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Review

A meta-analysis of computer-tailored interventions for health behavior change

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ABSTRACT

Objective. Computer-tailored interventions have become increasingly common for facilitating improvement in behaviors related to chronic disease and health promotion. A sufficient number of outcome studies from these interventions are now available to facilitate the quantitative analysis of effect sizes, permitting moderator analyses that were not possible with previous systematic reviews.

Method. The present study employs meta-analytic techniques to assess the mean effect for 88 computer-tailored interventions published between 1988 and 2009 focusing on four health behaviors: smoking cessation, physical activity, eating a healthy diet, and receiving regular mammography screening. Effect sizes were calculated using Hedges *g*. Study, tailoring, and demographic moderators were examined by analyzing between-group variance and meta-regression.

Results. Clinically and statistically significant overall effect sizes were found across each of the four behaviors. While effect sizes decreased after intervention completion, dynamically tailored interventions were found to have increased efficacy over time as compared with tailored interventions based on one assessment only. Study effects did not differ across communication channels nor decline when up to three behaviors were identified for intervention simultaneously.

Conclusion. This study demonstrates that computer-tailored interventions have the potential to improve health behaviors and suggests strategies that may lead to greater effectiveness of these techniques.

Contents

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Introduction

Health behaviors account for an estimated 60% of the risk associated with chronic illnesses such as diabetes, cardiovascular diseases, and some cancers (Institute of Medicine, 2001). With chronic illness responsible for the majority of deaths in the United States (Centers for Disease Control, 2008), effective strategies must be developed and disseminated for improving health-related behaviors on a population level. Computer-tailored interventions have become an increasingly common strategy for altering health risk behaviors such as tobacco use, poor diet, and lack of exercise that are linked to chronic disease. While early computer-tailored interventions relied largely on print materials as a communication channel, with more recent advances they can readily be provided via personal computer or even mobile phone, further reducing their cost and expanding their availability. Tailored messages are thought to foster behavior change by providing personally relevant feedback. For instance, a program could assess an individual's self-efficacy to quit smoking and suggest specific ways to increase confidence for dealing with the smoking cues they identified as most difficult.

As methods of computer tailoring have developed, numerous variations on the concept of tailoring have been employed in research trials, differing across number of contacts, communication channel, theory, number of contacts, and other intervention options. Such design decisions have usually been based on the assumption that each would contribute to the efficacy of an intervention, yet little research has compared these potential moderators of treatment efficacy across studies. These options have also led to confusion in distinguishing computer-tailored from computer-delivered interventions. While computer-delivery is a type of communication channel (such as printed letters), "computer-tailoring" is a method of assessing individuals and *selecting communication content* using data-driven decision rules that produce feedback automatically from a database of content elements. Computer tailoring is thus a form of tailored communications which involve a "combination of strategies and information intended to reach one specific person based on characteristics that are unique to that person, related to the outcome of interest, and derived from an individual assessment" (Kreuter and Skinner, 2000). This meta-analysis focuses on interventions that tailored feedback to individual users by means of computer algorithms, regardless of whether the feedback was delivered via print, telephone, or computer terminal.

Prior reviews of tailoring have drawbacks that limit their utility for advancing the effectiveness of this methodology. Reviews that focus solely on one behavior such as mammography (Sohl, 2007), smoking (Strecher, 1999), or nutrition (Brug et al., 1999) may confuse effects of computer-tailoring with behavior-specific findings. Those that examine a specific intervention medium such as interactive computer (Norman, 2007; Portnoy et al., 2008) or print (Noar et al., 2007) limit tailoring to a single communication channel. Finally, those that have not employed meta-analytic data analysis methods (Kroeze et al., 2006; Ryan and Lauver, 2002; Skinner et al., 1999; Strecher, 1999) succumb to the drawbacks of significance testing and are limited in their ability to analyze moderators. This study extends and builds upon the most comprehensive meta-analytic review to date (Noar et al., 2007) by examining both print and computer-delivered interventions, by modeling weighted group variance for statistical tests, and by systematically examining publication bias and study quality as is presently recommended (Lipsey and Wilson, 2001). Unlike past reviews, this meta-analysis also examines the effects of computer-tailored interventions across multiple outcome time points and examines the efficacy of employing dynamic tailoring (assessing intervention variables prior to each feedback) versus static tailoring (providing one baseline assessment on which to base all successive feedbacks), which are important analyses for informing future intervention design.

The present study accounts for these additional moderators and reports the efficacy of computer tailoring in facilitating health-related behavior change for smoking cessation, physical activity, healthy dietary practices, and regular mammography screening across multiple outcome time points. We hypothesize that non-engagement in each behavior as a participation criterion and comparison to assessment-only control groups will be related to larger effect sizes (Tunis et al., 2003). We also expect that studies completed outside of the United States (Noar et al., 2007), and those with lower study quality ratings (Moher et al., 1998) will show larger effects. Additionally, we expect that interventions provided for multiple behaviors simultaneously will show comparable effect sizes to those that concentrate on one behavior alone (Prochaska et al., 2008) and that dynamic tailoring will not differ from static tailoring (Heimendinger et al., 2005; Strecher et al., 2005). As demographic characteristics are often controlled for in randomization, we predict that age, gender, and minority representation will not be related to effect size.

Methods

Search strategy

A combination of search methods was used to locate all published and in-press studies that employed a tailored intervention. The electronic databases PsycInfo, PubMed, CINAHL, and the Cochrane library were searched for studies using following terms: "(tailor*) and (compute* OR feedback OR individualized)", "expert system", "e-health AND (tailor* OR feedback OR individualized)". Reference lists from published studies were examined, and authors were contacted for additional information. Electronic databases were then re-searched for articles published by authors previously identified to locate studies that may have employed similar techniques.

Selection criteria

The search was inclusive of studies published from 1988 (the year of the first tailored feedback study) to March 2009. Studies selected for analysis met the following criteria: a) were "computer-tailored" in that they used computers to choose individual feedback based on decision algorithms; b) provided the intervention primarily via communication channels that did not use live counselors; c) included a non-tailored comparison group; and d) reported sufficient statistical information to calculate effect size (e.g. means, standard deviations, odds ratios, t- and p-values). The final analysis included smoking cessation, physical activity, dietary practices, and mammography screening because the largest number of studies have been