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When It Comes to Lifestyle Recommendations, More is Sometimes Less: A Meta-Analysis of Theoretical Assumptions Underlying the Effectiveness of Interventions Promoting Multiple Behavior Domain Change

Kristina Wilson[1], **Ibrahim Senay**[2], **Marta Durantini**[3], **Flor Sánchez**[4], **Michael Hennessy**[1], **Bonnie Spring**[5], and **Dolores Albarracín**[3]

[1]University of Pennsylvania

[2]Istanbul Sehir Universitesi

[3]University of Illinois at Urbana-Champaign

[4]Universidad Autónoma de Madrid

[5]Northwestern University

Abstract

A meta-analysis of 150 research reports summarizing the results of multiple behavior domain interventions examined theoretical predictions about the effects of the included number of recommendations on behavioral and clinical change in the domains of smoking, diet, and physical activity. The meta-analysis yielded three main conclusions. First, there is a curvilinear relation between the number of behavioral recommendations and improvements in behavioral and clinical measures, with a moderate number of recommendations producing the highest level of change. A moderate number of recommendations is likely to be associated with stronger effects because the intervention ensures the necessary level of motivation to implement the recommended changes, thereby increasing compliance with the goals set by the intervention, without making the intervention excessively demanding. Second, this curve was more pronounced when samples were likely to have low motivation to change, such as when interventions were delivered to non-patient (vs. patient) populations, were implemented in non-clinic (vs. clinic) settings, used lay community (vs. expert) facilitators, and involved group (vs. individual) delivery formats. Finally, change in behavioral outcomes mediated the effects of number of recommended behaviors on clinical change. These findings provide important insights that can help guide the design of effective multiple behavior domain interventions.

Keywords

multiple behavior domain change; physical activity; diet; smoking cessation; lifestyle intervention; multi-domain intervention; multi-behavior intervention

Correspondence regarding this article should be addressed to Dolores Albarracín, Department of Psychology, University of Illinois Urbana-Champaign, Champaign, IL, 61820, dalbarra@illinois.edu..

Two alternative approaches have been used to prevent the cluster of diseases associated with smoking, poor diet, and physical inactivity: designing interventions to reduce each risk behavior as a separate entity with its unique set of determinants and methods of change (Nigg, Allegrante, & Ory, 2002), or embracing behavior co-occurrence by designing interventions that reduce the multiple behaviors associated with a disease or cluster of diseases (Fine, Philogene, Gramling, Coups, & Sinha, 2004; Klesges, Eck, Isbell, Fulliton, & Hanson, 1990; Pronk, et al., 2004). Multiple behavior domain interventions encourage change in two or more health behavior domains, such as diet and exercise, with the recommendations being delivered within a limited period of time (Goldstein, Whitlock, & DePue, 2004; Nigg, Allegrante, & Ory, 2002; Nigg & Long, 2012; Prochaska, Nigg, Spring, Velicer, & Prochaska, 2010; Prochaska & Prochaska, 2008). Few doubt that, if successful, multiple behavior domain interventions are a practical way of promoting health by adapting to the reality of the disease. Despite this appeal, however, cumulative efficacy data are limited, often based on a restricted set of studies (Smedley & Syme, 2000; Emmons, 2001), and the theoretical mechanisms underlying the efficacy of these programs are surprisingly unarticulated. One issue that is vital for the design of successful multiple behavior domain interventions is to determine the optimal number of behavioral recommendations to target. To close this critical gap in prevention science, we conducted a meta-analysis examining potential theoretical mechanisms driving the impact of differing numbers of lifestyle recommendations on behavioral and clinical change, and to determine whether these effects vary depending on conditions that may be associated with delivery to recipients with low motivation to change.

In this paper, we reviewed 150 research reports summarizing the results of interventions targeting change in the behavioral domains (broad risk factor being targeted) of diet, exercise, or smoking, to determine whether a higher number of behavior recommendations (the specific prescribed dietary, exercise, or smoking behaviors, such as engaging in moderate physical activity for 30-minutes on at least 5 days per week) results in healthier outcomes. There are at least two theoretical predictions for the influence of number of recommendations on behavioral and clinical change. On the one hand interventions may become more difficult to process when they include a greater number of recommended behaviors to change. Many decades ago, experimental research on memory processes demonstrated that upon intentional effort to remember multiple digits, humans can recall an average of seven (Miller, 1956; Shiffrin & Nosofsky, 1994). Just as more numbers overwhelm cognitive capacity and foster forgetting of all numbers in the sequence, how many behaviors can an intervention promote before its efficacy plateaus or plummets? How many recommended behaviors are too many given our self-control capacity?

On the other hand, interventions may be more interesting when they include more recommendations, increasing the probability of attracting attention and motivation to implement the recommended changes (e.g., Broadhurst, 1959; Hebb, 1955; Klein, 1982; Mendl, 1999; Teigen, 1994; Yerkes & Dodson, 1908). These predictions are consistent with Bandura's self-efficacy theory (1986, 1989, 1997, 2004) as well as Brehm's motivational intensity theory (Brehm & Self, 1989; Brehm, Wright, Solomon, Silka, & Greenberg, 1983), both of which assume that effort is greater for moderately difficult tasks, than for either easy or difficult ones (Brehm et al., 1983; Contrada et al., 1982; Light & Orbrist, 1980; Silvia, Jones, Kelly, & Zibae, 2011; Silvia, McCord, & Gendolla, 2010; Wright, Contrada, & Patane, 1986). If both motivation and capacity issues are implicated, one could expect an inverted U-type of effect in which a moderate number of recommendations is more effective at changing behavior than either a low or a high number of recommendations. That is, a moderate number of recommendations would be low enough to prevent disengagement while being high enough to ensure the necessary level of motivation and effort to maximize compliance and, ultimately, clinical change.

Health Change Following Multiple Behavior Domain Interventions

A common idea that often underlies the development of multiple behavior domain interventions is that if multiple behaviors contribute to a disease, they should all be targeted in a simultaneous prevention effort (Nigg et al., 2002; U.S. Department of Health and Human Services, 2000; Werch, Moore, DiClemente, Bledsoe, & Jobli, 2005). There is evidence suggesting that targeting multiple lifestyle changes is beneficial for change in clinical indicators of health. For instance, interventions promoting exercise and dietary changes have been shown to reduce the incidence of diabetes and other clinical outcomes related to diabetes (e.g., weight, glycaemia; Diabetes Prevention Program Research Group, 2002; Tuomilehto et al., 2001). Targeting multiple lifestyle domains in an intervention, such as diet and physical activity, can also have beneficial carryover effects on other behaviors that have not been systematically targeted by a behavioral recommendation. For example, intervening to increase fruit and vegetable intake and to decrease sedentary leisure screen time has been shown to produce a large and sustained decrease in saturated fat intake (Spring et al., 2012). Despite this intriguing evidence, prior research has not thoroughly examined whether single behavior domain interventions are similarly associated with improvements in untargeted behaviors. Due to this limitation, it remains unclear whether multiple behavior domain interventions promote improvement in multiple domains in a manner that does not happen spontaneously in single behavior domain interventions.

Although conclusions from prior reviews of multiple behavior domain interventions are far from being monolithic (see Table 1), they suggest that multiple behavior domain interventions are generally more effective than single behavior domain interventions. For example, a synthesis of multiple behavior domain interventions to reduce cardiovascular risk and disease found favorable effects on behavioral and clinical outcomes, particularly for recipients at high risk of illness (Ketola, Sipila, & Makela, 2000). A more recent review of interventions addressing prevention of cardiovascular disease suggested that multiple behavior domain interventions produced modest improvements in risk biomarkers (e.g., blood pressure, cholesterol) in the general population, and reduced cardiovascular events and total mortality among those with hypertension or diabetes (Ebrahim et al., 2011). Additionally, a promising meta-analysis of interventions for type-1 diabetes concluded that change is greater in programs targeting several behavior domains (i.e., exercise, diet, medication; d = 0.45) than in exercise-only programs (d = 0.03; Conn et al., 2008). Finally, a meta-analysis of smoking cessation and weight control programs concluded that, rather than being detrimental, jointly targeting smoking cessation and weight gain offers greater short-term benefits than targeting smoking cessation alone (Spring et al., 2009). Although this evidence speaks to the enhanced efficacy of multiple behavior domain interventions, the optimal number of behavioral recommendations to include in these interventions remains unclear.

Meta-Analyzing Optimal Recommendation Numbers Based on the Role of Motivation: The Inverted-U Prediction

What is problematic about past reviews of the multi-behavior domain intervention literature is their being based on a small number of reports (for similar points see Nigg & Long, 2012; Ussher, Taylor, & Faulkner, 2012) and not thoroughly considering the role of cognitive and motivational processes in intervention success. Brehm's motivational intensity theory (Brehm & Self, 1989; Brehm et al., 1983) assumes actions are costly and people invest only as much effort as is necessary to achieve a goal. According to this perspective, effort is determined by both the importance of a goal and the difficulty of achieving that goal. Whereas importance determines potential motivation (i.e., the amount of effort people are willing to put into attaining a particular goal), difficulty determines actual motivation (i.e., the amount of actual effort people put into reaching a goal). As easy tasks are perceived as attainable with minimal effort, the amount of effort put forth should be lower than for more difficult tasks, a prediction also possible from Bandura's (1977, 1986, 1997) conceptualization of moderate level goals as most motivating. Interventions recommending a greater number of behaviors are undoubtedly more demanding than single behavior interventions (Nigg & Long, 2012; Patterson, 2001) and, therefore, motivation and follow through should increase as the number of recommended changes increases. In other words, a greater number of recommendations may be associated with increased efficacy because intervention recipients may be further engaged with the intervention and put more effort into attaining the recommended changes than if a single behavior was recommended.

Despite potential advantages of ensuring the necessary level of motivation by targeting multiple behavior changes, a greater number of recommended behaviors may push the human limits of cognitive capacity and self-control (Baumeister, Heatherton, & Tice 1994; Muraven & Slessareva, 2003). Due to restrictions on attending to and implementing multiple recommended behavior changes (Meichenbaum & Turk, 1987; Ornstein et al., 1993), intervention efficacy may either plateau or decrease when more behavior changes are required. Outcome expectancies have been shown to play an important role in motivation (Bandura 1986, 1989, 1997; see Carver & Scheier, 1998; Duval & Silvia, 2002 for reviews on the issue), such that effort decreases when goals are perceived as unattainable. A high number of otherwise appropriate behavioral recommendations may overload the human limits of self-control, undermining self-regulation by leading to the perception that the goals are unattainable or inducing fatigue and resource depletion (Baumeister & Heatherton, 1996; Muraven, Tice, & Baumiester, 1998; Vohs & Heatherton, 2000), and potentially disengagement from the recommended behaviors. Therefore, a smaller number of recommendations may be more efficacious when capacity, instead of motivation, is taken into consideration.

Of course it is most likely that both of these two mechanisms contribute to behavior change. If this is the case, there may be an inverted U-type of effect with a moderate number of recommendations being more effective at changing behavioral, and ultimately clinical, outcomes than either a low or a high number of recommendations. That is, recommending a moderate number of behaviors may be most effective because the intervention ensures the necessary level of motivation to implement the recommended changes (e.g., Bandura 1986, 1989, 1997, 2004; Brehm & Self, 1989; Brehm et al., 1983; Wright, 1996), without making the intervention excessively demanding that engagement decreases (e.g., Baumeister & Heatherton, 1996; Muraven et al., 1998; Vohs & Heatherton, 2000). If both mechanisms co-exist, making more lifestyle recommendations may sometimes result in less behavior and clinical change.

Recipient Motivation to Change May Moderate the Curvature of the Association between Number of Recommendations and Resulting Change

If motivation drives the predicted curvilinear pattern of number of recommendations, delivery to samples that are likely to have low motivation to change may be adverse from the point of view of efficacy, except when the intervention can offset the potential impact of low motivation to change with increased motivation and engagement that may result when a moderate number of behaviors are recommended. As a result, conditions associated with delivery to samples with low motivation to change may show reduced efficacy when the number of recommendations is either low or high, and stronger effects when the number of recommendations is moderate and thus able to motivate the audience.

Modeling the efficacy of multiple behavior domain interventions with an eye on recipients' motivation to change suggests delivery to samples with low motivation to change will be associated with a stronger curvilinear effect of number of recommendations. Conditions that may be associated with delivery to samples with low motivation to change include delivery to non-patient populations, implementation at non-clinic settings, use of lay community facilitators, and group delivery formats. First, when interventions target non-patient populations or are delivered in non-clinic settings, they reach populations that are not already seeking out health care. Prior research suggests that individuals not currently experiencing a health condition may be less motivated, as evidenced by reduced intervention efficacy among lower risk populations (Ammerman, Lindquist, Lohr, & Hersey, 2002; Ebrahim et al., 2011; Hardcastle, Taylor, Bailey, Harley, & Haggar, 2013; Ketola et al., 2000; Corabian & Harstall, 2001; Norris, Englegau, & Narayan, 2001; Norris et al., 2002; Murchie et al., 2003). Furthermore, lay community facilitators are commonly viewed as an appropriate source of health information for populations not easily reached by health professionals, and thus offer a practical means to deliver interventions to audiences that are reluctant to access healthcare that must be captured through outreach efforts (Beck et al., 2013; Clements & Buczkiewicz, 1993; Deering et al., 2009; Enriquez, Farnan, & Neville, 2013; Jones, 1992; McClelland et al., 2002; Nies, Artinian, Schim, Wal, & Sherrick-Escamilla, 2004).[1] Specifically, lay community facilitators may be selected for samples reluctant to participate because they can help to overcome barriers to healthcare access among marginalized groups (e.g., language/cultural differences, lack of public transportation, lack of health insurance coverage; Glenton et al., 2013; Karawalajtys et al.,

[1]Perceived similarity between facilitators and recipients is orthogonal to expertise and contributes favorably to efficacy (Durantini et al., 2006). Perceived similarity was not examined in the current meta-analysis.

2009; Nies et al.; Slutsky & Bryan-Stevens, 2001). Similarly, group delivery formats may be more likely to be used with audiences with low motivation to change, because this type of delivery format is better suited for the delivery of simple messages that are less tailored to the individual (Ayala, 2006; Greaves & Campbell, 2007; Renjilian et al., 2001; Wright, Sherriff, Dhaliwal, & Mamo, 2011). Group delivery formats may also be selected for samples with low motivation to change, because this delivery format offers potential benefits of social support and shared experiences (Deakin, McShane, Cade, & Williams, 2005; Paul-Ebhohimhen & Avenell, 2009; Skinner & van der Ven, 2005; Trento et al, 2002; Wilson et al., 1993; Wingham, Dalal, Sweeney, & Evans, 2006; Yalom, 1975) that may prove useful for prompting the desire to change in those not currently considering change.

The Present Meta-Analysis

In summary, the optimal number of behavioral recommendations to include in interventions targeting multiple behavior domains remains unclear, as do the mechanisms driving the impact of differing numbers of recommendations. Although prior reviews suggest that promoting change in multiple domains is more effective than targeting a single domain, none have precisely estimated the effects of interventions making varying numbers of behavioral recommendations (e.g., 2 vs. 5 recommendations) on change in behavioral and clinical measures. Moreover, no prior reviews have examined whether the effects of differing numbers of behavioral recommendations vary depending on conditions that are likely associated with delivery to samples with low motivation to change using a sufficiently large set of diverse studies. Gaining a thorough understanding of the effects of interventions making varying numbers of recommendations, particularly among audiences with low motivation to change, is critical to the development of a theory and a set of guidelines that inform the development of multiple behavior domain interventions.

We included reports that summarized findings from interventions targeting change in the domains of smoking, diet, and exercise. As we were interested in examining change over time, reports were required to include a pretest assessment. Our search yielded 150 eligible reports, which provided approximately 93,600 participants. Analyses were conducted to examine the effects of number of lifestyle recommendations on change in behavioral and clinical measures with a sample of 216 intervention groups making multiple recommendations, 15 intervention groups recommending a single behavior, and 39 no-intervention control groups. Beyond considering the impact of differing numbers of recommendations on behavioral and clinical change, it is important to establish whether interventions also influence health behaviors not directly targeted by the intervention. Thus, we also assessed change in behavioral measures as a function of whether a behavior was either targeted or untargeted by the recommendation in interventions making a single recommendation. Finally, to gain an understanding of mechanisms through which multiple domain interventions produce change in clinical measures (e.g., blood pressure, BMI, cholesterol, percent with disease), this meta-analysis gauged whether the impact of an interventions' recommendations on change in clinical health outcomes is mediated by behavior change. As the accuracy of self-reported behavioral measures is often questioned, examination of this mediating mechanism will assist in determining whether the behavioral data included in our meta-analysis are valid and conducive to clinical change. We also conducted exploratory analyses to determine other factors that associated with increased efficacy in multiple domain interventions (e.g., active intervention, face-to face delivery).

Method

Review and Inclusion Criteria

We conducted a computerized search of MEDLINE and PsycInfo for reports published in English that were available by September 24, 2012 using a number of keywords for *intervention*. These search terms included Intervention, Health education, Persuasion, Recommendation, Treatment, Educational program, Rehabilitation, Counseling outcomes, Treatment outcomes, Treatment effectiveness evaluation, Treatment compliance, Health promotion, Behavior change, and *Randomized trial*. To identify interventions targeting multiple lifestyle behavior domains, these keywords were entered in combination with keywords for interventions promoting change in (a) diet, (b) exercise, and (c) smoking. To identify diet interventions, we used the keywords Binge eating, Body image, Body weight, Bulimia, Caloric intake, Craving, Diet, Dietary restraint, Eating behavior, Eating disorders, Fat intake, Food intake, Fruit intake, Metabolism disorders, Healthy nutrition, Obesity, Sugar intake, Vegetable intake, Weight control, Weight loss, and *Healthy eating*. Exercise interventions were searched using Aerobic exercise, Body image, Physical activity, Sport training, Strength training, Weight control, Weight loss, Lack of exercise, Walking, Gymnastics, Going to gym, Running, Biking, Work out, and *Physical inactivity* as keywords. To search for smoking interventions, we used the keywords *Tobacco* and *Smoking*. Next, we used additional strategies to search for published and unpublished work. Using the same keywords, we searched *Proceedings* and *Papersfirst* for conference titles. We also emailed the most published authors in our database to request their published and unpublished work. Finally, we examined the reference lists of prior reviews of multiple behavior domain interventions and the papers included in our database to identify other possible articles for inclusion. These additional search strategies did not result in the identification of any additional papers for inclusion although more materials were uncovered.

Once our search for relevant reports was complete, we used several eligibility criteria to select studies for inclusion. The eligibility criteria are explained below:

1. ***Presence of at least two groups***. To be eligible, reports must include a control group. We considered control groups those that did not expose participants to any kind of intervention at the time of the study (e.g., wait list group, no-intervention group), an intervention group targeting change in a single behavior domain, or a usual care group. In addition, reports were required to include an intervention group targeting change in multiple behavior domains.
2. ***Presence of an intervention targeting more than one behavior domain***. We included reports evaluating interventions promoting change in diet, exercise, or smoking. Given our interest in examining the effects of the number of recommendations in interventions promoting change in multiple lifestyle domains, only reports that included an intervention targeting at least two of these three

domains were considered for inclusion. As multiple behavior domain interventions were the primary focus of this meta-analysis, we did not search for single behavior domain interventions in the domains of concern.

3. ***Presence of information to determine the number of behavioral recommendations in the intervention***. We included reports that provided a description of the intervention that permitted determining the number of behavioral recommendations included in the intervention. Many control groups were excluded from our analyses because the description of the usual care group did not provide enough detail to code for number of behavioral recommendations (k = 96).

4. ***Presence of appropriate statistics***. We only included studies that provided information that made it possible to calculate effect sizes representing change over time. Thus, reports without a pretest were excluded (n = 140). In some cases, supplementary information to calculate effect sizes was supplied by the authors of the synthesized reports.

Coding of Study Characteristics

Relevant characteristics of the reports, as well as the methods used in the studies, were coded by two independent raters, as described below. Intercoder coefficients (kappas for categorical variables and simple correlations for continuous variables) are summarized in Table 2. Disagreements between coders were resolved by discussion and further examination of the reports.

Description of the report—We coded studies for characteristics of the report, including the (a) publication year, (b) the first authors' institution (e.g., college, research center), (c) the first authors' institutional area (e.g., psychology, community/public health, medicine), (d) source type (e.g., journal article, unpublished dissertation or thesis, conference paper), (e) location of the intervention, and (f) language of the intervention.

Domains of behavior change and recommendations—Papers were also coded for whether they encouraged change in the primary domains of (a) diet, (b) exercise, and (c) smoking, as well as frequent secondary domains of (d) alcohol use, (e) medication adherence, and (f) cancer screening. Interventions that targeted change in more than one domain (e.g., exercise and diet) were classified as multiple behavior domain interventions, whereas those targeting change in a single domain (e.g., exercise) were considered single behavior domain interventions. Although the presence of an intervention targeting more than one behavior domain was a criterion for eligibility, this variable was not used in our count for number of behavior recommendations.

We coded interventions for number of behavioral recommendations by counting the total number of primary goals (e.g., reduce calories, increase fruit and vegetable intake, increase physical activity) that interventions were described as targeting. For example, the multiple behavior domain intervention in Ussher, West, McEwen, Taylor, and Steptoe (2003) was coded as presenting two recommendations because participants were instructed to engage in physical activity for 30-minutes or more on at least 5 days per week, and to stop smoking. In contrast, the control group in Spring et al. (2004) was coded as making one behavioral recommendation because participants were instructed to quit smoking. All primary goals were included in our count for number of behavioral recommendations, but more specific behavioral skills discussed as means to reaching those goals (e.g., monitoring urges, coping with temptation) were not counted because they are not reported in a reliable way. Although we coded for the inclusion of biological methods (e.g., nicotine replacement drugs), their presence was not counted as a behavioral recommendation, but rather as a biomedical strategy to reaching the recommended behavior. For interventions making a single behavioral recommendation, we also coded for whether the behavioral outcome measures were targeted by the recommendation (i.e., yes vs. no). For example, in an intervention that made a single behavioral recommendation to increase physical activity, measures assessing physical activity level were coded as targeted by the recommendation whereas any additional measures (e.g., measures assessing fruit and vegetable intake) were coded as untargeted.[2]

Facilitator characteristics—As some interventions used both types of sources, we coded whether the facilitator was a lay community member (i.e., yes vs. no) and whether the facilitator was a professional expert (i.e., yes vs. no). Lay community members included community leaders and peers, such as nonprofessional peer counselors. Professional experts included physicians, public health educators, nurses, dieticians, physical therapists, teachers, members of the research team, social workers, psychologists, counselors, and medical students. Of course, the two dummy codes for expertise and lay community membership were extremely highly correlated ($r = -.89$, $p < .001$). However, as some interventions included both types of facilitators, the correlation was not perfect and we used both indexes in analyses.

Delivery format—We coded whether interventions were delivered to individuals (i.e., yes vs. no) and groups (i.e., yes vs. no). Interventions were coded for the use of both formats because some interventions used both group and individual formats. The two dummy codes for delivery format were highly correlated ($r = -.54$, $p < .001$) and both indexes were used in analyses.

Other characteristics—We coded the **demographic characteristics** of the participants. To describe the characteristics of the sample, we recorded the (a) sample size, (b) percentage of males in each group, (c) lowest, highest and mean age, (d) percentage of participants of European, African, Latin, Asian, and Native American descent[3], (e) percentage of participants who completed high school and mean years of education, and (f) percentage of participants with a health condition (e.g., diabetes, heart disease, and obesity).

We also coded for characteristics related to the **intervention setup**. We classified each intervention group according to (a) whether interventions included strategies that were active (e.g., behavioral skills training or client-tailored counseling components) or used only

[2]It was not possible to examine targeted vs. untargeted change interventions making multiple recommendations as all measures were targeted by the recommendations included in the intervention.

[3]When ethnicity data were not reported and countries were highly ethnically homogeneous (e.g., the Netherlands, Italy), we obtained the information from population reports from those countries.

passive strategies (e.g., attitudinal arguments, informational arguments; see Albarracín et al., 2005), (b) interventions were also coded for whether they included biological methods, such as nicotine patches or drugs to reduce food cravings, or asked recipients to sign a behavioral contract for performance of the recommended behaviors, and these ratings were made independent of the classification of an intervention being more or less resource demanding as both types of interventions included these strategies, (c) the setting of exposure (i.e., clinic, school, community, mass media), and recoded this variable to provide an indicator clinic vs. non-clinic setting, (d) the form of media used to deliver the intervention (i.e., face-to-face interactions, video or audio taped materials), (e) whether the intervention was defined as culturally appropriate, (f) the location of recruitment (e.g., drug treatment facility, classroom, hospital), (g) the duration of the intervention in terms of total number of counseling contacts/visits, the length of each visit in minutes, and the number of days from the baseline until the end of the intervention.

Finally, we coded for factors related to the **research design and implementation**. We coded studies for (a) whether the design was within-subjects or whether the samples were different at pre- and posttest, (b) whether participants were randomly assigned to conditions, (c) the amount of money (in U.S. dollars) received in exchange for participation, (d) the mean and median number of days between the intervention and the posttest, (e) whether clinical outcomes were assessed objectively or relied on participant self-reports, (f) the specific sample to which the intervention was targeted (e.g., cardiac patients, hypertensive patients on medication, college students, smokers, obese adults), and recoded this variable to indicate whether the intervention targeted non-patient vs. patient populations, and (g) whether the intervention was targeted to a specific (h) ethnic or (i) gender group. We also coded for whether the sample was (j) self-selected, as indicated by whether participants took part in the study on a voluntary basis versus were more captive groups, such as participants in classrooms, inpatient hospitals, or prisons.

Retrieval of Effect Sizes

Effect sizes were calculated independently by two coders. When different effect sizes were calculated, a third researcher examined the effect size calculations and resolved the disagreement by discussion. For reports containing more than one measure of a construct of interest, we calculated effect sizes for each measure and the average effect size was used as the effect size for that particular variable (see B.T. Johnson, 1993). To indicate change in pretest to posttest measures, we used Becker's (1988) g, which was calculated by subtracting the mean at posttest from the mean at pretest and dividing the difference by the standard deviation of the pretest measure. Effect sizes were also calculated from exact reports of t tests, F ratios, proportions, p values, and confidence intervals. Depending upon the behaviors targeted in an intervention, we calculated effects sizes representing change in outcomes related to diet, exercise, and smoking, as well as additional outcomes related to alcohol use, medication adherence, cancer screening, and more general health outcomes. Effect sizes were always calculated as improvements from a health perspective (e.g., decrease in BMI, increase in fruit and vegetable intake). Outcomes were assessed using behavioral, clinical, and psychological measures, as described below.

Behavioral measures—The synthesized reports included a large variety of behavioral measures, which were used to calculate effect sizes reflecting improvements in health. The most frequent measures in the area of *diet* were energy intake (e.g., kcal/week, kcal/day, kj/day); carbohydrate, protein, fiber, fat, calcium, iron, vitamin, fruit, and vegetable (in milligrams, grams or servings) intake; number of meals per day; whether participants complied with the dietary recommendations; whether participants met daily guidelines for fruit and vegetable intake; whether participants checked their blood pressure in the past 12 months; presence of unhealthy eating; presence of overeating; and water intake. The most frequent behavioral measures in the *exercise* domain were whether participants exercised daily; weekly hours of physical activity; presence of occupational physical activity; whether participants reported regular physical activity; whether participants complied with exercise recommendations; whether participants were sedentary; whether participants reported high impact activity; presence of self-monitoring of pulse and blood pressure; presence of self-monitoring with pedometer (daily pace); time spent in physical activity; energy expenditure in physical activity (k/cal); and number of TV hours per day.

The most frequent behavioral measures in the *smoking* domain were whether participants currently smoked; and number of cigarettes per day (often via diaries).

There were also *supplementary behavioral measures* related to medication and screening in areas for diseases associated with diet, exercise, and smoking. These measures included never forgetting to take medication; forgetting to take medication; lack of adherence to the treatment plan; picking up medications; refilling medication; missing medication doses; using medication delivery methods; incorporating the medication regimen into one's daily life; and acquiring social support for adherence (e.g., involvement with friends, attending support groups, and community involvement). Moreover, some studies included such measures as whether participants had a PAP test within the past 2 years; whether participants had a mammogram within the past 2 years; whether participants had a lipid panel test; whether participants had a chest X-ray within the past year; whether participants had a dental cleaning within the last 6 months; and presence of other health seeking measures including specific lab tests within the past year.

Clinical measures—Among the many clinical measures used in the studies were body weight in kilograms; body mass index; hip size; waist size, hip/waist ratio; body fat measures; whether participants were overweight; whether participants were obese; systolic blood pressure; diastolic blood pressure; triglycerides level; HDL/LDL cholesterol; fasting blood glucose; results from other lab tests for diabetes; whether participants had diabetes; whether participants had metabolic syndrome; pulse; results from spirometer tests; results from VO_2 Max tests; results from chest X-ray; whether participants had nicotine in blood; results from lab tests to confirm right dose of medication in blood; results from PAP reports; results from mammograms; results from dental records; and results from colonoscopy reports.

Psychological measures—Psychological measures present in the studies included beliefs about the benefits of a behavior for improving the desired clinical outcome (e.g., Physical activity is beneficial for lowering blood pressure; Burke, Giangiulio, Beilin, Houghton, & Millligan, 1999, p. 275); self-efficacy for performing the targeted behavior (e.g., How confident are you that you will be able to quit smoking for the next 3 months?; Kinnunen et al., 2008, p. 693); worry about weight (e.g., How concerned are you about gaining weight as a result of quitting?; Borrelli & Mermelstein, 1998; p. 622), and knowledge (e.g., ability to correctly identify LDL targets; Lichtman et al., 2003).

Analytic Strategy

We calculated weighted mean effect sizes to examine change over time for interventions making varying numbers of recommendations. Corrections for sample-size bias were performed to estimate the effect size of *d*. Hedges and Olkin's (1985) procedures were used to correct for sample size bias[4], calculate weighted mean effect sizes (*d*), confidence intervals, and to estimate homogeneity statistics (*Q*), which test the hypothesis that the observed variance in effect sizes is no greater than that expected by sampling error alone. For between-subject designs, we calculated the variance of effect sizes following Hedges and Olkin's procedures. For within-subjects designs, we followed Morris' (2000) procedures to calculate the variance of effect sizes, and the correlation between the pre- and posttest measures was estimated at $r = .50$. Changing this correlation did not alter the pattern of findings. After computing effect sizes for each outcome measure, for each case we computed an average effect size indicating overall change, as well as average effect sizes for change in behavioral and clinical outcomes.

We performed analyses using fixed- and random-effects procedures. When conducting fixed-effects analyses, we weighted effect sizes using the inverse of the effect size's variance, which allowed effect sizes from studies with larger sample sizes to carry more weight than effect sizes from studies with smaller sample sizes.[5] For random-effects models, we added a random variance component to the variance of each effect size, and recalculated the inverse variance prior to weighting the effects sizes. All analyses controlled for the effects of intervention duration by including this variable as a covariate in the model. In addition, as the type of strategies used in an intervention may vary as a function of the targeted domains, we controlled for whether studies targeted change in smoking, alcohol use, and medication adherence. Given that the majority of cases targeted change in exercise and diet (see Table 2), it was unnecessary to control for these domains in our analyses. We also controlled for whether the sample was self-selected, because self-selected samples were associated with stronger improvements in overall change than samples that were not self-selected, fixed-effects $QB = 159.98$, $p < .001$, $k = 271$.

Many of our analyses were conducted using analysis of variance (ANOVA) procedures. When conducting analyses, we entered the inverse of the variance of the effect size being predicted as a weight, and determined whether effects were significant by examining the significance of *QB*, which is a sum of squares analogous to an *F* ratio but distributed as a chi-square. *QBs* were obtained for the main effects of number of recommendations and

[4]When the *N* at the pretest differed from the *N* at the posttest, the smaller *N* was used.

[5]The distribution of weights was skewed due to sixteen cases with large weights. To correct for this, we curved weights over 999 to fit between the range of 1,000–2,000. Because results were similar regardless of whether we used the original or curved weights, we present only results from analyses using the curved weights.

intervention characteristics, the simple effects for intervention characteristics, and also for interaction terms between number of recommendations and intervention characteristics. After establishing the impact of differing numbers of recommendations, we conducted mediation analyses to identify the potential mechanism that accounts for the relation between number of recommendations and change in clinical outcomes. Specifically, we examined whether change in behavior following participation in a health promotion intervention mediates change in clinical indicators of health. Further details are provided as they become relevant.

Results

Sample of Interventions and Controls

We included 150 reports, which provided 216 intervention groups recommending multiple behaviors, 15 intervention groups recommending a single behavior, and 39 no-intervention control groups (e.g., waitlist, no treatment controls). Of the 150 reports, 50 provided a single data set, 80 provided two data sets, 16 provided three data sets, and 3 provided four data sets.[6] Table 2 provides information about the included reports, and contains descriptions of the intervention participants, recommendations, strategies, and methods, with separate columns for multiple behavior intervention and control groups. As can be seen, most of the studies were published around 2003 and the median sample sizes were about 86 and 63 participants for multiple behavior intervention and control groups, respectively. Thirty-one countries were represented, with the majority of studies being conducted in the United States. Of the studies conducted in the U.S., 24 states were represented with California providing more groups than any other state.

As can be seen in Table 2, the majority of interventions included recommendations targeting change in exercise, dietary, or smoking behaviors. Interventions less frequently included recommendations targeting change in behaviors such as alcohol use, medication adherence, and cancer screening. Interventions recommending multiple behaviors included on average 3.41 (*SD* = 0.86, Range = 2–5) recommendations. With respect to the type of intervention to which recipients were exposed, 70% of groups were exposed to an intervention that involved more resource demanding strategies, whereas the remaining 30% of groups were exposed to interventions that relied solely on less resource demanding strategies. Strategies that were less resource demanding commonly included (a) informational statements about the targeted behaviors (79%), (b) arguments designed to induce a positive attitude toward the recommended behaviors (80%), and (c) arguments to enhance perceptions of control (13%). Fourteen percent of interventions included biological treatments (e.g., nicotine patches), and these types of treatments were administered in both types of interventions.

The papers we examined were diverse, in terms of the participants, intervention set-up, and research design and implementation. Samples comprised both females and males, and participants were on average middle age. On average, 67% of participants were of European decent, 45% of participants had completed high school, and 90% were described as having a risk factor, precursor to a health condition, or a health condition at pre-intervention. The

[6]Data set refers to the number of conditions that each paper contributed to the final database.

samples included individuals at-risk or with a history of obesity, type-1 or type-2 diabetes, coronary heart disease, chronic kidney disease, congestive heart failure, hypertension, and high cholesterol, and 33% were described as a patient population at baseline. More interventions were delivered in clinics than in any other place, although interventions were also conducted in schools and in workplaces, as well as through the mass media. The majority of interventions were presented face-to-face (93%), exclusively used an individual delivery format in 45% of the cases, and exclusively used professional experts as facilitators in 61% of cases. On average, interventions lasted approximately 22 hours.

Finally, there was variability in research design and implementation across studies. All studies included pre- and posttest measures and the majority of the designs were within-subjects. However, some studies did use different participants at pre- and posttest. The assignment of participants to study condition was done at random in 87% of cases and participants were compensated on average U.S. $39.38. The mean length of time between the intervention and the posttest was slightly over three months for both interventions recommending a single behavior and those recommending multiple behaviors. Clinical outcomes were assessed objectively in the majority of cases (96%). The majority of interventions were targeted to a specific population, such as a population with a particular health condition or risk factor (e.g., women with coronary heart disease), and samples were frequently self-selected.

Average Intervention Effect Size

We first obtained a weighted-mean average of overall change and tested for variability among effect sizes in intervention groups recommending multiple behaviors, intervention groups recommending a single behavior, and control groups. For interventions recommending multiple behaviors, the average effects size was $d = 0.17$ (95% confidence interval [CI] = 0.16, 0.18; $Q(216)$ for homogeneity = 2,829.83, $p < .001$) according to the fixed-effects model, and $d = 0.23$ (95% CI = 0.19, 0.26; $Q(216)$ for homogeneity = 346.47, $p < .001$) according to the random-effects model. In interventions recommending a single behavior, the average effect size from the fixed-effects analysis was $d = 0.07$ (95% CI = 0.02, 0.13; $Q(14)$ for homogeneity = 48.66, $p < .001$), and the average effect size from the random-effects analysis was $d = 0.11$ (95% CI = −0.04, 0.24; $Q(14)$ for homogeneity = 11.06, $p > .05$). Finally, the average effect size for no-intervention control groups was $d = 0.06$ (95% CI = −0.01, 0.12; $Q(38)$ for homogeneity = 267.48, $p < .001$) according to the fixed-effects model, and $d = 0.04$ (95% CI = −0.06, 0.13; $Q(38)$ for homogeneity = 31.40, $p > .05$) according to the random-effects model. As most tests for homogeneity were statistically significant, indicating a large amount of variability between effect sizes, we examined whether our moderators accounted for a significant amount of this variability. We also conducted exploratory moderator analyses to identify other factors that likely influence efficacy in interventions recommending multiple behaviors.

Given that these initial analyses involved average effect sizes and that the number of measures contributing to our final effect size calculations differed across studies, we examined whether the number of measures included in an intervention varied as a function of number of recommendations. As interventions recommending a single behavior (Range

1–13, $M = 5.93$; $SD = 4.20$) included a comparable number of indicators as interventions making a moderate (Range 1–16, $M = 4.71$; $SD = 3.01$) and high (Range 1–16, $M = 5.05$; $SD = 3.17$) number of recommendations, $F(2, 228) = 17.41$, $p > .05$, it was unnecessary to control for the number of included measures in our analyses. This test provided reassurance for the use of average effect sizes in our final effect size calculations.

Furthermore, we compared the inclusion of clinical outcome measures across different intervention characteristics using chi-square tests. These analyses revealed that the inclusion of clinical measures was highly comparable across key intervention characteristics. Specifically, the inclusion of clinical measures was comparable for interventions recommending a single behavior (vs. multiple behaviors X^2 (1, $N = 231$) = 0.10, $p > .05$), interventions delivered to non-patient populations (vs. patient populations, X^2 (1, $N = 231$) = 0.77, $p > .05$), interventions implemented at non-clinic settings (vs. clinic settings, X^2 (1, $N = 231$) = 1.19, $p > .05$), interventions implemented by community member (vs. non-community members, X^2 (1, $N = 231$) = 1.88, $p > .05$), and interventions using group delivery formats (vs. individual delivery, X^2 (1, $N = 231$) = 0.16, $p > .05$). Finally, we examined whether the effect of number of recommendations on overall change varied depending on whether papers included clinical outcomes and found no evidence of moderation, fixed-effects $QB = 2.67$, $p > .05$, $k = 270$. Together, these tests provided reassurance for the use of an indicator of overall change, combining behavioral and clinical effects, in our subsequent analyses.

Targeted Versus Untargeted Behavioral Change

We next explored whether change in behavioral measures was greater when outcomes were targeted in comparison to when outcomes were not targeted by a behavioral recommendation. To conduct these analyses, we examined whether interventions making a single behavior recommendation assessed change in behavioral outcomes untargeted by the recommendation, as this allowed for the comparison of change in targeted versus untargeted measures. Among interventions making a single behavior recommendation that included multiple behavioral measures ($k = 5$), we computed a weighted mean effect size for change in targeted and untargeted measures. Whether a measure was targeted by the recommendation in an intervention making a single behavioral recommendation significantly predicted overall change. The weighted mean effects sizes from the fixed-effects analyses suggested that compared to untargeted behaviors ($d = 0.04$ (95% $CI = 0.01$, 0.06), change was significantly greater in targeted behaviors ($d = 0.33$ (95% $CI = 0.31$, 0.36), fixed-effects $QB = 4.99$, $p < .05$, $k = 5$, and random-effects $QB = 4.51$, $p < .05$, $k = 5$.

Change as a Function of Number of Recommendations

Overall effects across interventions and control groups—More important than establishing that change is greater when outcomes are targeted by a recommendation is to determine the optimal number of recommendations to include in behavioral interventions. Thus, we then examined change in behavioral and clinical outcomes, as well as overall change across the average of all outcomes, as a function of number of recommendations. As some values for the number of recommended behaviors had a low frequency, we recoded number of recommendations prior to conducting these analyses (0 = 0 recommendations; $k =$

39, 1 = 1 recommendation; $k = 15$, 2 = 2-3 recommendations[7]; $k = 110$, 3 = 4 or more recommendations; $k = 106$). Moreover, when number of recommendations was left as a continuous variable some cells had a low frequency in our moderator analyses and the recoding corrected for this issue. In these analyses, interventions making 0 recommendations represent no-intervention control groups.

The weighted mean effect sizes and confidence intervals (*CI*s) from the fixed-effects analyses, along with *QB*s from the fixed- and random-effects analyses, appear in Table 3. As can be seen, a curvilinear relation exists between the number of behavioral recommendations and intervention effectiveness, and for all three outcomes stronger average improvements across outcomes were observed with interventions making 2-3 recommendations.[8] However, a weaker effect was observed when change in clinical outcomes was considered. The stronger effect on average behavioral change is anticipated given that these outcomes are most proximal to the intervention and are likely to then drive clinical outcomes. Although interventions making multiple behavioral recommendations were in general more effective than interventions making a single recommendation, there is a limited benefit to increasing the number of recommendations in an intervention. In particular, our results indicate that interventions making a moderate number of recommendations are most efficacious, providing evidence that more lifestyle recommendations do not result in healthier outcomes.

Now, given that the number of outcomes assessed may vary depending on the number of recommendations included in an intervention, one could argue that smaller effect sizes may not necessarily equal less change. Specifically, our indicators of average change may not be ideal to capture improvements in interventions making varying numbers of recommendations. Given this possibility, we conducted additional analyses in which the dependent variables of behavioral, clinical, and overall change were computed by summing, rather than averaging, effect sizes. These analyses revealed a similar pattern of results for all three indicators of change, whereby interventions recommending a moderate number of behaviors were associated with stronger improvements. For example, the weighted mean effects sizes from the fixed-effects analyses suggested that overall change was significantly greater in interventions targeting 2-3 recommendations ($d = 2.03$ (95% $CI = 1.12, 2.94$) than in interventions making 0 ($d = 0.61$ (95% $CI = -0.27, 1.51$), 1 ($d = 0.69$ (95% $CI = -0.54, 1.92$), or 4 or more ($d = 1.26$ (95% $CI = 0.54, 1.99$) recommendations, respectively, fixed-effects $QB = 551.56$, $p < .05$, $k = 270$, and random-effects $QB = 34.57$, $p < .05$, $k = 270$. These additional analyses strengthen our conclusion that interventions making a moderate number of lifestyle recommendations are associated with stronger improvements than interventions making either high or low numbers of recommendations.

[7]We analyzed whether differences existed in the efficacy of interventions we coded as making a moderate number of recommendations. Our analyses revealed that there was not a significant difference in overall ($QB = 0.25$, $p > .05$, $k = 110$), behavioral ($QB = 0.01$, $p > .05$, $k = 76$), or clinical ($QB = 2.67$, $p > .05$, $k = 78$) change for interventions making two versus three behavioral recommendations.

[8]Due to the small number of cases that assessed clinical outcomes using self-report measures ($k = 7$), it was not possible to determine if the effect of number of recommendations differed depending upon whether clinical outcomes were measured objectively. When we removed cases where clinical outcomes relied on self-report from our analysis, the overall pattern of results remained the same ($QB = 32.63$, $p < .05$, $k = 192$). Because results were similar, we retained these cases in our analyses.

Intervention Duration

Given prior research suggesting that intervention intensity is related to intervention efficacy (e.g., Aguiar et al., 2014; Ebrahim et al., 2011; Ketola et al., 2000; McAlister et al., 2001), we examined whether duration interacted with number of behavioral recommendations to predict overall change. Our analyses revealed that interventions recommending a moderate number of recommendations were most effective (QB for main effect = 69.07, $p < .001$, k = 167) and that duration significantly interacted with number of recommendations (QB = 69.07, $p < .001$, k = 167). Interventions of shorter duration (1 *SD* below mean) were more effective when they recommended a single behavior (d = 0.24 (95% *CI* = −0.09, 0.57) than when they recommended a moderate (d = 0.12 (95% *CI* = 0.02, 0.23) or high (d = −0.03 (95% *CI* = −0.09, 0.07) number of behaviors. In contrast, interventions of average duration were more effective when they recommended a moderate number of behaviors (d = 0.20 (95% *CI* = 0.13, 0.28) than when they recommended a single (d = 0.11 (95% *CI* = −0.09, 0.33) or high (d = 0.02 (95% *CI* = −0.03, 0.07) number of behaviors. Similarly, interventions of longer duration (1 *SD* above mean) were more effective when they recommended a moderate number of behaviors (d = 0.28 (95% *CI* = 0.23, 0.37) than when they recommended a single (d = 0.00 (95% *CI* = −0.26, 0.263) or high (d = 0.07 (95% *CI* = 0.03, 0.11) number of behaviors.

Although these findings suggest that the best strategy when implementing shorter interventions is to recommend a single behavior, interventions of average or longer duration appear to be associated with improved outcomes when a moderate number of behaviors are targeted. As such, allowing adequate time for implementation must be considered when designing interventions that recommend multiple behavior changes. As intervention efficacy varied as a function of intervention duration, we introduced this variable as a covariate in all analyses.

Behavior Change as a Mediator of the Influence of Recommendation Number on Clinical Change

Next, we conducted analyses to identify whether behavior change mediates the relation between number of recommendations and change in clinical outcomes. The generic mediation model (MacKinnon, Fairchild, & Fritz, 2007) is presented in Figure 1. In this model, number of recommendations was treated as a continuous variable, and was used to predict the behavioral change outcome mediator and the clinical change outcome directly. To estimate the model, we used Mplus, Version 5 (Muthén & Muthén, 2006), using maximum likelihood estimation and analyzed all cases even though missing values were present (Enders & Bandalos, 2001). We also weighted the effect sizes based on the reciprocal of the standard errors of the effect size estimates, as discussed earlier. We report the parameters for the path going from number of recommendations to clinical change (parameter A), the path going from the number of recommendations to behavioral change (parameter B), the path going from behavioral to clinical change (parameter C), and the percent of the total effect of recommendations on clinical change that is mediated, calculated from the analysis of the direct, indirect, and total effects (Streiner, 2005). We present unstandardized results to permit direct comparability of effect sizes (Greenland, Schlesselman, & Criqui, 1986), as well as the standardized results.

Given our theoretical predictions and our results suggesting that intervention efficacy begins to decrease when interventions recommend a large number of behaviors (see Table 3), our models included a quadratic term for number of recommendations. Prior to squaring the number of recommendations term, we centered this variable on the mean of the sample. When we included both the linear and quadratic components in our model, the direct effect of number of recommendations on behavioral change (linear term = 0.018, $p > .05$; quadratic term = −0.008, $p > .05$) and its indirect effect on clinical outcomes (linear term = 0.005, $p > .05$; quadratic term = −0.002, $p > .05$) were not significant. The lack of mediation when both the linear and quadratic terms were included in the model is likely due to multicollinearity, as indicated by the high correlation between the two variables ($r = -.64$, $p < .001$) and VIFs that are greater than two for both variables. Thus, we report results from our final model that included only the centered quadratic term for number of recommendations. This functional form of recommendations assumes that recommendations have differential impact on changes as they differ either higher or lower from the average value. If the coefficient of this variable is negative, interventions with either high or low number of recommendations are *less effective* in producing change in effect size outcomes than interventions with average values. If the coefficient of this variable is positive, interventions with either high or low number of recommendations are *more effective* in producing change in effect size outcomes than interventions with average values.

As can be seen in Table 4, the effect of number of recommendations on clinical change was mediated by change in behavioral outcomes. The direct effect of number of recommended behaviors was nonsignificant when we introduced behavioral change, suggesting that behavioral change was in fact a plausible mediator. The indirect effect of number of recommendations on clinical change was negative: departures from the average (moderate) number of recommended behaviors reduced behavioral effect sizes (see parameter B). Furthermore, behavioral effect sizes were positively related to larger clinical effect sizes (see parameter C), resulting in a negative indirect B*C effect. Importantly, as the direct effect of number of recommendations on clinical change was positive and about the same size as the negative indirect effect, these two countering balancing processes operated cumulatively to produce a near zero total effect. Thus, the percent mediated of the total effect was not a meaningful concept in this case. This type of compensating mediation was highlighted in early work on mediation and meta-analysis (Shadish, 1996, p. 56). In sum, our results suggested that behavioral change completely mediates the relation between quadratic recommendations and clinical change. In addition, as departures from the average number of recommendations had a negative effect on behavioral change, these findings are consistent with our hypothesis that more lifestyle recommendations do not always result in healthier outcomes.

Effects of Number of Recommendations across Conditions of Varying Motivation to Change

Another goal of this meta-analysis was to test whether conditions related to implementation among intervention recipients with low motivation change moderates the effect of number of recommendations. One possible prediction is that among reluctant audiences, the intervention would have reduced effects, except when the intervention is sufficiently motivating to compensate for their lower levels of motivation. Given the similar effect of number of recommendations on behavioral and clinical change, we tested overall change as an outcome variable in ANOVAs weighted by the corresponding variance of the sample size, and our moderators as independent variables. All moderator analyses excluded control groups because there was no facilitator or delivery format to be coded (k = 39). Potential interactions can be examined from the *QBs* for the interactions between number of recommendations and intervention characteristics in Tables 5 and 6, complemented by the *QBs* for the simple effects. To further test our hypothesis regarding the effects of intervention conditions likely to be associated with recipients with low motivation to change, following significant interactions, we conducted follow-up analyses indicated with subscripts in Tables 5 and 6. Generally the results from fixed- and random-effects models demonstrated a similar pattern, although there were fewer significant interactions in our random-effects models. Thus, we focus on the results from fixed-effects models, which are more powerful and produce narrow confidence intervals (Rosenthal, 1995; Wang & Bushman, 1999).

The results from our univariate analyses examining the effects of our hypothesized moderators are presented in Table 5, and the results from our multivariate analysis, which takes into account potential intercorrelations among predictors, are presented in Table 6.[9], [10] Only the interactions for delivery to non-patient populations and the use of lay community facilitators remained significant in our multivariate analysis. In this model, interventions delivered to non-patient populations (fixed-effects $QB = 13.43$, $p < .01$, $k = 231$) and the use of lay community facilitators (fixed-effects $QB = 23.37$, $p < .001$, $k = 231$) were associated with significantly reduced effects. Importantly, delivery to non-patient populations interacted with number of recommendations to predict overall change, fixed-effects $QB = 20.24$, $p < .001$, $k = 231$. Examination of the *QB*s for the simple effects indicated that the curvilinear type of effect of number of recommendations was stronger when interventions were delivered to non-patient populations. Interventions delivered to non-patient populations were associated with significantly reduced effects when both a single or high number of behaviors were recommended, whereas interventions delivered to patient populations were only associated with reduced effects when a high number of behaviors were delivered.

Similarly, facilitator expertise interacted with number of recommendations to predict overall change, fixed-effects $QB = 164.20$, $p < .001$, $k = 231$. Interventions implemented by lay community facilitators were most effective when they recommended a moderate number of behaviors, and significantly reduced effects were observed when lay community members recommended a low or high number of recommendations. In contrast, as indicated by the *QB* for the simple effects, the effect of number of recommendations for interventions implemented by noncommunity members was weaker, presumably because these

[9]We analyzed whether professional expertise moderated the influence of numbers of recommendations on overall change. Our results replicated and the interaction between number of recommendations and expertise was significant, Fixed effects $QB = 276.25$, $p < .001$, $k = 231$.

[10]We analyzed whether the use of individual delivery formats moderated the influence of numbers of recommendations on overall change. Our results replicated and the interaction between number of recommendations and expertise was significant, Fixed effects $QB = 40.86$, $p < .001$, $k = 231$.

interventions are likely to be implemented to recipients with higher motivation to change. These analyses support the hypothesis that interventions implemented to recipients that likely have low motivation to change are associated with significantly reduced effects, unless the intervention is sufficiently motivating to compensate for their lower levels of motivation.

Exploratory Analyses

We also conducted exploratory analyses to determine other factors that influence intervention efficacy in interventions making multiple recommendations. The results from our fixed-effects analyses of the effects of various intervention characteristics are presented in Table 7. These analyses showed that interventions making multiple recommendations were more effective when they were passive (vs. active; *d*. = 0.33 vs. *d*. = 0.20) and were presented using face-to-face interactions (vs. other presentation methods; *d*. = 0.29 vs. *d*. = 0.14). Moreover, interventions recommending multiple behaviors were more effective when interventions were described as culturally appropriate (vs. not described as culturally appropriate; *d*. = 0.35 vs. *d*. = 0.25), and targeted to a specific gender (vs. not targeted; *d*. = 0.36 vs. *d*. = 0.23) or ethnic group (vs. not targeted; *d*. = 0.33 vs. *d*. = 0.24). These analyses imply that interventions recommending multiple behaviors that rely solely on strategies that involve minimal involvement from intervention recipients (e.g., attitudinal arguments, normative arguments, informational arguments) or that are presented using face-to-face interactions enhance the ability of intervention recipients to implement multiple recommended changes, possibly because these characteristics decrease the difficulty of implementing and receiving an already demanding multi-behavior intervention. Moreover, tailoring the intervention to a particular target audience also appears to effectively enhance the efficacy of multiple behavior domain interventions.

Assessment of Publication and Eligibility Biases

Our effect sizes are displayed in a funnel plot in Figure 2. As publication practices and eligibility criteria determine the sample of reports that are included in a meta-analysis, we estimated potential biases by examining the funnel plot of effect sizes. If the effect sizes are unbiased, the plot takes the form of a funnel centered on the mean effect size, with greater variability among effect sizes based on smaller sample sizes than larger ones. A distortion in the shape of the funnel is an indicator of the presence of publication bias. For example, if the true effect size is zero and there is bias, the funnel plot has a hollow in the middle. If the true effect size is not zero, the plot tends to be asymmetrical, having a large and empty section where the estimates from studies with small sample sizes and small effect sizes would otherwise be located. Following these guidelines, examination of the plot in Figure 2 suggests no publication or selection bias in our meta-analysis.

Discussion

The purpose of this meta-analysis was to examine the potential mechanism that drives the impact of the included number of behavioral recommendations on intervention efficacy. We found that interventions were most effective when they made a moderate number of recommendations, providing evidence that more lifestyle recommendations do not always equal healthier outcomes. A moderate number of lifestyle recommendations appears to be beneficial because it is low enough to prevent the intervention from becoming excessively demanding, while being high enough to ensure the necessary level of motivation to implement the recommended changes. Importantly, samples with low motivation to change benefited greatly from interventions recommending a moderate number of recommendations, suggesting that these interventions may be motivating enough to prompt the desire to change in audiences who are currently unmotivated to change.

Overview of Findings

This is the first meta-analysis to thoroughly examine the mechanism that accounts for the effect of differing number of recommendations on behavioral and clinical change, and to examine whether this relation varies as a function of recipients' motivation to change. Specifically, interventions encouraging change in lifestyle behaviors were most effective when they made a moderate number of recommendations, and efficacy began to decline when interventions recommended a low or high number of behaviors. The increased efficacy of interventions recommending multiple behavior changes relative those recommending a single behavior is consistent with prior meta-analyses that have concluded that stronger improvements in health outcomes are associated with participation in interventions targeting multiple behavior domains (Conn et al., 2008; Ebrahim et al., 2011; Ketola et al., 2000; Spring et al., 2009). We also examined differences in the amount of change depending on whether behaviors were targeted by a behavioral recommendation, and our findings suggested that changes in one health behavior may not spontaneously lead to changes in other, untargeted health behaviors. In addition, we considered the possibility that our indicators of average change were not ideal to capture improvements in interventions making varying numbers of recommendations. We, therefore, conducted analyses in which outcome variables were computed by summing, rather than averaging, effect sizes. These analyses revealed a similar pattern of results in which interventions recommending a moderate number of behaviors were associated with greater efficacy, and strengthen our conclusion that interventions making a high number of recommendations are associated with reduced effects due to increased demand. We also found that the effect of number of recommendations varied as a function intervention duration, with interventions recommending a moderate number of behaviors being most effective when they were of average or longer duration.

Beyond demonstrating the possible mechanism that accounts for the impact of various numbers of recommendations, we were also interested in the possible mechanisms through which interventions promote change in clinical outcomes. We demonstrated that interventions recommending a moderate number of behaviors were associated with stronger improvements in behavioral outcomes, and that change in behavioral outcomes mediated the effects of number of recommended behaviors on clinical change. Thus, our findings help to determine how behavioral recommendations impact clinical outcomes, the majority which were measured objectively, and highlight the value of self-reported behavioral measures (Schroder, Carey, & Vanable, 2003; Newell, Girgis, Sanson-Fisher, & Savolainen, 1999).

Importantly, our findings demonstrated that the curvilinear type of effect of number of recommendations varied as a function of recipients' motivation to change. However, when multivariate analysis was used to control for other predictors, only the interactions for delivery to non-patient populations and the use of lay community facilitator remained significant. These findings suggest that when recipients have low motivation to change, the intervention had significantly reduced effects except when the intervention was sufficiently motivating to compensate for the lower motivation level of the sample. Consistent with our hypothesis, audiences that are reluctant to change (i.e., as indicated by delivery to non-patient populations or the use of lay community facilitators) appear to benefit from interventions recommending a moderate number of recommendations. Once the target audience has been decided, our findings can guide selection of the most appropriate number of behaviors to target for optimal impact. Specifically, our results suggest that interventionists aiming to motivate reluctant audiences are more likely to succeed if they recommend a moderate number of behaviors, as these interventions may be most engaging to those with low motivation.

Our results also suggest that interventions with less difficult delivery (i.e., passive interventions, face-to-face presentation) or interventions tailored to specific target audiences enhanced the efficacy of interventions recommending multiple behavior changes. The impact of these various intervention characteristics highlights the importance of carefully considering how decisions about intervention design influence recipients' ability to pay attention to the content of a behavioral intervention and the impact this may have on intervention efficacy. The effectiveness of any intervention is dependent on exposure to and understanding of the program (McGuire, 1968; see Albarracín, 2002; Albarracín & Vargas, 2010; Wyer & Albarracín, 2005 for recent treatments of this issue). Additional research is necessary to understand the mechanisms that make some intervention characteristics more or less effective in multiple behavior domain interventions.

Theoretical Implications of Our Findings

Our meta-analysis has major theoretical implications for the mechanisms underlying the efficacy of multiple behavior domain intervention programs. Given the growing interest in the development of effective multiple behavior domain interventions, developing a theory that can both explain the mechanisms of multiple behavior domain change and guide implementation is of critical importance (Nigg et al., 2002). Although up to this point the majority of theorizing about behavior change has focused on the modification of behaviors in a single domain, our work sought to determine the optimal number of behaviors to target in a lifestyle behavior change intervention and tested whether motivation to change may moderate this relation.

Implications of number of recommendations—We proposed and tested the idea that a moderate number of recommendations would be associated with increased intervention efficacy with the assumption that these interventions would be challenging enough to increase motivation, without increasing difficulty to the extent that the intervention becomes too demanding and effort to implement the recommended changes decreases. Although our findings are consistent with prior theorizing on attention and self-control processes, as well as energerization theory (Brehm et al., 1983; Brehm & Self, 1989; Wright, 1996) and Bandura's self-efficacy theory (1986, 1989, 1997), they represent the first meta-analytic demonstration of the effects of motivational processes on multiple behavior change.

Various processes may underlie the enhanced efficacy of interventions recommending a moderate number of behaviors. In particular, our findings are consistent with a systems approach to behavior and the notion that a change in determinants of one behavior can lead to changes in other associated behaviors (Albarracín et al., 2008; Albarracín, Hepler, & Tannenbaum, 2011; Albarracín, Wang, & Leeper, 2009; Brent, 1978; Ford & Lerner, 1992; von Bertalanffy, 1968). For example, experiencing success in modifying one health behavior may increase self-efficacy to implement advocated changes in other recommended behavior changes that intervention recipients previously perceived as insurmountable (Emmons, Marcus, Linnan, Rossi, & Abrams, 1994; Prochaska, Spring, & Nigg, 2008). Similarly, learning a skill in one domain may map out onto other domains targeted in a multiple behavior domain intervention, thereby increasing problem solving capacity across the board (Botvin & Griffin, 2004; Griffin, Botvin, & Nichols. 2006; Noar, Chabot, & Zimmerman, 2008). Future research should examine whether multiple behavior domain interventions affect potential mediators of behavior change in this manner.

Our findings also suggest that recipients may feel overwhelmed when interventions attempt to modify too many behaviors (Meichenbaum & Turk, 1987; Ornstein et al., 1993), and that, after a certain point, recommending more behaviors becomes problematic and does not lead to healthier outcomes. Additional gains likely do not occur when interventions include a high number of recommendations due to limits on cognitive capacity and self-control (Baumeister et al., 1994; Muraven & Slessareva, 2003) that restrict the ability of recipients to implement multiple recommended actions. Consistent with these possibilities, our results demonstrated that interventions may become too difficult when a high number of behaviors are recommended, possibly leading to the perception that the goals set by the intervention are unattainable (e.g., Bandura, 1986, 1989, 1997, 2004; Carver & Scheier, 1998; see Duval & Silvia, 2001 for review on the issue) and disengagement from the intervention.

Implications of the influence of motivation to change—We also examined the possibility that intervention conditions that are likely associated with delivery to samples with low motivation to change would be associated with reduced effects, unless the intervention was sufficiently motivating to increase motivation and compliance. Overall, we found evidence that interventions delivered to reluctant audiences were associated with significantly reduced intervention effects, but only when a single or high number of behaviors were recommended. Our findings are consistent with prior research that suggests that the effectiveness of interventions depends on the intervention recipients' stage of change (see Albarracín, 2002; Albarracín et al., 2005; Bandura, 1997; Catania, Kegeles, & Coates, 1990; Noguchi, Albarracín, Durantini, & Glasman, 2007; Prochaska, DiClemente, & Norcross, 1992; Prochaska, Redding, Harlow, Rossi, & Velicer, 1994). Importantly, the results of our meta-analysis suggested that recipients are sensitive to the content of the intervention and that when interventions with a moderate number of recommendations are delivered to samples with low motivation to change, these interventions may be efficacious.

Public Health Implications of Our Findings

This meta-analysis has relevance to the way multiple behavior domain interventions are designed and implemented. To begin with, although there are benefits to designing interventions that promote change across multiple domains, cognitive ability and outcome expectancies may place limits on the number of recommendations that can be successfully delivered and adopted. Readers may be interested in estimating how large a change in specific health outcomes might result from varying numbers of recommendations. To this end, we applied the average effect sizes for behavioral and clinical change presented in Table 3 to national averages of health statistics obtained from the National Health and Nutrition Examination Survey (National Center for Health Statistics, 2011). Given an average daily energy intake for men of 2110 kcal, a *d*. of 0.11 for single behavior interventions implies a 172.67 kcal reduction, a *d*. of 0.29 implies a 764.10 kcal reduction for interventions recommending a moderate number of behaviors, and a *d*. of 0.14 implies a 368.88 kcal reduction for interventions making a high number of recommendations. Results are similar when change in energy intake for females was considered (national average = 1,811 kcal), with estimated 154.69 kcal, 407.82 kcal, and 196.87 kcal reductions following participation in interventions recommending change in a single, moderate, and high number of behaviors, respectively. As the national average for cholesterol is 196 mg/dL, a *d*. of 0.12 for clinical change in single behavior interventions implies a 6.43 reduction in cholesterol, a *d*. of 0.27 implies a 14.46 mg/dL reduction in cholesterol when interventions recommend a moderate number of behaviors, and a *d*. of 0.22 implies a 11.78 mg/dL reduction in cholesterol for interventions the recommend change in a large number of behaviors. Similarly, as the national average for BMI for men is 28.6, estimated reductions in BMI of 1.17, 2.63, and 2.15 can be expected following participation in interventions recommending change in a single, moderate, and high number of recommendations, respectively. These estimated values demonstrate the benefit of recommending a moderate number of behaviors, and demonstrate that more lifestyle recommendations do not always result in healthier outcomes. A moderate number of recommendations may be associated with increased efficacy because these interventions are challenging enough to keep receipts interested and engaged, thereby ensuring the necessary level of motivation, while at the same time not being so challenging that recipients perceive the intervention as too difficult and reduce the amount of effort they put into reaching the health goals set by the health promotion program.

Our findings also indicate that once a sample with low motivation to change has been selected, unless appropriate decisions are made about the number of behaviors to recommend, interventions will be associated with reduced effects. However, our findings can help guide the design of the most appropriate intervention. First, particularly when interventions target change in samples with low motivation, the implementation of an intervention that recommends a moderate number of behaviors should be favored wherever possible. Second, samples with greater motivation to change also appear to benefit from interventions that recommend a moderate number of behaviors. However, as the curvilinear relation was weaker for samples with higher motivation, there may be greater flexibility in the selection of the optimal number of behaviors to target. That is, other relevant information could be used to decide the number of behaviors to target in interventions delivered to samples with higher motivation, such as the resources for intervention implementation, recipient factors (e.g., demographic characteristics), or the behaviors that are targeted in the intervention.

Duration of the intervention should be taken into account when selecting the number of recommendations to target. Interventions of average or longer duration were associated with greater improvements in health outcomes when a moderate number of recommendations were made. In contrast, it appears beneficial to recommend a single behavior in interventions of shorter duration. These findings suggest that it is unlikely that an intervention will succeed if adequate time is not provided to ensure that all components are implemented. In addition, given their overall greater efficacy, the best advice may be to design interventions that recommend a moderate number of behaviors that are of a sufficient duration to ensure success. The use of mobile technologies that can assist in intervention implementation may be one method for increasing the intensity of an intervention when resources to deliver an intervention with a high number of face-to-face interactions is lacking.

Limitations of This Meta-Analysis and Future Directions

The current meta-analysis has several limitations that are important to discuss. These limitations are related to coding for number of recommendations, inability to directly assess motivation to change, the correlational nature of the results, the validity of self-report measures, the inability to explore the content of the recommendations, and the generalizability of our findings.

Number of recommendations—We operationalized number of recommendations as the total number goals, or broad behavioral categories, targeted in an intervention. Although we coded for specific strategies discussed as means to reaching those goals, as well as the inclusion of biological methods, these were not included in our count of number of recommendations. Other options for coding the number of behavioral recommendations are of course possible. For example, all interventions involving behavioral-skills training by definition target multiple behaviors, and interventions targeting a single behavior domain, such as smoking cessation, likely include recommendations to assist recipients in quitting their smoking behavior (e.g., monitoring urges, coping with temptation). The challenge of operationalizing number of recommendations is further complicated by the fact that papers vary in the extent to which interventions are described in detail. Coding number of recommendations by counting only primary goals set by the intervention likely resulted in a more consistent coding of number of recommendations across studies. At a minimum, papers likely report the primary goals of an intervention, whereas specific details on the strategies recommended to assist intervention recipients in modifying the recommended behaviors may vary greatly across papers. Nonetheless, it is important to acknowledge that interventions often recommend a number of strategies as a means to reach the primary goals set by the intervention. Future research should examine whether the curvilinear relation between number of recommendations and intervention efficacy replicates using more precise methods of counting behavioral recommendations.

Motivation to change—In this meta-analysis we assumed that specific intervention conditions (e.g., the use of lay community facilitators, delivery to non-patients populations) would be associated with intervention delivery to samples with low motivation to change. Unfortunately, because the research included in our meta-analysis did not measure motivation, it was not possible to verify whether our hypothesized moderators were indeed associated with lower initial levels of motivation to change. In the future, research should include measures of motivation to better understand the mechanism through which recommendations influence intervention efficacy. Moreover, future research should consider whether other aspects of multiple behavior domain interventions, such as the strategies used to promote behavior change, can increase motivation, and ultimately behavioral and clinical change, among samples with low motivation. Given disparities associated with many health conditions, future research must further examine the reduced efficacy of interventions delivered by lay community facilitators, which are commonly used in the delivery of interventions to marginalized groups. Interventions delivered by lay community facilitators cover a broad range of interventions that differ in terms of the level of training provided, the responsibility and latitude of facilitators in intervention delivery, and the extent to which implementation is monitored (Glenton et al., 2013; Nies et al., 2004). Closer examination of these various factors may increase our understanding of factors associated with the increased success of interventions implemented by lay community facilitators.

Intervention complexity—Up to this point, research examining the effect of the included number of recommendations on intervention efficacy has been limited. Determining the optimal number of behaviors to target became the focus of our meta-analysis, and our findings contribute broadly to our understanding of multiple behavior domain change. However, multiple behavior domain interventions are by their very nature complex interventions that seek to modify an important set of health behaviors in several different domains (Goldstein et al., 2004; Nigg et al., 2002; Nigg & Long, 2012; Prochaska et al., 2010). Evidence suggests that combining different types of behavioral recommendations impacts intervention efficacy. For example, there is evidence that reducing a behavior that acts as a barrier to a consequent behavior promotes the consequent behavior (e.g., reducing substance use influences medication adherence; Ingersoll et al., 2011; Parson, Golub, Rosof, & Holder, 2007). However, one important question for future research is whether the effect of number of recommendations varies across interventions targeting different combinations of behavioral domains (e.g., interventions targeting diet and exercise vs. interventions targeting diet and smoking), as well as interventions within a single domain. The behavior domains combined in an intervention will impact the outcomes used to assess the intervention and the strategies used to modify health behaviors, as well as other factors related to participant characteristics and the setting of delivery. Given the differences that exist between intervention recommending different combinations of behaviors, it will be important to determine whether the curvilinear pattern of number of recommendations replicates for interventions targeting different combinations of health behaviors.

Correlational nature of our results—As noted, a limitation of this meta-analysis is the correlational nature of the analyses we reported. Assignment to intervention and control groups in the papers we included was often conducted at random. However, the specific characteristics of an intervention and the participants particular researchers chose to study are subject to their preferences and may covary with other study characteristics. Although the various controls included in our models help to rule out spurious findings, other co-associations cannot be completely ruled out. When all is said and done, however, our conclusions represent important insights into the effectiveness of multiple behavior domain interventions, and fill important gaps in our knowledge of multiple behavior change processes.

Inaccuracy of self-report—Another limitation of this meta-analysis is related to potential inaccuracies in self-reported behavior. Various factors are known to influence the accuracy of self-report data, including (a) the length of the time interval respondents are asked to recall behaviors (Newell et al., 1999; Schroeder et al., 2003), (b) lack of knowledge to answer questions correctly (Newell et al., 1999), and (c) demand characteristics inherent in survey situations (Beach & Mayer, 1990; Furnham, 1986). Although prior research calls into question the accuracy of self-report data, it is important to note that many of the studies included in our meta-analysis reported data on objectively measured clinical biomarkers, as well as self-reported behavioral outcomes. Importantly, the convergence between our findings about the effect of number of recommendations on behavioral and clinical biomarker change and our finding that behavioral change mediated clinical change suggest that our findings reflect more than self-report bias.

Content of recommendation—Unfortunately, we could not examine how specific recommendation content, such as the framing of the recommendation, influenced change in health outcomes because few papers provided such detailed descriptions of behavioral recommendations. *Gain framed* messages emphasize the benefits of engaging in a behavior, whereas *loss framed* messages highlight the consequences of failing to engage in a behavior. Prior research has indicated that loss-framed messages most effectively promote detection behaviors (e.g., mammography), and that gain-framed messages more effectively promote prevention behaviors (e.g., physical activity; Banks et al., 1995; Latimer et al., 2008; Rothman & Salovey, 1997; Rothman, Salovey, Antone, Keough, & Martin, 1993). Given the effects that framing of recommendations can have on health decisions, we hope it will be possible to examine the influence of message framing in multiple behavior domain interventions in the future.

Potential sleeper effects—Although an important objective of this meta-analysis was to examine factors that influence the efficacy of multiple behavior domain intervention, we only considered outcomes at the immediate follow-up point. Future research should examine the possibility of sleeper effects (see Kumkale & Albarracín, 2004), given that some outcomes may change over longer periods of time. For example, more resource demanding interventions may be overwhelming in the beginning but become more effective over time. Understanding such long-term effects will be important to develop a more comprehensive understanding of the mechanisms whereby multiple behavior interventions exert their effects.

Generalizability to the study sample and to the population of all possible studies—Our paper presents the largest meta-analysis of interventions promoting change in multiple lifestyle behaviors. As such, our findings are likely to be most generalizable to date. In particular, the mean comparisons suggest that interventions are most effective when they attempt to modify a moderate number of behaviors. Moreover, our findings suggest that the curvilinear relation becomes stronger when intervention characteristics increase difficulty of intervention delivery and processing. However, our findings for the effects of intervention characteristics were obtained with fixed-effects models. Although the pattern of findings presented in Table 5 and 6 replicated using random-effects models, the number of significant effects declined. In the future, a meta-analysis with a sufficiently large number of effect sizes may allow for the estimation of population variance and establish the tenability of the findings in the broader universe of all possible studies.

Closing note—Our meta-analysis clearly shows that decisions about the number of recommendations to include in an intervention have important implications for intervention efficacy. We demonstrated that intervention outcomes were maximized when a moderate number of lifestyle behaviors were recommended, suggesting this amount is low enough to prevent a reduction in cognitive ability while being high enough to ensure the necessary level of motivation to maximize behavioral and clinical change. Our findings are consistent with various motivational models (Bandura, 1986, 1989, 1997; Brehm & Self, 1989; Brehm et al., 1983), and suggest that recommending a moderate number of behaviors is associated with stronger improvements because these interventions are challenging and motivating without becoming overwhelming, and potentially reducing the amount of effort recipients' put forth to implementing the recommended changes. Our findings also suggest that decisions about the number of behaviors to target has important consequences for the efficacy of behavior change interventions for reluctant audiences, such that recommending a moderate number of behaviors appears particularly beneficial when intervention recipients have low motivation to change. We hope that the results from this work will contribute to the development of a theory of multiple behavior domain change and provide guidelines for intervention implementation to make multiple behavior domain change programs more effective.

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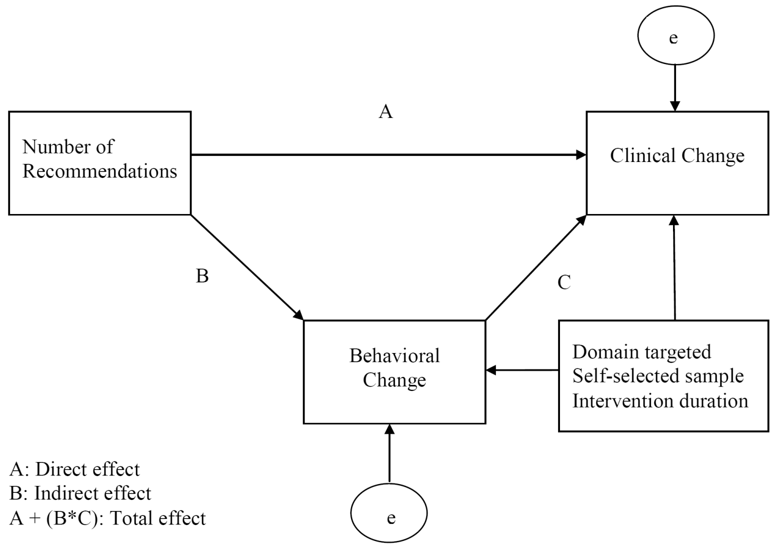

Note. Correlations between exogenous variables are not shown for clarity.

Figure 1.

Model to determine the mediating effects of change in behavioral outcomes on clinical change.

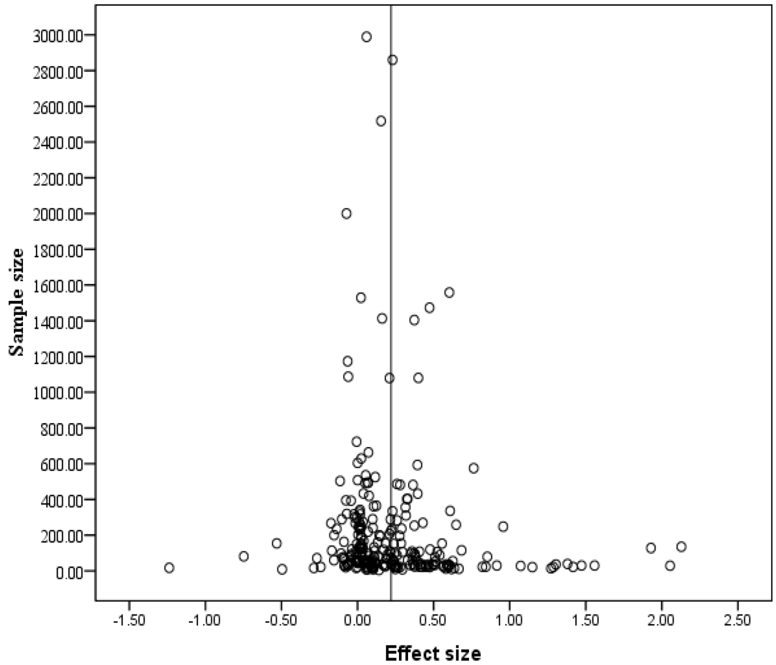

Figure 2.

Funnel plot for overall change. Four effects with extremely large sample sizes were excluded to make the shape of the plot more apparent. These large sample groups had average effect sizes.

Table 1

Summary of Prior Meta-Analyses of Lifestyle Interventions.

Authors, year	Sample	Type of design	Type of intervention (behaviors targeted)	Outcomes reported	Major finding
Auer, Gaume, Rodondi, Cornuz, & Ghali (2008) **Objective:** To assess effects of in-hospital interventions targeting change in multiple cardiovascular risk factors.	k = 26 n = 41,048 Population: mean age range = 42–76 years; hospitalized for acute coronary syndrome	Experimental, RCTs + follow-up	Intervention Groups: Smoking cessation, blood pressure, blood lipids, diet, weight, and physical activity *(several combinations of two or more behaviors)* Control Groups: No intervention	*Data reported are as RR with 95% CIs; between ( )number of trials where data are reported.* **All cause mortality** (19) Short-term: RR = 0.78, 95% *CI* = 0.71, 0.86. Long-term: RR = 0.79, 95% *CI* = 0.85, 0.92. RR for all cause mortality was lower at 1-year a) in pre-post studies vs. clinical trials, b) interventions including provider-level and system-level components vs. interventions that only targeted patients, and c) in studies targeting an increase in medication usage. **Readmission** (11) RR = 0.59, 95% *CI* = 0.32, 1.07. **Smoking cessation** (13) Interventions showed evidence of increased smoking cessation rates (RR = 1.29, 95% *CI* = 1.02, 1.63).	In-hospital multiple behavior domain interventions to reduce cardiovascular risk factors **reduce mortality**. However, this benefit was only statistically significant in pre-post studies. Interventions may be more effective when they target not only the patient, but also providers and the healthcare system.
Benedict & Arterburn (2008) **Objective:** To assess effects of work-site based weight loss programs.	k = 11 n = 2,502 Population: mean age range = 32–53 years	RCTs, non-RCTs, uncontrolled case series	Intervention Groups: Diet and/or exercise (8 targeted diet + exercise) Control Groups: No information provided	**Weight loss**: In general, mean weight loss and changes in BMI were significantly greater in the IGs vs CGs. **Serum lipids:** 7 (of 11) studies reported modest improvements in serum lipids. **Blood pressure (BP)** 6 (of 11) studies reported modest improvements in systolic and/or diastolic BP.	Multiple behavior domain work-site programs **promote modest, short-term** weight loss.
Boulware, Gaumit, Frick, Minkovitz, Lawrence, & Powe (2001) **Objective:** To assess effects independent and interactive effects of three interventions (counseling, self-monitoring, structured, training courses) on BP control.	k = 15 n = 4,072 Population: 53% male; age range = 50–65 years; 34% white	Experimental	Intervention Groups: Diet, exercise, smoking cessation Control Groups: Usual care	*Data reported as mean net changes.* **Counseling interventions:** Significant BP improvement over usual care in 4 (of 15) studies. 3.2 mmHg improvement in diastolic BP (95% *CI* = 1.2, 5.3) and 11.1 mmHg improvement in systolic BP (95% *CI* = 4.1, 18.1) over usual care. **Patient self-BP monitoring:** Offered no significant improvement in BP over usual care in 1 (of 1) studies. **Training courses:** Counseling associated with stronger improvements (10 mmHg decrease in diastolic BP, 95% *CI* = 4.8, 15.6) than training courses in 1 (of 1) studies. **Combined interventions:** Significant reduction (4.7 mmHG, 95% *CI* 1.2, 8.2) was found in systolic BP in 2 (of 2) studies that compared counseling plus training to counseling alone; Combination offered no improvement to diastolic BP. In 1 (of 1) study, counseling plus training was associated 95% achieving hypertension control (95% *CI* = 87, 99), representing a statistically significant increase over training alone and counseling alone.	Multiple behavior domain counseling interventions are associated with **stronger improvements** in blood pressure over usual care. Counseling interventions are also more effective than training courses. The addition of structured training courses to counseling interventions may enhance efficacy further.
Conn et al. (2008) **Objective:** To assess effects of interventions to improve health	k = 24; 11 (of 24) multiple behavior interventions n = 1,435	Quasi-experimental, experimental	Intervention: exercise, diet, medication (not all IGs targeted multiple behavior change)	*Data reported as standardized mean difference (Hedge's d)* **Glycosylated hemoglobin (HbA1c):** The overall effect size for IGs was d = 0.26.	Interventions for individuals with type-1 diabetes **decrease** HbA1c. Outcomes are maximized when interventions targeted

Authors, year	Sample	Type of design	Type of intervention (behaviors targeted)	Outcomes reported	Major finding
behavior among adults with type-1 diabetes.	Population: 52% female; age range= 25–54 years; adults with type-1 diabetes		Control: Not all studies had control groups. When this was the case, pre- vs. post-test comparisons were made	**Single vs. Multiple behavior intervention comparison:** Interventions targeting multiple behaviors (diet, exercise, medication) were more effective than those targeting exercise alone (0.45 vs 0.03).	**multiple behaviors domains**, rather than focusing on exercise alone.
Ebrahim et al. (2011) **Objective:** To assess the effects of multiple behavior domain interventions addressing coronary heart disease (CHD) among adults.	k = 55 n = 163,471 Population: Mean age = 50 years	RCTs + minimum 6 month follow-up	Intervention: diet, exercise, weight loss, salt intake, alcohol use, stress management, smoking cessation, adherence to medication *(several combination of two or more behaviors)* Control: no specific information reported	*Data reported are weighted mean difference between intervention and control (OR or RR with 95% CIs; between ( ) number of trials where data are reported.* **Total mortality** (14) No strong evidence of reduction (RR: 1.00; 95% CI = 0.96, 1.05). A significant decrease seen in trials (6) where patients were recruited with hypertension or diabetes (RR= 0.78; 95% CI = 0.68, 0.89) and in trials where patients were prescribed medication (RR = 0.86; 95% CI = 0.78, 0.96). **CHD mortality** (11): OR = 0.99 (95% CI = 0.92, 1.07). Only one trial reported a significant decrease in stroke mortality but the pooled relative risk favored intervention (RR = 0.75; 95% CI = 0.60, 0.95). **Fatal and non-fatal clinical events** (9). A reduction in events was observed (RR = 0.84; 95% CI = 0.73, 0.98). Effect explained by inclusion of patients with hypertension or diabetes in whom the combined event relative risk was 0.71 (95% CI = 0.61, 0.83). **Changing risk factors**: Initial level and magnitude of risk factor reduction for diastolic BP (r = 0.73, p = .006), smoking (r = 0.63, p = .01), and cholesterol (r = 0.74, p = .004) indicated that samples with the highest baseline risk demonstrated greater change at follow-up. **BP** (48). Significant reduction in BP. The weighted mean difference between IGs and CGs was −2.71 mmHg (95% CI = −3.49, −1.93) for systolic BP and −2.13 mmHg (95% CI = −2.67, −1.58) for diastolic BP. **Cholesterol** (44) Small but highly significant decrease (OR = −0.07 mmol/L; 95% CI = −0.08, −0.06). Stronger effects in trials using antihypertensive and cholesterol lowering drugs (OR = −0.18 mmol/L; 95% CI = −0.22, −0.14). **Smoking prevalence** (20). Non-significant reduction in smoking prevalence (OR = 0.87; 95% CI = 0.75, 1.00).	Multiple behavior domain interventions resulted in **small reductions in risk factors**, including: BP, cholesterol, and smoking. Studies with the **highest baseline** blood pressure, smoking, and cholesterol levels demonstrated **larger decreases** in these risk factors at follow up. Interventions using counseling and education aimed at behavior change do not reduce total or CHD mortality or clinical events in general populations, but may be effective in reducing mortality in high-risk hypertensive and diabetic populations.
Ketola et al. (2000) **Objective:** To assess the effectiveness of lifestyle interventions addressing cardiovascular disease (CVD).	k = 21 multiple behavior interventions n = 103,416 Population: Working-aged adults (18–65 years); 10 (of 21) multiple behavior	RCTs + minimum 1 year follow-up	Intervention Groups: Diet, smoking cessation, exercise, alcohol use, CVD medication *(several combinations of two or more behaviors)*	*Data reported as mean net changes for( ) number of trials where data are reported.* **Primary Prevention Studies:** **Morbidity and mortality:** 2 (of 8) studies showed a significant effect on mortality, p < .05. None on morbidity, p > .05. **BP**: Clinically modest but non-significant improvement in systolic and diastolic BP, p > .05. **Cholesterol**: −0.36 mmol/L (IGs), p = .08.	Multiple behavior domain interventions produced significant improvements in **behavioral** and **clinical** risk factors for CVD. Multiple behavior domain intervention outcomes optimized when used for **secondary prevention**,

Authors, year	Sample	Type of design	Type of intervention (behaviors targeted)	Outcomes reported	Major finding
	interventions were secondary prevention studies interventions were secondary prevention studies interventions were secondary prevention studies		Control Groups: No specific information reported	**Weight loss**: −0.9 kg (IGs) vs 1.2 kg (CGs), $p = .023$. **Smoking**: 2 (of 9) studies reported a significant improvement, $p < .05$ **Alcohol use**: 1 (of 1) reported non-significant effect, $p > .05$. **Sodium excretion:** Data not reported **Exercise:** 3 (of 4) studies showed significant effect, $p < .05$. **Secondary Prevention Studies:** **Morbidity and mortality:** 2 (of 5) studies showed a significant effect on mortality, $p < .05$. One showed a significant effect on CVD morbidity, $p < .05$. **BP**: Clinically modest but non-significant improvement in systolic and diastolic BP, $p > .05$. **Cholesterol**: −0.43 mmol/L (IGs) vs −.07 mmol/L (CGs), $p = .007$ **Weight loss**: −0.6 kg (IGs) vs 1.3 kg (CGs), $p = .026$. **Smoking**: 2 (of 7) studies showed a significant effect, $p < .05$ **Alcohol use**: 1 (of 3) reported a significant decrease; 37% (IGs) vs 5% (CGs), $p = 02$. **Sodium excretion:** 2 (of 4) studies reported significant decrease, $p < .05$. **Exercise:** 4 (of 10) studies showed significant improvement, $p < .05$.	rather than primary prevention.
Nigg & Long (2012) **Objective:** To assess effects of single vs. multiple behavior domain interventions in older adults.	$k = 18$ $n = 2,233$ Population: mean age range = 60–79 years; more females than males; mainly non-Hispanic White	RCTs	Multiple health behavior change (MHBC): physical activity, diet, smoking cessation, alcohol use *(several combinations of two or more behaviors)* Single health behavior change (SHBC) interventions: physical activity, diet, smoking cessation, alcohol use *(individually)*	**SHBC interventions** **Physical activity studies:** (12) Improvements were generally observed in physically activity level (at 6–12 months). **Nutrition/weight loss studies:** (2) IGs did better than CGs at follow-up (6 months), improving fruit and vegetable intake and adherence to dietary recommendations. **Alcohol use studies:** (2) IGs reduced their consumption of alcohol, up through 12 months post-intervention. **MHBC interventions** **Physical activity & nutrition related studies:** (2) In one study, fruit and vegetable consumption improved, physical activity decreased. In second study, weight loss behavior (meeting calorie and saturated fat goals) and physical activity improved.	Effective SHBC interventions exist for older adults. **Too few studies exist to make comparisons** between the effectiveness of MHBC and SHBC interventions in older adults. More research is necessary to determine if older adults benefit from MHBC interventions.
Norris et al. (2004) **Objective:** To assess effects of weight loss and weight control interventions in adults with type-2 diabetes.	$k = 22$; 11 (of 22) multiple behavior interventions $n = 4,659$ Population: mean age = 55 years; adults with type-2 diabetes	RCTs + minimum 1-year follow-up	Intervention Groups: Diet, physical activity Control Groups: Usual care, diet or physical activity intervention differing from the IGs on some dimension	*Data reported as mean net changes for( ) number of trials where data are reported.* **Weight change:** (7) In control groups, weight change ranged from a gain of 2.1 kg (usual care) to a loss of 8.2 kg (diet intervention). In intervention groups, weight change ranged from a loss of .06 kg (diet intervention) to 14.5 kg (diet + physical activity + behavioral intervention).	Weight loss strategies involving dietary, physical activity, or behavior interventions are associated with small improvements in weight. **Multiple behavior domain interventions appear effective** for achieving

Authors, year	Sample	Type of design	Type of intervention (behaviors targeted)	Outcomes reported	Major finding
			(e.g., type of diet, method of delivery)	**HbA1c:** (6) Between-group changes (range −2.6%–1.0%) corresponded to changes in weight, and between-group pooled estimates were generally not significant. **Systolic & Diastolic BP:** (7) Between-group changes ranged from 1–4mmHG. **Cholesterol:** (13) Between-group changes ranged from −0.4 to −0.33mmol/L.	weight loss in adults with type-2 diabetes.
Spring et al. (2009) **Objective:** To assess effects of multiple behavior domain interventions to promote smoking cessation and weight control.	*k* = 10 *n* = 2,233 Population: 93% female; age range = 18–70 years	RTCs + minimum 1 month follow-up	Intervention: smoking cessation + weight control (energy intake, energy expenditure, or attitudes about weight) Control: smoking cessation	*Data reported as OR with 95% CIs* **Smoking cessation** Short-term: OR = 1.29, 95% *CI* = 1.01, 1.64, *p* = .041; Long-term: OR = 1.23, 95% *CI* = 0.85, 1.79; *p* = .27. *Data reported as standardized mean difference (Hedge's g)* **Post-quit weight gain** Short-term: g = −0.30, 95% *CI* = −0.57, −0.02, *p* =.035; Long-term: g = −0.17, 95% *CI* = −0.42, 0.07, *p* = 0.16.	Smoking + weight control interventions **increase** smoking abstinence and **decrease** weight gain in the short-term (< 3 months) compared with smoking cessation interventions alone. No differences observed in the long-term (> 6 months).
Ussher, Taylor, & Faulkner (2012) **Objective:** To assess effectiveness of exercise as an aid to smoking cessation.	*k* = 15 *n* = 7,095 Population: Mean age range = 28–59; smokers or recent quitters	RCTs + minimum 6 month follow-up	Intervention: exercise + smoking cessation, or exercise alone Control: smoking cessation	**Smoking cessation** (15) Short-term: Three studies reported significantly higher abstinence rates in IGs vs. CGs; Long-term: One study found significantly higher abstinence rates in IGs vs. CGs at the 3 month follow-up, and a marginally significant benefit for exercise at 12 month follow-up. One study found significantly higher abstinence rates in IGs vs. CGs at the 3 month follow-up, but not at the end of treatment or at the 12 month follow-up. **Nicotine replacement therapy (NRT):** (4) One study found higher abstinence rates at the end of treatment and at 12 months follow-up in the exercise + NRT group than in the CG.	Only one study provided evidence that exercise aids smoking cessation in the long-term (> 6 months abstinence). Other studies were too small to exclude an intervention effect, or had exercise interventions that were not sufficiently intense. More research is necessary to determine if exercise is a beneficial aid to smoking cessation.

Note. *k* = number of studies; OR = odds ratio; RR = relative risk, *CI* = confidence interval; IGs = intervention groups; CGs = control groups

Table 2

Descriptive Statistics

Variable	Multiple behavior groups (*k* = 216)	Control groups (*k* = 54)
General characteristics of the reports		
Publication year (*r* = 1)		
M	2002.24	2000.94
Mdn	2003	2002
SD	6.70	7.95
k	216	54
Source type (κ = 1)		
Journal article	97.2(208)	94.4(51)
Conference proceeding	0.0(0)	0.0(0)
Doctoral dissertation	2.8(6)	5.6(3)
Master's thesis	0.0(0)	0.0(0)
Academic affiliation (κ = .91)		
University	39.8(86)	53.7(29)
College	4.2(9)	3.7(2)
Research center	20.4(44)	9.3(5)
Hospital or health center	16.2(35)	13.0(7)
Medical school	15.3(33)	18.5(10)
Other	4.1(11)	1.9(1)
Institutional area (κ = 1)		
Psychology	9.3(20)	11.1(6)
Epidemiology	4.6(10)	0.0(0)
Community/Public health	6.9(15)	11.1(6)
Medicine	58.8(127)	59.3(32)
Education	2.8(6)	0.0(0)
Other	4.2(9)	13.0(7)
Not identified	13.4(29)	5.6(3)
Country (κ = 1)		
United States	48.2(104)	38.9(21)
Finland	6.0(13)	5.7(3)
United Kingdom	6.0(13)	9.5(5)
Other	39.8(112)	45.9(33)
Language (U.S. only; κ = 1)		
English	100.0(216)	100.0(54)
Types of intervention strategies		
Passive strategies		
Attitudinal arguments (κ = 1)		
Yes	32.4(70)	6.7(1)
No	67.6(146)	93.3(14)
Normative arguments (κ = 1)		

Variable	Multiple behavior groups (*k* = 216)	Control groups (*k* = 54)
Yes	6.5(14)	0.0(0)
No	93.5(202)	100(15)
Control arguments (κ = .85)		
Yes	18.5(40)	6.7(1)
No	81.5(40)	93.3(14)
Threat arguments (κ = 1)		
Yes	5.1(11)	0.0(0)
No	94.9(205)	100(15)
Informational arguments (κ = 1)		
Yes	91.7(198)	66.7(10)
No	8.3(18)	33.3(5)
Behavioral skills arguments (κ = 1)		
Yes	1.4(3)	0.0(0)
No	98.6(213)	100(15)
Active strategies		
Behavioral skills training (κ = 1)		
Yes	48.6(105)	33.3(5)
No	51.4(111)	66.7(10)
Communication skills training (κ = 1)		
Yes	3.7(8)	0.0(0)
No	96.3(208)	100(15)
Setting of goals or review of past goals (κ = 1)		
Yes	44.4(96)	7.7(1)
No	55.6(120)	92.3(12)
Role playing exercises (κ = 1)		
Yes	4.2(9)	0.0(0)
No	95.8(207)	100(15)
Teaches cues to engage in behavior (κ = 1)		
Yes	5.1(11)	0.0(0)
No	94.9(205)	100(15)
Training on coping with barriers (κ = 1)		
Yes	18.1(39)	6.7(1)
No	81.9(177)	93.3(14)
Relapse prevention training (κ = 1)		
Yes	7.9(17)	13.3(2)
No	92.1(199)	86.7(13)
Relaxation training (κ = 1)		
Yes	10.2(22)	0.0(0)
No	89.8(194)	100(15)
Time management training (κ = 1)		
Yes	3.7(8)	0.0(0)
No	96.3(208)	100(15)

Variable	Multiple behavior groups (*k* = 216)	Control groups (*k* = 54)
Teaches self-monitoring prompts (κ = 1)		
Yes	26.4(57)	13.3(2)
No	73.6(159)	86.7(15)
Stress management skills training (κ = 1)		
Yes	13.4(29)	0.0(0)
No	86.6(187)	100(15)
Strategies in both intervention types		
Biological methods (κ = 1)		
Yes	14.4(31)	13.3(2)
No	85.6(185)	86.7(13)
Behavioral contract (κ = 1)		
Yes	4.6(10)	6.7(1)
No	95.4(206)	93.3(14)
Participant characteristics		
Sample size (*N*) (*r* = 1)		
Sum total	73,858	19,709
M	341.94	364.98
Mdn	85.50	62.50
SD	1,125.39	960.84
k	216	54
Age in years (*r* = 1)		
M	46.22	43.09
Mdn	50.00	44.10
SD	15.64	17.24
k	206	47
% men (*r* = 1)		
M	46.58	47.07
Mdn	47.30	50.00
SD	31.30	34.61
k	213	53
% women (*r* = 1)		
M	54.25	53.08
Mdn	52.70	50.00
SD	31.33	34.39
k	213	53
% high school graduates (*r* = 1)		
M	46.48	43.63
Mdn	56.00	37.00
SD	35.72	38.63
k	87	23
% with risk factor or health condition at pretest (*r* = 1)		

Variable	Multiple behavior groups (*k* = 216)	Control groups (*k* = 54)
M	91.53	86.65
Mdn	100.00	100.00
SD	25.13	33.19
k	116	34
Ethnic decent		
% European (*r* = 1)		
M	62.99	71.25
Mdn	75.00	85.00
SD	36.55	31.47
k	203	51
% African (*r* = 1)		
M	29.92	15.82
Mdn	4.35	2.00
SD	31.55	24.14
k	150	35
% Latin American (*r* = 1)		
M	11.08	8.01
Mdn	.00	.00
SD	23.87	18.92
k	132	30
% Asian (*r* = 1)		
M	18.21	14.97
Mdn	2.90	2.90
SD	35.45	30.73
k	134	36
% North American Indian (*r* = 1)		
M	1.09	.21
Mdn	.00	.00
SD	9.14	.43
k	120	32
Intervention set-up		
Domains targeted		
Diet (κ = 1)		
Yes	96.8(209)	33.3(5)
No	3.2(7)	66.7(10)
Exercise (κ = 1)		
Yes	99.1(214)	46.7(7)
No	.9(2)	53.3(8)
Tobacco use (κ = 1)		
Yes	52.8(114)	20.0(3)
No	47.2(102)	80.0(12)

Variable	**Multiple behavior groups (*k* = 216)**	**Control groups (*k* = 54)**
Alcohol use (κ = 1)		
Yes	10.2(22)	0.0(0)
No	29.8(194)	100.0(15)
Medication adherence (κ = 1)		
Yes	7.4(16)	0.0(0)
No	92.6(200)	100.0(15)
Cancer screening (κ = 1)		
Yes	0.5(1)	0.0(0)
No	99.5(217)	100.0(15)
Number of recommendations (*r* = 1)		
M	3.41	1.0
Mdn	3.00	1.0
SD	.86	0.0
k	216	15
Setting of exposure (κ = 1)		
School		
Yes	7.9(17)	13.3(2)
No	92.1(199)	86.7(13)
Clinic		
Yes	57.4(124)	73.3(11)
No	42.6(92)	26.7(4)
Community (street, community center, bar)		
Yes	4.6(10)	0.0(0)
No	95.4(206)	100.0(15)
Business		
Yes	8.3(18)	0.0(0)
No	91.7(198)	100.0(15)
Mass media		
Yes	8.8(19)	0.0(0)
No	91.2(197)	100.0(15)
Medium of delivery (κ = .97)		
Face to face		
Yes	86.1(186)	100.0(15)
No	13.9(30)	0.0(0)
Delivery format (κ = 1)		
Groups	20.4(44)	33.3(5)
Individuals	44.0(95)	46.7(7)
Both	35.6(77)	20.0(3)
Facilitator (κ = .93)		
Professional expert	69.0(149)	53.3(8)
Lay community member	25.9(56)	46.7(7)
Both	5.1(11)	0.0(0)

Variable	Multiple behavior groups (*k* = 216)	Control groups (*k* = 54)
Culturally appropriate intervention (κ = .89)		
Yes	11.1(24)	0.0(0)
No	88.9(192)	100.0(15)
Duration of intervention in hours (*r* = 1)		
M	18.46	25.78
Mdn	10.00	12.00
SD	22.83	31.06
k	158	9
Research design and implementation		
Random assignment to conditions (κ = .97)		
Yes	86.5(187)	85.2(46)
No	13.5(29)	14.8(8)
Payment received (U.S. dollars; *r* = .93)		
M	55.00	23.75
Mdn	20.00	22.50
SD	146.44	27.50
k	23	4
Days between intervention and posttest (*r* = .88)		
M	103.90	93.39
Mdn	28	14
SD	143.71	135.55
k	195	15
Patient population (κ = 1)		
Yes	34.7(75)	33.3(5)
No	65.3(141)	66.3(10)
Sample targeted by ethnicity (κ = 1)		
Yes	11.6(25)	0.0(0)
No	88.4(191)	100.00(15)
Sample targeted by gender (κ = 1)		
Yes	26.9(58)	46.7(7)
No	73.1(158)	53.3(8)
Self-selected sample (κ = 1)		
Yes	89.4(193)	83.3(45)
No	10.6(23)	16.7(9)

Note. *k* = number of cases. *r* = intercoder reliability for continuous variables. κ = intercoder reliability for categorical variables.

Table 3

Change as a Function of Number of Recommendations Controlling for Duration, Domain Targeted, and Self-Selected Sample.

	***d* (95% CI)**						
	Number of Recommendations						
Outcome	**0**	**1**	**2–3**	**4 or more**	**Fixed-effects *QB***	**Random-effects *QB***	***k***
Behavioral	0.05_a(−0.07, 0.17)	0.11_b(−0.11, 0.33)	0.29_c(0.17, 0.41)	0.14_b(0.03, 0.25)	300.09^{***}	34.87^{***}	205
Clinical	0.17_a(0.04, 0.30)	0.12_a(−0.13, 0.36)	0.27_b(0.13, 0.40)	0.22_c(0.12, 0.33)	32.56^{***}	12.07^{**}	199
Overall	0.10_a(0.01, 0.20)	0.17_b(−0.02, 0.36)	0.33_c(0.23, 0.43)	0.19_b(0.10, 0.27)	282.94^{***}	33.74^{***}	270

Note. Change for intervention and control groups as a function of number of recommendations. *CI* = confidence interval. *d* = fixed-effects weighted means. *QB* = homogeneity coefficient for the difference across levels of a factor, distributed as a chi-square with degrees of freedom equal to the number of factor levels − 1. Within each row, *d*s with similar subscripts are not significantly different from one another.

* $p < .05$,

** $p < .01$,

*** $p < .001$.

Table 4

Mediational Analysis of Centered Squared Form of Number of Recommendations.

	Mediator and Outcome				
	Mediator: Behavioral Change		Outcome: Clinical Change		
Predictor	**Direct Effect on Behavioral Change**	**Direct Effect on Clinical Change**	**Indirect Effect on Clinical Change**	**Total Effect on Clinical Change**	**% Indirect of Total**
Quadratic Recommendation	−0.016*(−0.19) (B parameter)	0.007(0.07) (A parameter)	−0.006*(−0.07)	0.001(0.007)	See text
Number Behavioral Change	--	0.371*(0.35) (C parameter)	--	--	--

Note. Model is Mediation Figure 1 with adjustment variables noted there. $k = 267$ effect size records. Data are weighted. Entries are unstandardized coefficients with standardized coefficients in parentheses. R^2 of behavioral change is .15. R^2 of clinical change is .17.

* $p < .05$

Table 5

Overall Change as a Function of Number of Recommendations and Intervention Characteristics-Univariate Analyses (k = 231).

	Number of Recommendations					
	d			*QB*		
	1	**2–3**	**4 or more**	**Simple Effects**	**Main Effect**	**Interaction**
Non-patient population	--	--	--	--	65.92***	12.55**
Yes (k = 151)	0.08_a	0.34_b	0.17_c	189.17***	--	--
No (k = 80)	0.41_d	0.46_d	0.27_e	50.46***	--	--
Non-Clinic Setting	--	--	--	--	56.57***	13.49**
Yes (k = 96)	0.03_a	0.30_b	0.13_a	132.26***	--	--
No (k = 134)	0.29_b	0.37_c	0.26_b	51.17***	--	--
Community Member	--	--	--	--	73.56***	186.74***
Yes (k = 73)	0.01_a	0.37_b	0.05_a	397.23***	--	--
No (k = 158)	0.36_b	0.34_b	0.28_c	12.83***	--	--
Group Delivery	--	--	--	--	58.03***	42.15***
Yes (k = 118)	0.09_a	0.39_b	0.18_c	200.20***	--	--
No (k = 113)	0.42_b	0.41_b	0.31_d	40.38***	--	--

Note. Change for intervention groups as a function of number of recommendations and intervention characteristics. Passive control groups (d = 0.15) were excluded. d = fixed-effects weighted means. Following the means, we present the *QBs* for each intervention characteristic alone and in interaction with the number of recommendation. *QB* for simple and main effects = homogeneity coefficient for the difference across levels of a factor, distributed as a chi-square with degrees of freedom equal to the number of factor levels − 1 degrees of freedom. *QB* for interaction = homogeneity coefficient for the interaction between factors, distributed as a chi-square with (number of levels of factor A − 1) × (number of levels of factor B − 1) degrees of freedom. *ds* with similar subscripts are not significantly different from one another.

* $p < .05$,

** $p < .01$,

*** $p < .001$

Table 6

Overall Change as a Function of Number of Recommendations and Intervention Characteristics-Multivariate Analyses (k = 231).

	Number of Recommendations					
	d			*QB*		
	1	**2–3**	**4 or more**	**Simple Effects**	**Main Effect**	**Interaction**
Non-patient population	--	--	--	--	13.43^{**}	$20\ 24^{***}$
Yes (*k* = 151)	0.10_a	0.34_b	0.18_c	135.98^{***}	--	--
No (*k* = 80)	0.32_b	0.47_d	0.18_c	99.71^{***}	--	--
Non-Clinic Setting	--	--	--	--	0.30	0.71
Yes (*k* = 134)	0.23_a	0.38_b	0.16_a	104.78^{***}	--	--
No (*k* = 97)	0.20_a	0.43_b	0.20_a	146.72^{***}	--	--
Community Member	--	--	--	--	23.37^{***}	164.20^{***}
Yes (*k* = 73)	0.06_a	0.45_b	0.08_a	293.06^{***}	--	--
No (*k* = 158)	0.36_c	0.36_c	0.28_d	20.83^{***}	--	--
Group Delivery	--	--	--	--	0.03	3.22
Yes (*k* = 118)	0.22_a	0.40_b	0.16_c	149.80^{***}	--	--
No (*k* = 113)	0.20_a	0.41_b	0.20_a	108.27^{***}	--	--

Note. Change for intervention groups as a function of number of recommendations and intervention characteristics. Passive control groups (*d* = 0.15) were excluded. *d* = fixed-effects weighted means. Following the means, we present the *QBs* for each intervention characteristic alone and in interaction with the number of recommendation. *QB* for simple and main effects = homogeneity coefficient for the difference across levels of a factor, distributed as a chi-square with degrees of freedom equal to the number of factor levels − 1 degrees of freedom. *QB* for interaction = homogeneity coefficient for the interaction between factors, distributed as a chi-square with (number of levels of factor A − 1) × (number of levels of factor B − 1) degrees of freedom. *d*s with similar subscripts are not significantly different from one another.

$^{*}p < .05$,

$^{**}p < .01$,

$^{***}p < .001$

Table 7

Overall Change as a Function of Intervention Characteristics (k = 216).

	d.			
	Yes	**No**	**Fixed-effects *QB***	**Random-effects *QB***
Active intervention	0.20	0.33	140.01***	.34
Face-to-face delivery	0.29	0.14	330.60***	7.00*
Culturally appropriate intervention	0.35	0.25	17.28***	3.44
Intervention targeted to specific gender	0.36	0.23	121.83***	6.50*
Intervention targeted to specific ethnic group	0.33	0.24	12.24***	1.21

Note. *d*. = fixed-effects weighted means. No-intervention control groups (*k* = 39, *d*. = .06, confidence interval = −0.01, 0.12) and groups making a single recommendation (*k* = 15, *d*. = .07, confidence interval = 0.02, 0.13) were excluded. All factors were dummy coded (characteristic present = 1; characteristic not present = 0). *QB* = homogeneity coefficient for the difference across levels of a factor, distributed as a chi-square with degrees of freedom equal to the number of factor levels − 1.

* $p < .05$,

** $p < .01$,

*** $p < .001$