity is significant at $P$<.05.

† The weighted mean effect sizes for smoking cessation,[67] dental caries,[53] and secondhand smoking[66] was estimated as 0 for a single study. The overall weighted mean effect size for smoking cessation, dental caries, and secondhand smoking, after eliminating the estimated effect size, is $d$+=0.40 (95% CI=0.08, 0.73), $k$=5, $Q$ (4)=22.11, $P$<.001, $d$+=0.36 (95% CI=0.18, 0.55), $k$=2, $Q$ (1)=0.24, $d$+=0.06 (95% CI=-0.06, 0.19), $k$=2, $Q$ (2)=0.01.

meta-analytic methods compare subcategories of mean effect sizes rather than averaging the effect sizes from distinctly different outcomes.[36]) Several predictors of smoking cessation (e.g., intervention dose, level of parental involvement, and use of MI components) were found, but these results must be interpreted with caution as subsequent analyses indicated that the results were largely influenced by a single study. Therefore, more studies should be conducted to add to these data.

Treatment fidelity was low across the studies in our sample. The proportion of adherence to treatment fidelity strategies was 0.40 (±0.19 SD). Borrelli et al.[34] evaluated treatment fidelity in papers published in five peer-reviewed health behavior journals over 10 years and found a 55 percent adherence rate to treatment fidelity strategies, with only 16 percent of articles achieving more than 0.80 proportion adherence to the checklist. In the current study, none of the studies achieved greater than 0.80 proportion adherence, and only nine studies achieved more than 50 percent adherence to strategies. Only four of the studies in our sample used the Motivational Interviewing Treatment Integrity Coding[59] to objectively rate whether or not MI was delivered. Therefore, we cannot conclude with certainty that MI was actually implemented in the majority of the studies included in the meta-analysis. Future studies of the effect of MI on pediatric health can benefit from greater attention to treatment fidelity, especially in the areas of assessment of initial acquisition of MI skills, monitoring skills over time, and assessment of whether or not the intervention was delivered as specified.

Our meta-analysis is the only one that assessed whether or not the articles mentioned delivering specific MI components. The vast majority of trials included in our meta-analysis indicated that their MI intervention involved collaboration ($k$=20 out of 25), and most of the trials indicated that their MI intervention involved evocation ($k$=15), patient-centeredness ($k$=14), and autonomy ($k$=13). Less than half of the trials indicated that they delivered other components that are central to the spirit of MI (e.g., empathy, reflections, open-ended questions, affirmations, asking permission, decisional balance, and values clarification). It is unknown whether these components were delivered and not mentioned in the papers or whether these components were not delivered at all. Either way, lack of reporting or lack of implementation makes it difficult for readers to make strong conclusions about the effect of MI or to replicate findings and test mechanisms of the effects.

Our meta-analysis shows that parent-involved MI is effective in changing pediatric health behaviors, reducing BMI, and having a promising effect on dental caries. As of October 2014, 192 trials are currently funded by the NIH using MI. Many more trials have been conducted and concluded since the inception of MI. MI is increasingly being incorporated into medical education as a patient-centered method of assessment and intervention. The majority of the studies included in our meta-analyses were implemented in clinical settings or by phone supporting the feasibility of implementation by providers. Future research should focus on examining the effects of parent-involved MI on both behavior and health outcomes in longitudinal designs. Furthermore, greater attention needs to be paid to treatment fidelity in order to improve both internal and external validity. Additionally, MI training and intervention features should be described in greater detail in published articles or online supplements for the purpose of aiding in interpretability and replicability.

## Conclusions

Based on this study's results, the following conclusions can be made:

1. There is evidence to support the use of parent-involved motivational interviewing in improving a variety of pediatric health behaviors and outcomes (e.g., oral health, diet, physical activity, reduced screen time, smoking cessation, reduced secondhand smoke, body mass index).
2. Parent-involved MI improves pediatric oral health behaviors. MI may be useful for reducing dental caries, but more studies are needed.
3. Parent-involved MI interventions were more successful at improving diet when the intervention included a greater number of MI components.
4. There is insufficient evidence to support the use of MI interventions for other weight-related outcomes (i.e., proportion of overweight/obese, waist circumference, proportion of body fat) or objectively measured secondhand smoke exposure.

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