2013

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Mia Lustria, Seth M. Noar, Juliann Cortese, Stephanie Van Stee, Robert L. Glueckauf, and Junga Lee

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By

Mia Liza A. Lustria, Ph.D. [2]
School of Library and Information Studies
College of Communication & Information, Florida State University
142 Collegiate Loop, Tallahassee, FL 32306-2100
Phone: (850) 644-6237
mlustria@fsu.edu

Seth M. Noar, Ph.D.
School of Journalism and Mass Communication
University of North Carolina at Chapel Hill
363 Carroll Hall (CB 3365), Chapel Hill, NC 27599-3365
noar@email.unc.edu

Juliann Cortese, Ph.D.
School of Communication
College of Communication & Information, Florida State University
296 Champions Way, Tallahassee, FL 32306-2664
jcortese@fsu.edu

Stephanie K. Van Stee, M.A.
Department of Communication, University of Kentucky
227 Grehan Building, Lexington, KY 40506-0042
skvans2@uky.edu

Robert L. Glueckauf, Ph.D.
Department of Medical Humanities & Social Sciences
College of Medicine, Florida State University
1115 W. Call St., Suite 1310 L, Tallahassee, FL 32306-4300
Robert.Glueckauf@med.fsu.edu

Junga Lee, Ph.D.
Sports Medicine Laboratory, Yonsei University
Seoul, South Korea
junga613@gmail.com

[1] *This is an Author's Original Manuscript of an article whose final and definitive form, the Version of Record, has been published in the Journal of Health Communication [2013] [copyright Taylor & Francis]. Please do not distribute without the authors' permission. Citation:* Lustria, M. L. A., Noar, S. M., Cortese, J., van Stee, S., Glueckauf, R. L., & Lee, J. (2013). A meta-analysis of web-delivered tailored health behavior change interventions. *Journal of Health Communication, 18*(9), 1039-1069. doi:10.1080/10810730.2013.768727

[2] Corresponding author.

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Abstract

Background: Web-based, tailored intervention programs show considerable promise in effecting health-promoting behaviors and improving health outcomes across a variety of medical conditions and patient populations. ***Purpose***: This meta-analysis compares the effects of tailored versus non-tailored, web-based interventions on health behaviors, and explores the influence of key moderators on treatment outcomes. ***Methods***: Forty experimental and quasi-experimental studies (N = 20,180) met criteria for inclusion and were analyzed using meta-analytic procedures. ***Results***: The findings indicated that web-based, tailored interventions effected significantly greater improvement in health outcomes as compared to control conditions both at post-testing, d = .139 (95% CI = .111, .166, p<.001, k = 40) and at follow-up, d = .158 (95% CI = .124, .192, p<.001, k = 21). No evidence of publication bias was found. ***Conclusions***: These results provided further support for the differential benefits of tailored web-based interventions over non-tailored approaches. Analysis of participant/descriptive, intervention, and methodological moderators shed some light on factors that may be important to the success of tailored interventions. Implications of these findings and directions for future research are discussed.

Keywords: *Internet, web-based, tailoring, intervention, health behavior change*

INTRODUCTION

It has been a common misconception of public health programs that health messages and modes of delivery can fit all populations, medical conditions or circumstances (Kreuter, Strecher, & Glassman, 1999; Sutton, Balch, & Lefebvre, 1995). A growing body of research shows that presenting general health information without considering individual needs or personal relevance may limit substantially the extent of health behavior change (Caiata Zufferey & Schulz, 2009; Gans et al., 2009; Lambert, Loiselle, & Macdonald, 2009; Lustria, Cortese, Noar, & Glueckauf, 2009; Neville, Milat, & O'Hara, 2009; Neville, O'Hara, & Milat, 2009a, 2009b; Noar, Harrington, & Aldrich, 2009; Strecher et al., 2008; Suggs & McIntyre, 2009; Te Poel, Bolman, Reubsaet, & de Vries, 2009; Wangberg, 2008).

Tailoring is a multi-dimensional communication strategy that involves developing individualized messages based on pre-assessment of key individual-difference variables or characteristics linked to the underlying model of behavior change (Kreuter, Farrell, Olevitch, & Brennan, 2000; Lustria, et al., 2009). Numerous studies have found that compared to non-tailored materials, tailored health messages command greater attention, are processed more intently, contain less redundant information, and are perceived more positively by health consumers (Bandura, 1998; Brug, Oenema, & Campbell, 2003; Kreuter, Caburnay, Chen, & Donlin, 2004; Kreuter & Wray, 2003; A. C. Marcus et al., 2005; Smeets, Brug, & de Vries, 2008; Williams-Piehota, Schneider, Pizarro, Mowad, & Salovey, 2003).

Tailoring works by increasing the personal relevance of health messages (Hawkins, Kreuter, Resnicow, Fishbein, & Dijkstra, 2008). According to the Elaboration Likelihood Model, when individuals perceive information to be personally relevant, this may enhance

their motivation to elaborate on the message, and increase their sensitivity to argument strength (Petty & Cacioppo, 1979). Alternatively, if the arguments presented are perceived to be strong, perceived personal relevance can increase persuasion. Thus, tailoring may play an important albeit indirect role in creating an ideal environment for persuasion and, potentially, health behavior change (Dijkstra, 2005; Hawkins, et al., 2008; Rimer & Kreuter, 2006).

Computing technologies have contributed significantly to the level of sophistication of tailoring. Such systems can facilitate theory-based assessment to support tailoring on a number of key personal characteristics. Moreover, multiple interactive modalities can enhance the delivery of health messages. In a meta-analysis of 75 randomized controlled trials, Portnoy et al. (2008) found that computer-tailored interventions led to post-treatment changes on a number of theoretically-relevant antecedent variables (e.g., self-efficacy, knowledge, attitudes, perceived norms, behavioral intentions, and readiness to change) hypothesized to improve conditions for behavior change (Bandura, 1998; Fishbein & Cappella, 2006; Prochaska & DiClemente, 1984). Krebs and Prochaska (2010) aggregated the results of 88 tailored computer-, print- or telephone-based health interventions targeting four health behaviors (i.e., smoking cessation, physical activity, healthy eating, and breast screening) and found a significant mean effect size ($g = 0.17$) across these interventions. These findings have been corroborated in a number of systematic reviews, showing differential positive effects for computer-tailored interventions on nutrition and dietary behaviors (Kroeze, Werkman, & Brug, 2006; B. H. Marcus et al., 2007; Neville, Milat, et al., 2009; Neville, O'Hara, et al., 2009a, 2009b),

smoking cessation, and other risk behaviors (Revere & Dunbar, 2001; Rimer & Glassman, 1998; Strecher, 1999; Strecher, Wang, Derry, Wildenhaus, & Johnson, 2002).

Web-based, computer-tailored interventions have multiple advantages over single-mode, static interventions: (1) wider access to expert care and feedback; (2) ability to toggle between modalities and formats to suite different learning styles and literacy levels; (3) option to communicate synchronously and asynchronously thus enabling convenient scheduling of interactions and delivery of reminders and messages; (4) a wide array of interactive components to enhance user experiences and support skills development, behavior/goal monitoring, and progress tracking (e.g., e-journals, simulations, games, etc.) (Lustria, et al., 2009; Portnoy, et al., 2008).

As such, the process to develop tailored interventions can be more complex than what would be involved in the development of interventions delivered via traditional modes (e.g., print). Additionally, the multi-modal, interactive nature of web-based tailored interventions makes it difficult to tease out moderators of efficacy compared to traditional, single-mode approaches. Consequently, efficacy can be influenced by a number of factors: (a) the nature of the intervention (i.e., health focus and number and types of target health behaviors); (b) modes of delivery; (c) study characteristics; (d) participant population; (e) number of intervention contacts; and (f) application of theory-based assessment (Lustria, et al., 2009; Noar, et al., 2009).

While previous meta-analyses have examined web-based interventions, none of these have focused specifically on web-*delivered* tailored programs. This study, therefore, fills a gap in the literature given the large and rapidly growing number of studies on web-delivered tailored programs (e.g., Lustria, et al., 2009; Noar, et al., 2009). Portnoy et al.

(2008) focused their meta-analysis on computer-delivered interventions, examining any intervention delivered via computer and examining short-term effects only. Krebs et al. (2010) focused their meta-analysis on computer-tailored programs delivered via any channel, with most interventions (75%) delivering print-based reports and only 19 studies (22%) delivering content via computers or the web. Webb et al. (2010) examined the broad web-based intervention literature and focused their analysis primarily on the use of theory and behavior change techniques.

The current meta-analysis focuses on web-based, computer-tailored health intervention studies, and examines both short and longer-term effects of such interventions on behavioral outcomes. Following meta-analyses that have focused on tailoring but solely or primarily on print-based content delivery (Krebs, et al., 2010; Noar, Benac, & Harris, 2007; Sohl & Moyer, 2007), the current study examines the potential of tailoring strategies using the web as the primary delivery mechanism. Specifically, it assesses the efficacy of web-based, computer-tailored health behavior change intervention studies using meta-analytic procedures. Moreover, this study compares the efficacy of tailored web-based health behavior change interventions to standard or generic approaches and explores several sets of moderators that may impact the effects of tailoring.

The specific moderators and research questions tested are as follows:

1. *Participant/Descriptive characteristics*: Have outcomes of tailored web-based behavioral interventions varied with regard to gender, age, population type, country and behavior studied?

2. *Intervention/tailoring characteristics*: Have outcomes of tailored web-based behavioral interventions varied when differing tailoring strategies have been applied? These include tailoring strategies such as frequency of tailoring assessment and user control.
3. *Methodological characteristics*: Have outcomes of tailored web-based behavioral interventions varied with regard to study design, type of comparison condition, length of follow-up, and study retention?

METHOD

Search Strategy

We conducted comprehensive searches of the *Medline* and *PsycINFO* databases for potentially eligible studies in peer-reviewed journals and book chapters published from January 1999 to December 2009. An initial scan of the literature revealed that studies predating 1999 did not meet the full criteria for computer-tailored, web-delivered interventions, thus this year was set as the starting point for our search. Search queries were formulated using different combinations of the following terms: "computer", "Web", "Internet", "tailored", "health" and "intervention." All potentially eligible articles were examined to determine the extent of relevance. We also examined review articles and reference lists of selected articles (Kroeze, et al., 2006; Lustria, et al., 2009; Noar, et al., 2007; Portnoy, et al., 2008; Richards et al., 2007; Suggs & McIntyre, 2009; Marleen H. van den Berg, Schoones, & Vlieland, 2007; Weinstein, 2006) to ensure our search process was exhaustive. We only included work published in peer-reviewed journals, books, or book chapters.

Initial searches resulted in 825 abstracts that were examined for relevance. Studies were screened in several stages using explicit inclusion and exclusion criteria (see Figure 1):

- published from January 1999 to December 2009 in English-language, peer-reviewed journals
- randomized controlled trials or quasi-experimental studies
- efficacy studies of online health interventions, that:
    - had at least one web-based component (delivered over the Internet, e.g., using e-mail, website, etc.)
    - used a computer algorithm for tailoring
    - evaluated at least one health behavior or clinical outcome measure
    - primarily targeted patients or general health consumers and NOT caregivers or providers

[INSERT FIGURE 1]

Citations were evaluated and ineligible studies (i.e., studies about online health information seeking, and web-based continuing medical education; or duplicated publications) were excluded (*n*=488). Abstracts of the remaining potentially eligible studies were located and closely examined for relevance (*n*=337). Studies that did not have a web component or did not focus on patients (*n*=132), or were review articles (*n*=40) were subsequently excluded. Since we were interested in coding and comparing studies across a wide range of characteristics, we also considered the comprehensiveness of reporting in selecting articles. We also excluded studies that: (a) did not use computer-based assessment and tailoring (*n*=15), (b) did not measure any behavioral outcomes (*n*=31), or

(c) were not randomized controlled trials or had no meaningful comparison groups (*n*=80; these included feasibility studies, proposals, usability studies, and qualitative studies). As a result, a final set of 39 articles (11%) met criteria (Figure 1). Because one article reported data from 2 studies, the final set of studies in the meta-analysis was *k* = 40 (Table 1).

[INSERT TABLE 1]

Article Coding and Intercoder Reliability

Articles were evaluated for eligibility by two independent coders. Eligible studies were coded on the following variables: demographic and sample characteristics; intervention characteristics (i.e., health content, tailoring criteria and strategies, and modalities/delivery mode); and methodological characteristics (i.e., recruitment procedure, comparison conditions, intervention length, intervention dose, length of follow up, and study retention). Operational definitions were summarized in a codebook to ensure that categorization was consistently and accurately applied throughout the coding process. Two coders tested and modified this codebook using an iterative process of data review, consultation, and consensual validation.

Intercoder reliability was calculated for each characteristic using Krippendorff's alpha (Hayes & Krippendorff, 2007; Krippendorff, 2004), which can calculate reliability for categorical and continuous variables. Krippendorff's alpha ranged from a low of 0.92 to a high of 1.0, with a mean alpha of 0.998. Percentage of agreement for each coding category was also calculated by dividing the number of agreed upon coding instances by the total. Percentage of agreement ranged from a low of 87.5% to a high of 100%, with a mean percent agreement of 99.6% (most categories had 100% agreement). These coefficients indicated very good agreement between the coders.

Effect Size Extraction and Calculation

The standardized mean difference statistic (i.e., the difference in treatment and control means divided by the pooled standard deviation) was used as the effect size indicator (Carlson & Schmidt, 1999; Lipsey & Wilson, 2001). Because this effect size index has been shown to be upwardly biased when based upon small sample sizes (Hedges & Olkin, 1985), the recommended statistical correction for this bias was applied (Lipsey & Wilson, 2001). Effect sizes were calculated from data reported in the articles (e.g., *t*-test, summary statistics) using appropriate formulas (Lipsey & Wilson, 2001; Rosenthal, 1991). Adjusted statistics were used in calculating effect sizes to ensure that any baseline differences in groups were taken into account. When adjusted statistics were not reported, but baseline data were available, we adjusted for baseline differences in computing effect sizes.

In most cases, only one comparison condition existed and was used when computing effect size estimates. In a few cases, both no treatment control and non-tailored website control conditions existed. Since the goal of the study was to examine the relative impact of *tailored* programs, in these cases the non-tailored condition was chosen (over the no-treatment control condition). Additionally, less than half of the studies (k = 19) reported having collected posttest data only. Posttest and posttesting refer to the administration of dependent measures closely after the termination of treatment. In those cases, effect sizes were computed from that single time point. The overall dataset included 40 studies, with each study presenting data for the posttesting phase at a minimum. The other set of studies (k = 21) reported having collected data from one or more follow-up periods after posttesting. In order to maximize the use of the data reported, a second dataset was

created (using these 21 studies) and we coded the longest follow-up time point that was reported. In this way, we were able to assess the impact of tailored programs at posttesting and at a longer-term follow-up phase. Hereafter, for clarity, we will refer to these two datasets as those examining *posttesting* and *follow-up* effects, respectively.

Further, given that only one effect size per outcome could be included in the meta-analysis, when articles reported two similar outcome measures (e.g., two different measures of dietary change), effect sizes were calculated for both and subsequently, averaged together. Similarly, when articles reported outcomes on multiple health behaviors, effect sizes were calculated for each behavior and then averaged together. In addition, in order to keep effect sizes consistent and interpretable, all studies in which the tailored condition outperformed the comparison condition were given a positive sign (+), whereas a negative sign (-) indicated that the reverse of this was true.

Meta-Analytic Approach

Effect sizes were weighted by their inverse variance and combined using standard fixed effects meta-analytic procedures (Lipsey & Wilson, 2001). The Q statistic was used to examine whether significant heterogeneity obtained among the effect sizes. Effect sizes for hypothesized categorical moderators were calculated along with their 95% confidence intervals, and those effect sizes were statistically compared using the Q_b statistic. Additionally, in the case of continuous (i.e., interval-level) moderator variables, correlations were calculated between particular moderator variables and effect sizes. All analyses were conducted using Comprehensive Meta-Analysis software, Version 2.2.046, and SPSS Version 17.

RESULTS

The *k* = 40 studies included in the meta-analysis had a cumulative *N* = 20,180 (median *N* per study = 196; range *N* = 3,477), and were published from January 1999 to December 2009, with a median publication year of 2006. Tables 2 and 3 provide summaries of the eligible studies. Thirty-five studies (88%) included combined male/female samples, whereas the remaining studies focused on females only (*k* = 5, 12%). Among the combined male/female studies, the mean proportion of females was 64%. Mean age across the studies was 34.36 (SD = 15.69). Finally, *k* = 22 studies (55%) involved U.S. samples, whereas *k* = 18 (45%) involved samples from several other countries.

[INSERT TABLES 2 & 3]

Majority of the studies (*k* = 29 ; 73%) were single-behavior studies, the remainder (27%) targeted multiple behaviors. The most frequently studied behaviors were physical activity (42% of all behaviors), followed by nutrition/diet (25%), and smoking/tobacco (18%). However, many of these behaviors were studied in the context of multiple behavior interventions. For example, of the 23 studies that included physical activity as a focus, 11/23 (47%) were single-behavior studies focusing only on physical activity. The remainder examined physical activity plus other health behaviors.

Finally, *k* = 18 studies (45%) reported no explicit theory guiding the intervention effort. The remaining 22 studies each reported one or more theories used to guide the intervention. The most common theories used were: Transtheoretical Model, Social Cognitive Theory, and the Health Belief Model. Other theories used, but much less often, were: Theory of Reasoned Action, Theory of Planned Behavior, Precaution Adoption Process Model, and Social Comparison Theory (see Table 3).

Efficacy of Interventions

The first question examined was the overall magnitude of effect. The weighted mean effect size for the posttest effects of interventions was d = .139 (95% Confidence Interval [CI]= .111, .166, p<.001, k = 40). Thus, tailored, web-based interventions had a significantly greater impact on health behavior outcomes than the comparison/control conditions (see Figure 2).

[INSERT FIGURE 2]

We then calculated the average effect size for 21 studies with follow-up administrations of the dependent measures. The weighted mean effect size of studies comparing the follow-up effects of tailored versus non-tailored web-based interventions was d = .158 (95% CI = .124, .192, p<.001, k = 21). Hence, the differential positive effects of tailored web-based versus non-tailored web-based interventions were maintained over the longer term, with no observable decay in effects over time (see Figure 3). To ensure that these similar effect sizes were not due to the differential make-up of studies in the two separate analyses (40 studies versus 21 studies), we examined the immediate posttest effects of the 21 studies. The mean effect size was found to be, d = .135 (95% CI = .100, .169, p<.001, k = 21), a value almost identical to the d = .139 reported above.

[INSERT FIGURE 3]

In order to examine the possibility of publication bias, fail-safe N values were calculated and the trim and fill procedure was applied (Lipsey & Wilson, 2001). Orwin's (1983) method to calculate fail-safe N indicated that 71 studies with non-significant findings would need to exist to reduce the d = .139 posttest effect to a trivial effect of d = .05, while 46 non-significant studies would need to exist to reduce the d = .158 follow-up effect to a trivial effect of d = .05. Funnel plots of these effects were also examined. Such

plots were found to be quite symmetrical and the trim and fill analysis suggested no adjustment to these mean effect sizes (Duval & Tweedie, 2000). These results indicate no evidence of publication bias among the current set of studies.

Next, heterogeneity of the weighted mean effect sizes was examined. Statistical testing indicated significant heterogeneity at posttesting (Q_{39} = 168.03, p<.001, I^2 = 76.79), as well as at follow-up (Q_{20} = 76.09, p<.001, I^2 = 73.72), suggesting the presence of moderator variables. The next set of analyses explored the influence of the *a priori* determined moderators on changes in health behavior outcomes. Because the posttest effects dataset included all 40 studies, these data were used in the moderator analyses below (except in one case as noted below).

Moderator Testing

Participant/Descriptive moderators. Participant/descriptive moderators were gender (proportion of females in the samples), age, target population, country and health behavior. The correlation between gender (proportion female) and effect size was r (39) = -.29, p=.10, whereas the correlation between age and effect size was r (35) = -.05, p=.80. This indicated that neither of these participant variables was significantly associated with intervention outcomes. Results of the remaining moderator analyses indicated that interventions had significantly greater effects when focused on general population groups (referring to individuals not screened for any particular chronic illness or other disease factor) and when focused on U.S. samples (versus non-U.S. samples) (both p<.05) (see Table 4). No significant differences were found when comparing mixed to female-only samples, single versus multiple behavior interventions, and when comparing health behaviors targeted by the intervention (p>.05).

[INSERT TABLE 4]

Intervention moderators. Intervention moderators focused on frequency of tailoring assessment and user control (see Table 5). We evaluated whether conducting the tailoring assessment at baseline only or multiple times throughout the intervention was related to efficacy. Since this strategy can only have an impact over time, we used the N=21 follow-up data for this particular analysis. Results demonstrated no significant difference among studies that administered multiple assessments over the course of the intervention to create tailored messages (n=10) compared to those that employed a single tailoring assessment at baseline (n=11). Additionally, we examined whether the amount of user control (e.g., whether the tailored intervention involved substantial expert guidance or was largely self-guided) influenced outcomes, but our analyses revealed no significant differences (p>.05) (see Table 5).

[INSERT TABLE 5]

Methodological moderators. Methodological moderators were study design, type of comparison condition, length of follow-up, and study retention (see Table 6). Our analysis showed that randomized controlled trials obtained significantly greater effect sizes (d = .16, p<.001, k = 31) than quasi-experimental designs (d = .07, p<.05, k = 9). With regard to comparison condition, most studies used either a non-tailored website (k=18) or a no treatment control (k=18) comparison. Four studies compared tailored websites to non-tailored print materials. Analysis of comparison conditions revealed that tailored websites significantly outperformed non-tailored websites on health behavior outcomes (d = .188, p<.001). Studies that compared tailored websites to no-treatment control conditions achieved significantly smaller effect sizes, d = .07, p<.01, as did studies that compared tailored websites to non-tailored print materials, d = .08, p = .35, k = 4 (see Table 6). Also, the correlation between follow-up time point and effect size was r (39) = .004, p=.98, for

posttest effects, and r (20) = -.176, p=.50, for follow-up effects. This suggests that length of follow-up did not significantly influence intervention outcomes. The correlation between study retention and effect size was r (39) = .017, p=.92, indicating that retention did not influence study outcomes.

[INSERT TABLE 6]

DISCUSSION

Compared to single-mode tailored interventions, web-based tailored interventions may include other modalities (i.e., video, audio, discussion forums, chat, etc.) that provide greater interactivity and different knowledge, skills building, and self-management tools (e.g., blood glucose monitoring tools; electronic journaling, etc.). The multi-modal and interactive nature of web-based tailored interventions may improve their effectiveness by enhancing patient participation and engagement, but the confluence of modalities and features makes it difficult to tease out the differential effects of these components on intervention efficacy.

This meta-analysis is the first to explore the efficacy of computer-tailored, web-based health behavior change interventions across a wide range of health foci. In particular, we examined the efficacy of tailored, web-based approaches on health behavior outcomes and explored moderators of intervention efficacy. This analysis of 40 studies (cumulative N = 20,180) revealed that these interventions impacted health behavior outcomes at posttesting (weighted mean effect size of d = .139). Analysis of follow-up effects of tailored interventions was also promising (effect size estimate of d = .158). Although maintenance of behavior change has long been a major challenge for health communication programs (Rothman, 2000), the results indicated that tailored interventions may help individuals maintain changes over time. A unique advantage of

web-based delivery is the capacity to tailor interventions to target population characteristics (e.g., specific risk factors). Compared to interventions requiring face-to-face contact with the healthcare provider, tailored web-based programs may facilitate wider access and encourage self-care, which may improve efficacy and maintenance of gains over time. This can benefit individuals who live in rural areas, are economically disadvantaged, or have significant mobility impairments. To this point, Healthy People 2020 (U.S. Department of Health and Human Services, 2011) strongly endorses the widespread deployment of interactive, communication technologies geared towards making health education and services more accessible to and engaging for the public.

Moderators of Efficacy

We also examined the effects of a set of participant/descriptive, intervention, and methodological moderators on intervention efficacy. From the viewpoint of building a cumulative science of tailoring, such analyses are critical in advancing the field's understanding of how tailoring exerts its effects (Hawkins, et al., 2008; Noar, et al., 2009).

Results indicated that tailored, web-based interventions have been most successful when targeting general populations compared to specific patient groups (e.g., chronically ill patients or minors). Interventions targeting general health consumers were largely preventive in nature and did not require support for complex tasks involved in managing chronic conditions. These findings do not necessarily imply that web-based tailored approaches would be less effective for chronically ill patients. Rather, these findings may indicate that these patients may suffer from a host of conditions that can make it physically, emotionally and mentally difficult to fully engage in these interventions (e.g., vision or

mobile impairments can affect the ability to computer equipment). As such, these limitations must be considered when designing web-based interventions for these groups.

This study also found that web-based tailored interventions conducted in U.S. settings tended to be more successful compared to those launched elsewhere. Beliefs about health, disease and treatment have been found to diverge across racial and ethnic minority groups (Cheng et al., 2010; Groeneveld, Sonnad, Lee, Asch, & Shea, 2006; Jean-Pierre et al., 2010; Noel, 2010; Shire, 2002). Research has shown that individualism-collectivism, in addition to other cultural-related constructs (i.e., health locus of control or belief in who ultimately has responsibility for one's health), play an important role in an individual's health decision-making and health behaviors and has been found to explain some amount of variance in preferences for health messaging (Dutta, 2007).

There is also limited evidence regarding how cultural differences might influence the *acceptance* of tailored approaches. Davis (2008) compared the reactions of American (representing individualistic cultures) and Japanese (representing collectivistic cultures) individuals to culturally-tailored messages. The study found significant differences between cultural orientations in terms of reported engagement, perceived attractiveness and novelty of the information presented in the tailored condition. While Japanese participants were more likely to re-read the tailored information, they were *less* likely to find it useful to change their dietary behaviors compared to those who were shown the generic messages.

Turning to outcome criteria, the results indicated that tailored web-based interventions targeting a single health behavior were not significantly more efficacious than those targeting multiple health behaviors. It is important to note that effect sizes of interventions targeting multiple health behaviors were calculated by averaging all

behavioral outcomes because each study could only contribute one effect size to the meta-analysis. The lack of significant differences suggests that the effects of web-based interventions may not attenuate across multiple health behavior endpoints. These findings are largely consistent with recent research (Krebs, et al., 2010; Prochaska, 2008).

Regarding analyses of tailoring strategies, findings show that the frequency of tailoring assessments did not significantly affect intervention efficacy. A recent meta-analysis examining long-term effects of tailored interventions found that dynamic tailoring is more efficacious than static tailoring for all interventions employing either single or multiple delivery modes (Krebs, et al., 2010). We found that studies employing a single assessment were slightly more effective than those employing multiple assessments over time, though not significantly so.

Upon closer examination, most studies using a single tailoring assessment were brief, targeted behaviors, such as levels of physical activity, fruit and vegetable intake, saturated fat intake and abstinence from smoking and alcohol consumption, and were evaluated within shorter follow-up periods. Studies employing multiple and iterative tailoring assessment were typically longer term, focused on more complex conditions (i.e., management of chronic diseases such as asthma and arthritis), and typically targeted either patient or high risk population groups (e.g., established smokers, obese adults, diabetics). This confluence of factors may have made it more difficult to achieve intervention goals and thus, inadvertently attenuated the potential benefits of multiple tailoring assessments.

Moreover, it was unclear from most reports how multiple, iterative assessments were actually administered and how these informed the development of tailored health messages. Timing of "re-assessment" may be important especially in cases where health messages are tailored according to readiness to change. In this case, the assumption is that

the participant will have undergone meaningful changes before they can be re-assessed and motivated to move on to the next stage of change.

Next, no significant differences were obtained when comparing effect sizes of self-guided and expert-guided, web-based tailored interventions. Self-guided interventions require more active engagement from participants and rely heavily on the patient to "drive" their progress through the health program. Expert-guided interventions, on the other hand, require greater involvement from healthcare practitioners to direct patients through the program and provide more immediate feedback. Results indicated that while additional feedback from experts can improve efficacy, interventions with less expert input can be just as effective. Thus, web-based tailored approaches for self-management can be useful even when support from healthcare experts may not be readily available.

The most compelling finding here is that tailored websites were significantly more effective than non-tailored websites in achieving behavioral outcomes (d = .188). This supports earlier meta-analyses that have found that tailoring can be an effective strategy for health behavior change (Krebs, et al., 2010; Noar, et al., 2007; Portnoy, et al., 2008; Sohl & Moyer, 2007). This is ***not*** to say that all tailored websites will be similarly efficacious. There is great variability in how tailoring was carried out. There was significant heterogeneity among this set of studies because the web allows for a variety of features, and formats, and levels of interactivity. This may help explain why studies comparing tailored websites to no treatment control conditions exhibited significantly smaller weighted mean effect sizes (d = .071) than those comparing tailored to non-tailored websites (d = .188). This is counter-intuitive, as one would expect the *largest* effect to be exhibited when a trial compares an intervention to "nothing" (i.e., no treatment control). This is likely to be a methodological artifact of these studies. It is possible that in order to

facilitate more rigorous testing, more effective messages were generated in studies comparing tailored and non-tailored websites than those studies with only no treatment control groups. One lesson here is that researchers should not think of tailoring as a "magic bullet" and should follow a careful process of development (e.g., Kreuter et al., 2000) based on comprehensive formative work.

Limitations

One limitation of the study, which is common when assessing moderators in meta-analyses, is that variables may sometimes be confounded with other variables and this, in turn, may result in counter-intuitive findings (Lipsey, 2003). Nevertheless, it is critical that tailoring researchers continue to examine under what circumstances and for what conditions web-based tailored health behavior change interventions can be most effective. This can be achieved through new primary studies as well as meta-analyses. The growing web-tailoring literature provides an opportunity to conduct meta-regression analysis, which may better control for "artifact" variables and help advance our understanding of mechanisms in tailoring.

Implications and Future Directions

In sum, this study provides evidence for the overall efficacy of web-based tailored approaches for both short and longer-term behavior change interventions .

Web-based tailored interventions targeting general population groups were significantly more effective than those targeting specific patient groups or minors. Web-based tailored interventions in the U.S. were found to have significantly greater effect sizes than those conducted elsewhere. Interestingly, this analysis found no significant difference in effect sizes for studies targeting single vs. multiple health behaviors. Since we averaged effect sizes across various behaviors in multiple-behavior tailored interventions, this

suggests that the latter may be equally effective as interventions targeting only a single behavior.

Counter to previous meta-analyses, we found that randomized controlled trials comparing a web-based tailored intervention with a meaningful comparison group (e.g., a non-tailored or waitlist control condition) were significantly more effective than quasi-experimental studies with no treatment control groups.

Overall, this study raises a number of important questions that need further exploration to enable us to optimize the use of web-based tailoring in behavior change interventions. Researchers should be encouraged to provide better descriptions of their tailoring criteria and tactics used for message design, modes of delivery and components of the intervention, including number and intensity of intervention contacts per tailored component (see Harrington & Noar, 2012). Such descriptions will facilitate more accurate coding and testing of possible moderators of efficacy and will help clarify some of the issues raised here.

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Appendix A: Tables

Table 1

List of Studies Included in Meta-Analysis

ELIGIBLE STUDIES INCLUDED IN META-ANALYSIS
1. An, L. C., Klatt, C., Perry, C. L., Lein, E. B., Hennrikus, D. J., Pallonen, U. E., . . . Ehlinger, E. P. (2008). The RealU online cessation intervention for college smokers: A randomized controlled trial. *Preventive Medicine, 47*(2), 194-199. doi: 10.1016/j.ypmed.2008.04.011
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Table 2

Summary of Web-Based Tailored Health Behavior Change Interventions

Study	Focus	Sample Characteristics	Intervention Characteristics	Conditions
(An et al., 2008)	Smoking	517 college student smokers; mean age=20; 73% female; US setting	30-week tailored smoking cessation intervention requiring 20 visits to a website; also included email reminders, weekly self-monitoring, interactive tailored quizzes and email support from peer coaches; targeted behavior: 7- and 30-day smoking prevalence; 100% retention rate	tailored online magazine (n=257) vs. general online resources (n=260)
(Buller et al., 2008)	Smoking	1234 adolescents; mean age=12; 52% female; US setting	web-based tailored smoking cessation intervention delivered during 6 class meetings; each 45-60 minute session focused on different content and included self-monitoring, multi-media content; targeted behavior: 30-day smoking prevalence; 81% retention	tailored website (n=640) vs. standard health education (n=364)
(Buller, et al., 2008)	Smoking	2077 adolescents; mean age=12; 49% female; non-US setting (Australia)	web-based tailored smoking cessation intervention delivered during 6 class meetings; each 45-60 minute session focused on different content and included self-monitoring, multi-media content; targeted behavior: 30-day smoking prevalence; 73% retention	tailored website (n=754) vs. standard health education (n=756)
(Chiauzzi, Green, Lord, Thum, & Goldstein, 2005)	Alcoholism	265 college students who were heavy drinkers; mean age=20; 46% female; US setting	4-week web-based tailored intervention designed to reduce heavy drinking; each 20-minute session included tailored content, interactive activities, peer stories, ask an expert, and a social norm "calculator"; targeted behaviors: alcohol use; binge drinking, and readiness to change; 80% retention rate	tailored website (n=131 vs. generic website (n=134)
(Dunton & Robertson, 2008)	Physical Activity	156 adult women; mean age=43; 100% female; US setting	12-week web-based tailored physical activity intervention; also included activity monitor and weekly newsletters sent via email; targeted behaviors: level of physical activity and readiness to change; 74% retention	tailored website (n=85) vs. waitlist control (n=71)

Study	Focus	Sample Characteristics	Intervention Characteristics	Conditions
(Frenn et al., 2005)	Nutrition/Diet; Physical Activity	132 middle school kids; mean age=13; 52% female; US setting	web-based tailored physical activity intervention delivered in 8, 40-minute in-class sessions; included tailored content, videos, discussion forums and tailored email feedback; targeted behaviors: level of physical activity & dietary fat intake; 77% retention	tailored educational site vs. control (standard classes; n for each condition not clearly reported)
(Hageman, Walker, & Pullen, 2005)	Physical Activity	31 older women; mean age=56; 100% female; US setting	8-week web-based tailored physical activity intervention delivered via 3 tailored online newsletters; targeted behaviors: level of physical activity and self-efficacy; 97% retention rate	tailored (n=15) vs. generic (n=16) online newsletters
(Huang et al., 2006)	Nutrition/Diet	497 online consumers; mean age=40; 87.5% female; non-US setting (Sydney, Australia)	brief web-based tailored intervention to reduce high-fat purchases on an online shopping website; based on contents of shopping cart, tailored advice was given to encourage shoppers to buy similar products lower in saturated fat; targeted behavior: purchase of products high in saturated fat; 100% retention rate	tailored (n=251) vs. general (n=246), non-specific shopping advice
(Hurling et al., 2007)	Physical Activity	77 overweight/obese adults; mean age=40; 64% female; non-US setting (Bedfordshire, United Kingdom)	9-week web-based physical activity intervention; involved tailored solutions; weekly exercise plan, self-monitoring of PA, discussion forum, reminders sent via email and text (SMS); targeted behavior: level of physical activity; 100% retention rate	tailored (n=47) vs. generic website (n=30)
(Joseph et al., 2007)	Asthma	314 AA high schoolers; mean age=17; 63% female; US setting	12-month web-based asthma management program; included tailored feedback and animation; targeted behaviors: controller medication adherence, rescue inhaler availability, and smoking cessation/reduction; 86% retention	tailored (n=162) vs. generic (n=152) website

Study	Focus	Sample Characteristics	Intervention Characteristics	Conditions
(Kypri & McAnally, 2005)	Nutrition/Diet; Physical Activity; Smoking; Alcoholism	218 college students; mean age=20; 49% female; non-US setting (New Zealand)	brief, web-based tailored intervention conducted at student health services targeting multiple health behaviors; involved web-based assessment with immediate tailored feedback and phone and email reminder to complete a follow-up survey at 6-weeks; targeted behaviors: fruit & vegetable intake, levels of physical activity, alcohol consumption; 85% retention	1) web-based assessment and personalized feedback (n=72); vs. (2) assessment only (n=74); vs. (3) minimal contact (n=72)
(Kypri et al., 2004)	Alcoholism	104 college students who were heavy drinkers; mean age=20; 50% female; non-US setting (New Zealand)	brief, web-based tailored intervention to reduce hazardous drinking; involved 10-15 minute web-based assessment with immediate tailored feedback and phone and email reminder to complete a follow-up survey at 6-weeks; targeted behaviors: alcohol consumption and binge drinking; 62% retention	web-based assessment and tailored feedback (n=51) vs. generic print (n=53)
(Kypri, Langley, Saunders, Cashell-Smith, & Herbison, 2008)	Alcoholism	576 college students who were heavy drinkers; mean age=20; 52% female; non-US setting (New Zealand)	brief and multiple-dose web-based tailored motivational intervention to reduce hazardous drinking; involved web-based assessment with tailored feedback, with one arm receiving multiple assessments and tailored feedback at 1 and 6 months; targeted behaviors: alcohol consumption and binge drinking; 63% retention	(1) single dose evidence-supported screening and brief intervention (e-SBI, n=138); (2) multiple dose evidence-supported screening; and brief interventioncontrol (n=145); (3) general pamphlet (n=146); (4) alternate control (n=147)
(Lorig, Ritter, Laurent, & Plant, 2008)	Arthritis	855 patients with rheumatoid arthritis, osteoarthritis, or fibromyalgia; mean age=52; 90% female; US setting	6-week web-based arthritis self-management program; involved interactive, web-based instruction, bulletin board discussion, exercise logs, medication diaries, and tailored exercise programs, and an Arthritis Helpbook containing all of the program content; targeted multiple behaviors: i.e., aerobic exercise, stretching and strengthening exercise, practice of stress management, and communication with physicians, and self-efficacy; 75% retention	tailored website (n=433) vs. usual care (n=422)

Study	Focus	Sample Characteristics	Intervention Characteristics	Conditions
(Mangunkusumo, Brug, de Koning, van der Lei, & Raat, 2007)	Nutrition/Diet	495 adolescents; mean age=10; 53% female; non-US setting (The Netherlands)	brief web-based tailored nutrition intervention; involved web-based assessment and tailored nutrition advice, at a later date followed up by 5-minute dietary counseling involving parents; targeted behavior: fruit & vegetable intake; 98% retention	Internet-tailored nutrition advice for schoolchildren and brief dietary counseling (with child and parent; n=263) vs. brief web-based nutrition advice (n=223)
(A. C. Marcus, et al., 2005)	Physical Activity	249 healthy but sedentary adults; mean age=45; 83% female; US setting	web-based tailored physical activity intervention; included tailored evidence-based physical activity educational and motivational materials, monthly questionnaires with tailored immediate feedback, a goal-setting, and links to other sites and email reminders; targeted behavior: level of physical activity; 89% retention	(1) motivationally tailored Internet (n=81); vs. (2) motivationally tailored print (n=86); vs. (3) 6 standard website (n=82)
(McKay, King, Eakin, Seeley, & Glasgow, 2001)	Physical Activity	78 Type 2 diabetics; mean age=52; 53% female; US setting	8-week web-based tailored physical activity intervention; tailored website included goal setting and personalized feedback, online access to personal coach and peer support groups; targeted behavior: level of physical activity; 87% retention	fully tailored website (n=38) vs. information-only website (n=40)
(Napolitano et al., 2003)	Physical Activity	65 sedentary adults; mean age=43; 86% female; US setting	12-week web-based tailored physical activity intervention; tailored website with weekly email tip sheets and activity quizzes; targeted behavior: level of physical activity; 88% retention	tailored website (n=30) vs. waitlist control (n=35)
(Norman, Maley, Li, & Skinner, 2008)	Smoking	1402 adolescents; mean age=13; 46% female; non-US setting (Toronto, Canada)	6-month web-based tailored smoking cessation intervention; involved a single 60-minute exploration of an interactive tailored website, and completion of paper journal and small-group motivational interview, and supported with tailored follow-up emails delivered monthly over the 6-month period; targeted behavior: cigarette use, behavioral intentions and self-efficacy to resist smoking; 83% retention	tailored web-based instruction (n=not reported) vs. standard class exercise (n=not reported)

Study	Focus	Sample Characteristics	Intervention Characteristics	Conditions
(Oenema, Brug, Dijkstra, Weerdt, & Vries, 2008)	Nutrition/Diet; Physical Activity; Smoking	2159 adults; mean age=44; 54% female; non-US setting (The Netherlands)	4-week web-based tailored lifestyle intervention; involved tailored information modules with online quizzes, graphics and goal setting activities; targeted behaviors: saturated fat intake, level of physical activity and smoking cessation; 63% retention	tailored web intervention (n=1080) vs. waitlist control (n=1079)
(Oenema, Tan, & Brug, 2005)	Nutrition/Diet	782 adults; mean age=42; 43% female; non-US setting (The Netherlands)	3-week web-based tailored nutrition intervention; involved a tailored website including information on how to make implementation intentions, sex and age-tailored role model stories and list of healthy recipes; targeted behaviors: saturated fat intake and fruit and vegetable intake; 79% retention	tailored intervention (n=261) vs. generic information control (n=260) vs. no-information control (n=261)
(Palmer, Graham, & Elliott, 2005)	Physical Activity	233 fifth graders; mean age = nr; 66% female; US setting	4-week web-based tailored physical activity intervention; involved bi-weekly 50-minute exploration of a tailored website including online quizzes, writing activities, weekly activity checklist, graphics and animation; targeted behavior: level of physical activity; 100% retention	involved pre-post cross-over design
(Ritterband et al., 2003)	Encopresis	24 children with encopresis; 21% female; US setting	3-week web-based tailored intervention dealing with encopresis; involved three web-based core modules that could be completed in a total of 60-90 minutes in single or multiple sessions, this was followed up with assessments and tailored modules and personalized instruction sheets 1 and 2 weeks after completion of the core modules, presentation formats included animation, online quizzes, audio narration, online games, video, telephone and print support; targeted behavior: toileting behaviors; 100% retention	web-based enhanced toilet training intervention (n=12) vs. no-web intervention involving unspecified routine medical care (n=12)

Study	Focus	Sample Characteristics	Intervention Characteristics	Conditions
(Rothert et al., 2006)	Nutrition/Diet; Physical Activity	2862 overweight/obese adults; mean age=45; 83% female; US setting	6-week web-based tailored self-help weight management program; involved development of individually tailored weight management plans, exercise plans, "buddy" support via email, and follow-up tailored action plans; targeted behavior: weight management behaviors including dietary and physical activity; 100% retention	tailored website (n=1475) vs. information only control (n=1387)
(Severson, Gordon, Danaher, & Akers, 2008)	Smoking	2523 adult smokeless tobacco users; mean age=37; 2.5% female; US setting	6-month web-based tailored smoking cessation intervention; tailored website include an "personal quitting assistant" to create individualized quit plans, streaming videos (with quitting information and testimonials), printable resources, annotated links to other websites, peer and expert support via discussion forums and email reminders; targeted behavior: smokeless tobacco use; 34% retention	interactive, tailored web-based intervention (n=1260) vs. linear text-based website (n=1263)
(Slootmaker, Chinapaw, Schuit, Seidell, & Van Mechelen, 2009)	Physical Activity	102 adults; mean age=32; 60% female; non-US setting (The Netherlands)	3-month web-based tailored physical activity intervention; involved use of physical activity monitor with a PAM Coach which developed individualized PA advice based on completion of online questionnaires, activity logs, goal setting activities; targeted behavior: levels of physical activity; 96.3% retention	tailored website (n=51) vs. generic print brochure (n=51)
(Spittaels, De Bourdeaudhuij, & Vandelanotte, 2007)	Physical Activity	434 adults; mean age=41; 66% female; non-US setting (Belgium)	6-month web-based tailored physical activity intervention; involved tailored PA advice generated via user assessment and included links to goal setting tools, weekly plans, flexibility and strength exercises, discussion forums and tailored email feedback; targeted behavior: levels of physical activity; 66% retention	tailored intervention with repeated tailored feedback (n=173) vs. tailored intervention with single tailored feedback (n=129) vs. waitlist control (n=132)

Study	Focus	Sample Characteristics	Intervention Characteristics	Conditions
(Spittaels, De Bourdeaudhuij, Brug, & Vandelanotte, 2007)	Physical Activity	526 adults; mean age=40; 31% female; non-US setting (Belgium)	8-week web-based tailored physical activity intervention; involved tailored PA advice and individualized action plans with 5 stage-based reinforcement emails; targeted behaviors: levels of physical activity and sedentary behaviors; 72% retention	(1) online-tailored physical activity advice + stage-based reinforcement emails (n=174) vs. (2) online-tailored physical activity advice only (n=175) vs. (3) online non-tailored standard physical activity advice (n=177)
(Strecher, Shiffman, & West, 2005)	Smoking	3971 online consumers of nicotine patch; mean age=37; 57% female; non-US setting (England & Ireland)	10-week web-based tailored smoking cessation intervention; involved a tailored web-based cessation guide, three sequential tailored web-based newsletters and behavioral support messages delivered via e- mail over a 10-week period; targeted behavior: abstinence from smoking; 53% retention	tailored intervention (n=1759) vs. generic intervention (n=1742)
(Swartz, Noell, Schroeder, & Ary, 2006)	Smoking	351 adults willing to make quit attempt in 30 days; mean age=40; 48% female; US setting	web-based tailored smoking cessation intervention; the tailored website could be accessed in one extended session or multiple times over the 90-day intervention period, this included tailored content, individualized tips and quit plan calendar, video segments and email reminders; targeted behavior: abstinence from smoking; 51% retention	tailored intervention (n=170) vs. waitlist control (n=180)
(Tate, Jackvony, & Wing, 2006)	Nutrition/Diet; Physical Activity	192 overweight/obese adults; mean age=49; 84% female; US setting	6-month web-based tailored weight loss program; the interactive website included weekly reports and graphs showing weight changes, email prompts, emailed weight loss tips, recipes and access to a weight-loss e-buddy network system plus computer-automated tailored feedback; targeted behavior: levels of physical activity and dietary behaviors; 81% retention	(1) tailored website only (n=67) vs. (2) tailored website with computer-automated feedback (n=61) vs. (3) tailored website with human email counseling (n=64)

Study	Focus	Sample Characteristics	Intervention Characteristics	Conditions
(Te Poel, et al., 2009)	Smoking	615 adults smokers; mean age=46; 56% female; non-US setting (The Netherlands)	brief web-based smoking cessation intervention; immediately after completing a brief-web-based assessment, participants were sent emails with tailored feedback; targeted behavior: abstinence from smoking; 43% retention rate	tailored intervention (n=224) vs. non-tailored intervention (n=234)
(M. H. Van Den Berg et al., 2006)	Physical Activity	160 physically inactive RA patients; mean age=50; 61% female; non-US setting (The Netherlands)	12-month web-based tailored physical activity intervention; involved an individualized training intervention requiring weekly activity logs, personalized program schedule involving different exercise and physical activity recommendation supported by weekly tailored emails from physical therapists, access to a discussion forum and invitations to attend face-to-face group meetings every 3 months; targeted behavior: level of physical activity; 100% retention	web-based individualized training (n=82) vs. (web-based general training (n=78)
(Verheijden et al., 2004)	Nutrition/Diet	146 patients with high-risk for CVD; mean age=63; 45% female; non-US setting (Canada)	8-month web-based tailored nutrition intervention; tailored website included weekly assessments and personalized nutrition counseling, access to peer support via a discussion forum, dietary fat intake logs, and links to other resources; targeted behavior: dietary fat reduction; 86% retention	tailored intervention (n=73) vs. usual care (n=73)
(Wanner, Martin-Diener, Braun-Fahrlander, Bauer, & Martin, 2009)	Physical Activity	1369 adults; mean age=44; 75% female; non-US setting (Geneva, Switzerland)	web-based tailored physical activity intervention; involved tailored website with individual assessments leading to stage-matched content, tailored feedback and individualized emails - additional support tools, such as strength and stretching exercise sheets, and organizational and motivational forms were available for download; targeted behavior: levels of physical activity; 79.2% retention rate	tailored website (n=681) vs. non-tailored website (n=688)

Study	Focus	Sample Characteristics	Intervention Characteristics	Conditions
(Williamson et al., 2006)	Nutrition/Diet; Physical Activity	37 overweight AA female adolescents; with at least 1 obese parent mean age=13; 100% female; US setting	24-month web-based tailored weight loss program for overweight African-American female adolescents; involved a tailored behavior therapy website with self-monitoring tools, goal-setting tools, interactive activities and email support; targeted behavior: physical activity and dietary behaviors; 70% retention	tailored site (n=not reported) vs. generic site (n=not reported)
(Winett et al., 1999)	Nutrition/Diet; Physical Activity	180 female high schoolers; mean age=15; 100% female; US setting	web-based tailored nutrition intervention; involved 5, 15-20 minute interactive tailored modules with online assessments and personalized feedback provided in text and graphics forms; targeted behaviors: dietary behaviors and level of physical activity; 100% retention	tailored intervention (n=103) vs. no-treatment control (usual classes) (n=77)
(Winett, Anderson, Wojcik, Winett, & Bowden, 2007)	Nutrition/Diet; Physical Activity	1071 overweight/obese adults; mean age=51; 77% female; US setting	12-week web-based tailored nutrition and physical activity intervention; involved a 12-module tailored website - each module used 15 to 20 screens with streaming audio, took 5 to 10min to complete, and included program interactions and a narrator ‘‘guide’’, also included online assessments, video, goal and self-monitoring tools; targeted behavior: dietary behaviors and physical activity; 89% retention	tailored website (n=364) vs. tailored website plus peer support (n=364) vs. waitlist control (n=343)
(Womble et al., 2004)	Nutrition/Diet; Physical Activity	47 overweight/obese women; mean age=44; 100% female; US setting	52-week commercial, web-based tailored weight loss intervention; involved access to an online commercial weight loss program that included tailored diet plans, customized grocery lists, animated fitness instructor, online social support, bi-weekly email newsletters and email reminders; targeted behaviors: dietary behaviors and level of physical activity; 66% retention	eDiets.com (n=23) or commercial tailored website vs. weight loss manual (n=24)

Study	Focus	Sample Characteristics	Intervention Characteristics	Conditions
(Woolf et al., 2006)	Nutrition/Diet; Physical Activity; Smoking; Alcoholism	273 adults; mean age= not reported; % female not reported; US setting	9-month web-based tailored health behavior intervention; the website was tailored based on users' health behaviors and readiness to change and included tailored health advice and customized links to resources; targeted behaviors: levels of physical activity, dietary behaviors, tobacco use, alcohol consumption; 29% retention rate	pre-post design

Table 3

Summary of Characteristics of the 40 Studies

Study Characteristic	*k*	%
Target Population		
General population	26	65
Children	7	18
Patients (diagnosed with condition)	6	15
Students	1	2
Total	40	100
Gender		
Female	5	12
Male	0	0
Both (mean proportion = 63% female)	35	88
Total	40	100
Behaviors		
Single Behavior	29	73
Multiple Behaviors	11	27
Total	40	100
Behaviors		
Physical Activity	23	42
Nutrition/Diet	14	25
Smoking/Tobacco	10	18
Drinking	5	9
Medication Adherence (Asthma management)	1	2
Stress Management	1	2
Fecal Soiling (Encopresis)	1	2
Total	55	100
Behavioral Theories		
Stages of Change/Transtheoretical Model	11	50
Social Cognitive Theory	8	36
Health Belief Model	6	27
Theory of Reasoned Action/Planned Behavior	3	14
Precaution Adoption Process Model	2	9
Social Comparison Theory	2	9
Decisional Balance	2	9
I-Change Model	1	5
Problem Behavior Model	1	5
Elaboration Likelihood Model	1	5
Goal Theory	1	5

Self-Determination Theory	1	5
Total	39	---

Note: *k* = number of studies. The behavioral theories sum to more than 100 because some studies used more than 1 theory.

Table 4

Sample Size-Weighted Effect Sizes by Participant/Descriptive Moderating Variables

Variable	*k*	*d*	95% CI	*p*	Q_B
Population Type					
General population	26	.181	[.148, .214]	***	
Children	7	-.007	[-.068, .054]	NS	
Patients	6	.140	[.037, .244]	*	***
Country of Sample					
United States	22	.182	[.141, .223]	***	
Non-US	18	.101	[.063, .139]	***	**
Gender					
Mixed samples	35	.140	[.111, .168]	***	
Female Samples	5	.102	[-.088, .292]	NS	NS
Single Vs. Multiple Behavior					
Single	30	.146	[.113, .180]	***	
Multiple	10	.121	[.070, .172]	***	NS
Single Behavior Studies					
Smoking/Tobacco	8	.152	[.110, .193]	***	
Nutrition/Diet	4	.223	[.118, .328]	***	
Physical Activity	12	.059	[-.020, .138]	NS	
Drinking	3	.081	[-.088, .251]	NS	NS

Note: *k* = number of studies, *d* = sample size-weighted mean effect size, CI = Confidence Interval, NS = non-significant.
*p<.05; **p<.01; ***p<.001

Table 5

Sample Size-Weighted Effect Sizes by Tailoring Strategies

Variable	*k*	*d*	95% CI	*p*	Q_B
No. of Tailoring Assessments[1]					
Baseline	11	.194	[.136, .252]	***	
Iterative	10	.140	[.098, .182]	***	NS
User Control					
Expert led	8	.159	[.070, .247]	***	
Self guided	32	.137	[.107, .166]	***	NS

Note: *k* = number of studies, *d* = sample size-weighted mean effect size, CI = Confidence Interval, NS = non-significant. [1]This variable was tested using the follow-up data (N=21) to allow enough time for baseline vs. iterative assessment to have an impact.
*p<.05; **p<.01; ***p<.001

Table 6

Sample Size-Weighted Effect Sizes by Methodological Moderating Variables

Variable	*k*	*d*	95% CI	*p*	Q_B
Study Design					
Randomized controlled trial	31	.159	[.127, .190]	***	
Quasi-experimental	9	.066	[.006, .126]	*	**
Comparison Condition					
No treatment control	18	.071	[.027, .115]	**	
Non-tailored website	18	.188	[.152, .225]	***	
Non-tailored print materials	4	.078	[-.107, .264]	NS	***

Note: *k* = number of studies, *d* = sample size-weighted mean effect size, CI = Confidence Interval, NS = non-significant.
*p<.05; **p<.01; ***p<.001

Appendix B: Figures

Figure 1. Summary of the selection process used in the meta-analysis.

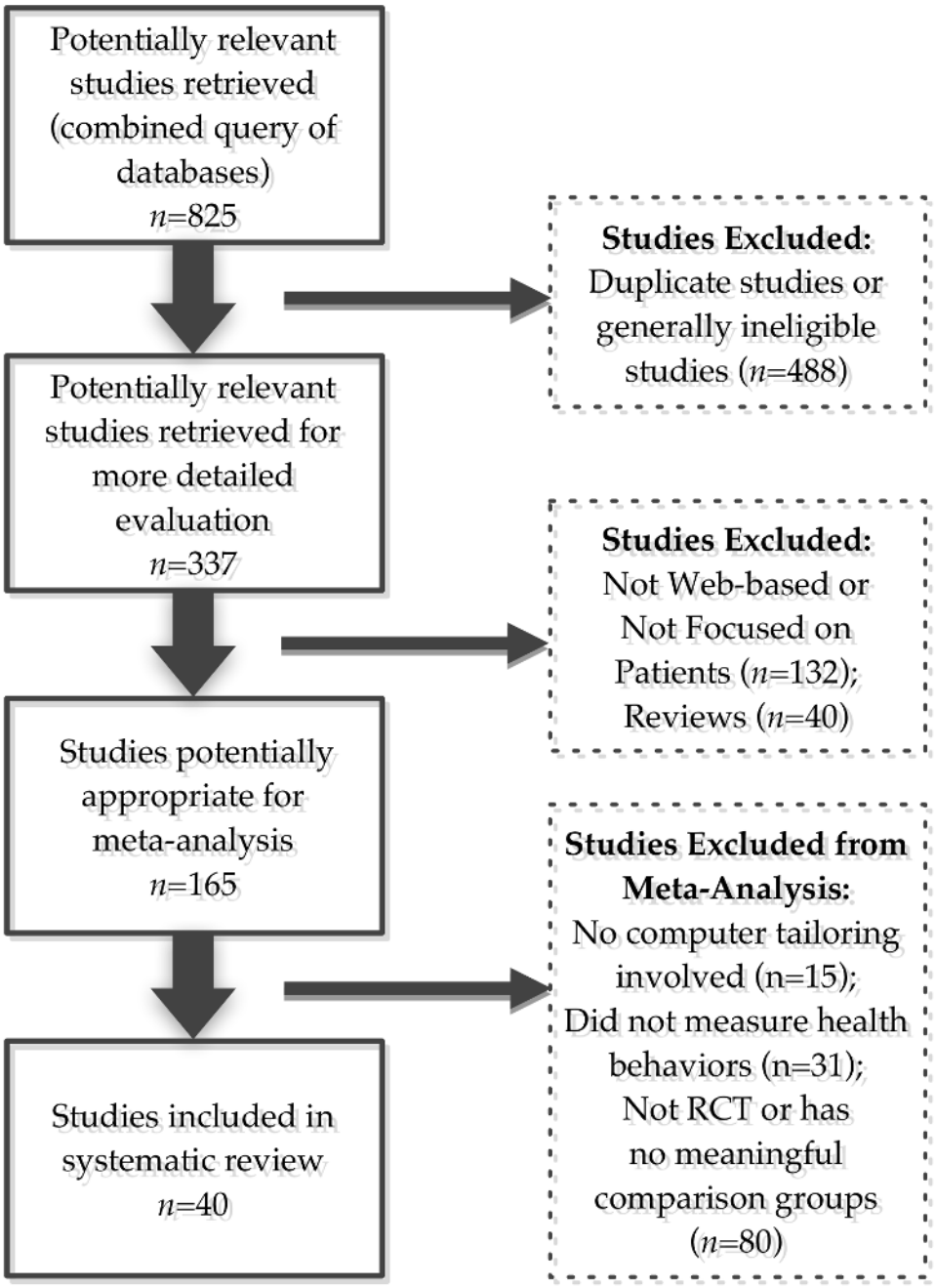

Figure 2. Forest plot displaying effect sizes and 95% confidence intervals for all 40 studies (short term effects).

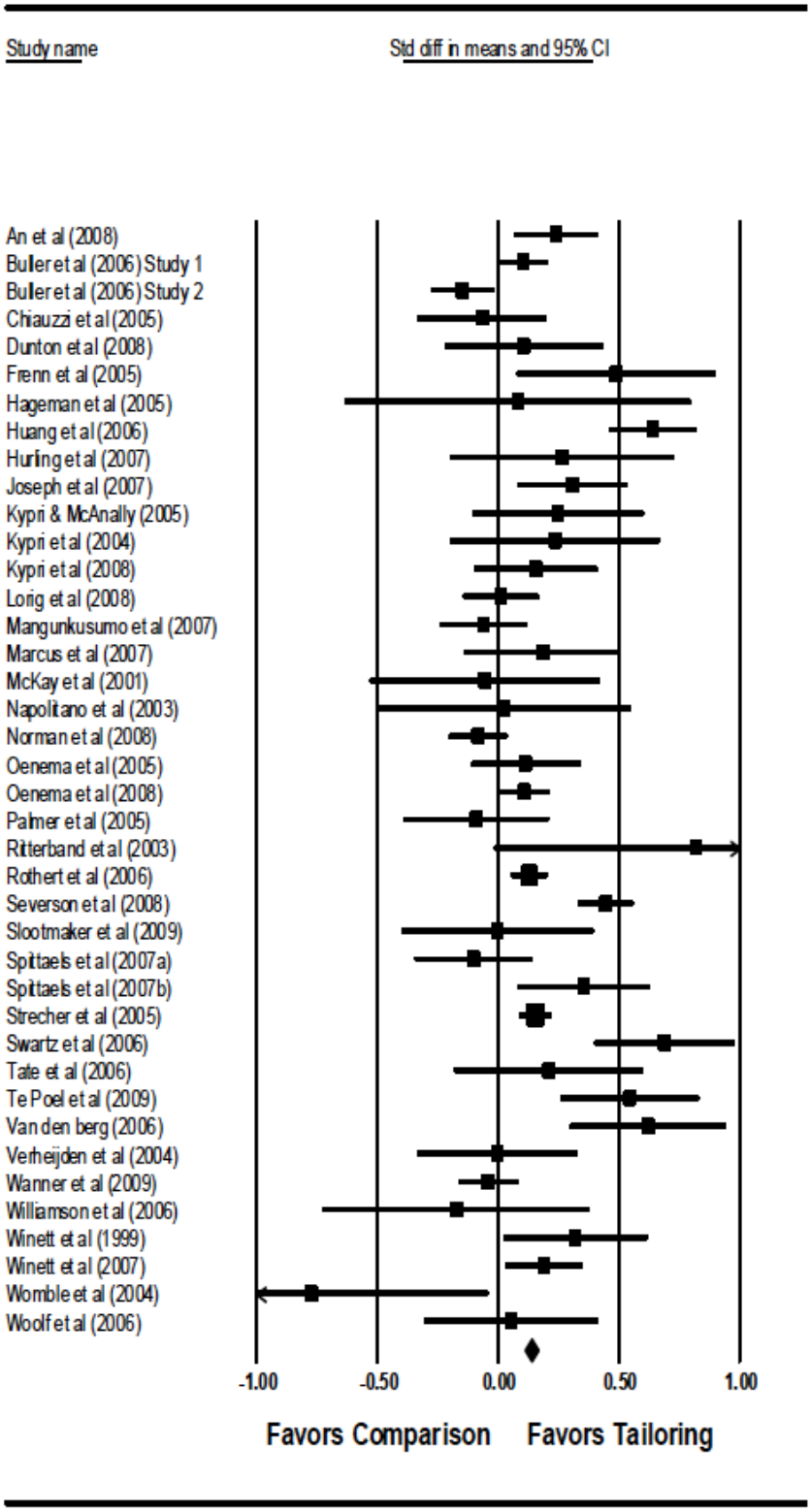

Figure 3. Forest plot displaying effect sizes and 95% confidence intervals for the 21 studies reporting long term effects.