

Systematic review of the effectiveness of health behavior interventions based on the transtheoretical model

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(Received 21 May 2003; in final form 11 November 2004)

Abstract

The Transtheoretical Model (TTM) has gained widespread popularity and acceptance, yet little is known about its effectiveness as a basis for health behavior intervention. A systematic review was conducted in order to evaluate the effectiveness of TTM interventions in facilitating health-related behavior change. Thirty-five electronic databases, catalogues, and internet resources were searched for relevant studies. In addition, the bibliographies of retrieved references were scanned for further relevant publications and authors were contacted for further information where necessary. Thirty-seven randomized controlled trials, targeting seven health-related behaviors, satisfied the inclusion criteria. Overall, the methodological quality of trials was variable, and there was limited evidence for the effectiveness of stage-based interventions as a basis for behavior change or for facilitating stage progression, irrespective of whether those interventions were compared with other types of intervention or with no intervention or usual care controls. The theoretical and practical implications of these findings are discussed.

Keywords: *Transtheoretical model, health behavior intervention, systematic review*

Introduction

Much of the mortality and morbidity in industrialized societies is due, in part, to individual patterns of behavior. Individuals contribute to their own health by avoiding health damaging behaviors such as smoking, and by adopting health enhancing behaviors such as taking regular physical exercise. Consequently, there has been much interest in reducing early mortality and preventing morbidity through developing interventions that enable lifestyle changes. Interventions used to modify risky behaviors have increasingly been based on stage theories, such as the Transtheoretical Model (TTM) (Prochaska & DiClemente,

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1983; Prochaska, DiClemente & Norcross, 1992), the Health Action Process Approach (Schwarzer, 1992) and the Precaution Adoption Process Model (Weinstein & Sandman, 1992).

Stage-based models of behavior change

Stage-based theories propose that behavior change is not a continuous process but something that occurs through a series of qualitatively different stages. The theories also propose that the barriers people face in trying to change their behavior will differ at different stages in the change process. These models consequently suggest that interventions will be most effective when they are tailored to an individual's current stage of change. The number of stages put forward varies between models, but they all distinguish between three broad categories of individual: (1) those who have not yet decided to change their behavior, (2) those who have decided to change, and (3) those who are already engaged in overt change.

The attraction of stage-based models lies not only in their intuitive and theoretical plausibility, but also in their apparent ability to explain why interventions aimed at large groups or the general public, such as mass media or community interventions, are rarely effective (Lichtenstein & Glasgow, 1992). They propose that 'tailored' interventions, which take into account the current stage which the individual has reached in the change process, will be more effective than 'one size fits all' interventions.

The TTM is the most widely used stage model and its theoretical framework has been applied to a range of different behaviors including smoking, exercise, and diet (Sutton, 1997). The model has gained widespread popularity among practitioners, clinicians and researchers and it is being used to guide intervention design and allocate treatment resources in several fields (Littell & Girvin, 2002).

The TTM separates individuals into five different stages: (1) *precontemplation* where there is no intention to change within the next 6 months, (2) *contemplation* where change is intended sometime in the future (usually defined as between 1 and 6 months), (3) *preparation* where change is intended in the immediate future (1 month) and steps are taken to help prepare for change, (4) *action* where the target behavior has been modified for less than 6 months, and finally (5) *maintenance* which is the stage characterized by temporally robust behavior change extending beyond 6 months. The first three stages are motivational, whilst the latter two stages are actional in nature. Progression through the stages is seen as sequential, though relapse to an earlier stage can occur.

In addition to identifying the five *stages* of change, the TTM proposes that there are ten *processes* of change (Prochaska, Velicer, DiClemente & Fava, 1988). These are activities in which people engage to overcome the barriers they encounter at particular stages, and thus progress toward their desired endstate. For example, finding out more about the effects of the behavior (consciousness raising), seeking support and help from others (helping relationships), or rewarding oneself for making changes (reinforcement management), are activities likely to be most beneficial with regard to forward movement from *precontemplation*, *contemplation*, and *action*, respectively. The theory thus proposes that the effectiveness of different processes of change will vary according to the individual's stage of readiness to change (Prochaska et al., 1992).

The TTM also involves a series of intermediate or outcome measures which are sensitive to progress through all stages (Velicer, Prochaska, Fava, Norman & Redding, 1998). These constructs include the pros and cons from the Decisional Balance Scale, Self-efficacy, or Temptation. The Decisional Balance construct reflects the relative weighing of the pros and cons of changing. The Self-efficacy construct represents the situation-specific

confidence people have in their ability to cope with high-risk situations without relapsing to their unhealthy or high-risk habit. This construct is represented either by a Temptation measure or a Self-efficacy measure, since both measures have the same structure (Velicer, DiClemente, Rossi & Prochaska, 1990). The Temptation/Self-efficacy measures are particularly sensitive to the changes that are involved in progress in the later stages and are good predictors of relapse (Velicer et al., 1998).

To summarize, the stages of change construct represents the central organizing construct of the TTM, processes of change are conceptualized as independent variables, whilst pros and cons, and self-efficacy and temptations are conceptualized in the model as intermediate dependent outcomes (DiClemente, 2003; Velicer et al., 1998).

Some reviews of the literature have suggested that stage-based interventions result ultimately in more behavior change than non-stage-based interventions (Prochaska, DiClemente, Velicer & Rossi, 1993; Campbell et al., 1994). More recent reviews, however, have suggested that there is little evidence regarding the effectiveness of this approach in changing health-related behavior (Bunton, Baldwin, Flynn & Whitelaw, 2000; Littell & Girvin, 2002). Whilst there are a number of reasons why stage-based interventions may sometimes lack effectiveness, three explanations have been dominant.

First, different types of evidence have been used not only to evaluate the model but also to develop arguments in literature reviews. For instance, whilst some research has utilized a randomized control trial (RCT) design, other research has not included a control group and much has been cross-sectional (Prochaska & Velicer, 1997). Clearly, different research designs offer different levels of evidence about effectiveness, yet this distinction is often neglected in reviews of the literature. Specifically, 'the literature highlights the tendency for supportive and critical contributions to be advanced on the basis of widely different types of evidence and that different levels of credibility are conferred to these' (Whitelaw, Baldwin, Bunton & Flynn, 2000, p. 712).

Two recent reviews of the effectiveness of the TTM for smoking cessation demonstrate the problematic nature of inferring effect on the basis of different levels of evidence. On one hand Spencer and colleagues (Spencer, Pagell, Hallion & Adams, 2002) concluded that there was strong evidence for the validity of the TTM as it applies to tobacco use, whilst, on the other hand, Riemsma and colleagues (Riemsma et al., 2003) concluded that only limited evidence exists. Close inspection of the evidence used in each review serves to elucidate this discrepancy. The Riemsma review identified 23 trials, all of which were RCTs, whilst the Spencer review identified 22 trials, 6 of which were included in the Riemsma review, with the remaining 16 studies employing less rigorous designs, such as cohort and case control studies. Cogent arguments concerning effectiveness should be drawn from systematic reviews of the best available evidence, which, in the case of interventions, derives from the RCT design.

Second, since there are fundamental differences between some health behaviors and the addictive behaviors upon which the model was originally formulated, a lack of evidence may be due to the fact that some behaviors are simply more suitable or amenable to stage-based intervention. For example, Orford (1992) has suggested that the TTM may be less applicable to alcohol and drug use than to smoking, whilst others have demonstrated the problematic nature of adopting a stage-based approach to dietary change interventions (Povey, Conner, Sparks, James & Shepherd, 1999). One might anticipate, therefore, that stage-based interventions would be more effective with some target behaviors than with others.

Third, it has been suggested that behavior change should not necessarily be the primary outcome of interest, rather proxy measures such as increases in knowledge and,

in particular, stage progression, are valid and accurate indicators of the model's effectiveness as a basis for intervention (Campbell et al., 1994; Cole, Leonard, Hammond & Fridinger, 1998). For these proponents, the effectiveness of the stages of change approach is demonstrated through forward stage movement, although for some it is a contentious issue that stage progression equates ultimately to behavior change (Clarke & Eves, 1997).

The present review

Although recent reviews have made observations on the nature of the evidence associated with stage models and TTM interventions in particular, they are limited to the extent that they fail to use systematic review methods, or focus upon a specific behavior. A systematic review was thus undertaken in order to draw together the evidence regarding the effectiveness of interventions based on the TTM for promoting health-behavior change.

The review had four specific aims: (1) to assess the methodological quality of interventions based on the TTM, (2) to determine whether TTM interventions are effective in promoting behavior change, (3) to examine whether some behaviors are more amenable to TTM interventions and, if necessary, to explore other potential sources of heterogeneity, and (4) to investigate whether TTM interventions are effective in facilitating stage progression. Answering these empirical questions allows the generalizability of findings to be assessed across different settings and different population groups, as well as enabling observations about effective and ineffective interventions to be made.

Method

A systematic review of the literature was undertaken following the NHS Centre for Reviews and Dissemination guidelines on Undertaking Systematic Reviews of Research on Effectiveness (NHS Centre for Reviews and Dissemination, 2001).

Search strategy

In order to identify relevant research, 35 electronic databases were searched from inception to May 2000, including PsychLit, Medline, and CINAHL. Key search terms included stage of change, transtheoretical model, processes of change, and readiness to change (full search strategies are available on request). In addition, searches of the Internet were carried out using a number of different search engines. The bibliographies of retrieved references were also scanned for further relevant publications, and the authors of abstracts appearing in conference proceedings were contacted for further information. Finally, specific attempts were made to identify gray or unpublished literature via an electronic database that records details of unpublished reports: System for Information on Grey Literature in Europe (SIGLE).

Selection criteria

Studies were eligible for inclusion if they were RCTs that evaluated the effectiveness of TTM interventions for any health behavior and which reported appropriate outcomes i.e., behavior change or stage movement. No language or date restrictions were applied.

Quality assessment

Each included trial was assessed against a comprehensive checklist for methodological quality (NHS Centre for Reviews and Dissemination, 2001). The checklist refers to 13 distinct items that assess for example, method of randomization, adequacy of concealment allocation, blinding of participants, baseline comparability of groups, and handling of drop-outs and missing data (intention-to-treat analysis). Quality assessment criteria reflect sources of potential bias and are commonly used as a basis for appraising the methodological quality of randomized trials (Bridle, 2003; Schulz, Chalmers, Hayes & Altman, 1995; Juni, Altman & Eggar, 2001).

In addition to the assessment of methodological quality, the quality of the implementation of the intervention was assessed according to five criteria: (1) whether stage of change was assessed at baseline, (2) whether the stages of change instrument was validated, (3) whether details of training for care providers/educators were reported, (4) whether any process evaluation was reported, and (5) whether the intervention was clearly and explicitly tailored to stage of change. Regarding this latter point, although studies were included in the review if authors stated that the intervention was based on the TTM, we made a separate assessment of the extent to which authors reported methodological details that described an intervention that was clearly and explicitly based on the TTM.

Procedure

Assessment of titles and abstracts was performed independently by two reviewers. If either reviewer considered a reference to be relevant, the full paper was retrieved. Full papers were assessed against the review selection criteria by two reviewers independently. Data were extracted by one reviewer into structured summary tables and checked by a second reviewer. Extracted data¹ included intervention details, participant characteristics, and both primary (behavioral) and secondary (stage movement) outcomes.

Synthesis

Studies should be combined statistically only to the extent that they are sufficiently similar so as to produce a meaningful combined estimate of the intervention effect. We assessed the degree of heterogeneity between studies along three dimensions: (1) clinical, which refers to differences in the studies concerning the participants, interventions and outcomes (e.g., study setting, age, sex, intervention intensity, definition of outcomes, etc.), (2) methodological, which refers to differences between studies in how they were conducted (e.g., study design, unit of randomization, study quality, method of analysis, etc.), and (3) statistical, which refers to variation between studies in the measured intervention effect. If there is reason to believe that any clinical or methodological differences may influence the size or direction of the intervention effect, it may not be appropriate to pool studies statistically. Similarly, it is usually inappropriate to calculate an average effect if there is a large amount of statistical heterogeneity between studies. The studies were judged to be too heterogeneous to carry out a formal statistical pooling, and therefore a qualitative synthesis was undertaken with studies being grouped and discussed according to their targeted health behavior.

¹Download data extraction tables: <http://science.uwe.ac.uk/StaffPages/CB/TTMAAppendix.PDF>

Results

The search strategy generated 2168 references of possible relevance. Once titles, and where available, abstracts were assessed, hard copies of 516 papers were retrieved and examined in detail. Thirty-seven RCTs met the criteria for inclusion. The trials focused on seven target behaviors: smoking cessation, physical activity, dietary change, multiple lifestyle changes, screening mammography, treatment adherence in the context of mental illness, and preventing the uptake of unhealthy behaviors such as smoking and alcohol use. Table I gives details of trials falling under the rubric of each behavior.

Study quality

Methodological quality of the trials was variable (Table I). Of the 13 individual quality items assessed, the number satisfied by each study ranged from 2 to 11. The main problems were lack of detail about the methods used to produce true randomization, lack of blinding of participants, outcome assessors and care providers (where appropriate), and failure to use intention-to-treat analysis.

Scores on the quality of the implementation assessment ranged from 2 to 5. The main issue related to lack of information about the validity of instruments used to assess stage of change. Twelve out of the 37 RCTs evaluating stage-based interventions reported some detail about the validation of the instrument used to assess stage-of-change. In 2 of these 12 studies the authors reported their own validation of the instrument (Aveyard *et al.*, 1999; Havas *et al.*, 1998). In the other ten trials, four instruments were used to assess the stage of change: Cardinal's 5-item ordered categorical scale (Cardinal & Sachs, 1996; Cash, 1997), the exercise Stages of Change instrument developed by Marcus and colleagues (Goldstein *et al.*, 1999; Braatz *et al.*, 1999; Peterson & Aldana, 1999; Steptoe, Doherty, Rink & Kerry, 1999; Scales, 1998), Biener's contemplation ladder (Lennox *et al.*, 1998), and the University of Rhode Island Change Assessment (URICA) (DiClemente *et al.*, 1991; Swanson, Pantalon & Cohen, 1999).

Evidence of effectiveness

Intervention effects were classified as either positive (mainly significant outcomes in favor of the stage-based intervention), no significant differences between groups, negative (where the intervention performed worse than the control), or inconclusive. Intervention effects were classified as inconclusive for three reasons. First, some trials measured multiple outcomes, some of which were positively influenced by the intervention, whilst others were not (Butler *et al.*, 1999; Lutz, 1996; Werch, Pappas, Carlson & DiClemente, 1996; Gritz, Thompson, Emmons & Ockene, 1998). Second, some trials examined the effectiveness of more than one stage-based intervention, and the direction of the effects of these interventions differed (Brug, Glanz, Van Assema, Kok & Van Breukelen, 1998; Cardinal & Sachs, 1996; Woollard *et al.*, 1995). Third, in one trial participants were assessed at a 12 week and one year follow-up; at 12 weeks some significant effects of the interventions were recorded but at one year follow-up differences were no longer significant (Harland *et al.*, 1999). In each case, whether multiple outcomes, multiple interventions, or multiple assessments, there was no clear evidence regarding the effectiveness of stage-based interventions, and hence, they were classified as inconclusive.

As Table II shows, 35 of the 37 included trials reported outcomes comparing a stage-based intervention with a non-stage-based intervention or a no intervention control. One trial

only compared stage-based interventions (Velicer, Prochaska, Fava, Laforge & Rossi, 1999), whilst another failed to report behavioral outcome data (Braatz et al., 1999). Overall, the 35 trials reported behavioral data on 42 comparisons, of which 11 favored TTM interventions, 20 showed no difference between the intervention and control groups, and 11 comparisons were inconclusive.

Of the 20 trials that compared a TTM intervention with a non-stage-based intervention, five reported statistically significant effects in favor of the TTM intervention, 5 reported mixed effects and 10 reported no statistically significant differences between groups. Of the 22 trials that compared a TTM intervention with a no-intervention or usual care control, six reported statistically significant effects in favor of the TTM intervention, 6 reported mixed effects, and ten reported no statistically significant differences between groups. Overall, there is limited evidence that interventions based on the TTM are more effective in changing behavior when compared with either non-stage-based interventions or even with no intervention or usual care.

Smoking cessation

Thirteen trials focused on smoking cessation, though only 12 trials compared a stage-based intervention with a non-stage-based intervention or usual care control. The 12 trials reported data on 14 comparisons. Overall, four comparisons favored the stage-based intervention, three of which were compared with usual care. Two comparisons were inconclusive, both of which were compared with a non-stage-based intervention, and eight comparisons showed no difference between groups, of which three were compared with usual care.

Physical activity

Seven trials focused on promoting physical activity, though one trial did not report data on behavioral outcomes. The six remaining trials reported behavioral data for eight comparisons. In only one trial did the effect favor the stage-based intervention compared to usual care. Three comparisons were inconclusive, two of which were compared with usual care. Four comparisons showed no difference between groups, of which three were compared with usual care.

Dietary change

Five intervention trials, reporting six comparisons, attempted to promote dietary change. Two comparisons favored the stage-based intervention, one of which was compared to a non-stage-based intervention, and the other was compared to usual care. Similarly two comparisons were inconclusive, one of which was compared with usual care, and the remaining two comparisons showed no differences when compared with non-stage-based intervention and usual care.

Multiple lifestyle changes

Six intervention trials, reporting seven comparisons, attempted to promote multiple lifestyle changes. One comparison favored the stage-based intervention compared to a non-stage-based intervention. Three comparisons were inconclusive, two of which were compared

Table I. Methodological quality.

| Target Behavior × Study | Blinding of | | | | | | | | | | | | | | |
|--|--------------------------|---------------|---------------------------|--------------|-------------------|----------------|------------------------|-------------------------------------|---------------------------|--------------------|---------------------------------|--------------------------------|------------------------------------|-------------------------|-------------------------|
| | Methodological quality † | Randomization | Concealment of allocation | Participants | Outcome assessors | Care providers | Baseline comparability | Adjustment for baseline differences | Completeness of follow-up | Inclusion criteria | Point estimates and variability | Drop-outs (intention-to-treat) | Description of statistical methods | Sample size calculation | Treatment comparability |
| <i>Smoking cessation</i> | | | | | | | | | | | | | | | |
| Butler et al., 1999 | 9/13 | Yes | Yes | N/S | Yes | No | Yes | N/A | No | Yes | Yes | Yes | Yes | Yes | No |
| Lennox et al., 1998 | 8/13 | N/S | Yes | Yes | N/S | No | No | Yes | No | Yes | Yes | No | Yes | Yes | Yes |
| Resnicow, Royce, Vaughan & Orlandi, 1997 | 7/13 | N/S | N/S | N/S | N/S | No | No | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes |
| Dijkstra, DeVries & Roijackers, 1999 | 6/11 | N/S | N/S | N/A | N/S | N/A | No | Yes | Yes | Yes | No | Yes | Yes | N/S | Yes |
| Pallonen et al, 1998 | 6/12 | Yes | N/S | N/S | N/S | N/A | Yes | N/A | No | Yes | Yes | No | Yes | N/S | Yes |
| Wang, 1994 | 6/13 | N/S | N/S | N/S | N/S | No | Yes | N/A | Yes | Yes | Yes | N/S | Yes | N/S | Yes |
| DiClemente et al., 1991 | 5/13 | Yes | N/S | N/S | N/S | No | No | No | Yes | Yes | No | No | Yes | No | Yes |
| Morgan et al., 1996 | 5/13 | N/S | N/S | N/S | N/S | No | No | No | Yes | Yes | No | Yes | Yes | N/S | Yes |
| Velicer et al., 1999 | 4/12 | N/S | N/S | N/S | N/S | N/A | Yes | N/A | No | Yes | No | No | Yes | N/S | Yes |
| Berman, Gritz, Braxton-Owens & Nisenbaum, 1995 | 4/13 | Yes | N/S | N/S | N/S | No | N/S | N/S | No | Yes | No | No | Yes | N/S | Yes |
| Gritz et al. 1993 | 3/13 | N/S | N/S | N/S | N/S | No | N/S | No | No | Yes | No | Yes | Yes | N/S | No |
| Sinclair, Silcock, Bond, Lennox & Winfield, 1999 | 3/13 | N/S | N/S | N/S | N/S | No | N/S | N/S | Yes | Yes | No | N/S | N/S | N/S | Yes |
| Pallonen et al., 1994 | 2/12 | N/S | N/S | N/A | N/S | No | N/S | N/S | No | Yes | No | No | Yes | No | No |
| <i>Physical activity</i> | | | | | | | | | | | | | | | |
| Harland et al., 1999 | 11/12 | Yes | Yes | N/A | Yes | No | Yes | N/A | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Cardinal and Sachs, 1996 | 6/12 | N/S | N/S | N/S | N/S | N/A | Yes | N/A | No | Yes | Yes | Yes | Yes | N/S | Yes |
| Cash, 1997 | 6/12 | N/S | N/S | N/A | N/S | No | Yes | N/A | Yes | Yes | Yes | No | Yes | N/S | Yes |
| Goldstein et al., 1999 | 5/13 | N/S | N/S | N/S | N/S | No | Yes | N/A | Yes | Yes | Yes | N/S | Yes | N/S | No |

| | | | | | | | | | | | | | | | |
|---|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Braatz et al., 1999 | 5/13 | N/S | N/S | N/S | N/S | No | No | Yes | Yes | Yes | Yes | No | Yes | N/S | No |
| Graham-Clarke and Oldenberg, 1994 | 5/13 | N/S | N/S | N/S | N/S | No | No | Yes | No | Yes | Yes | N/S | Yes | N/S | Yes |
| Peterson and Aldana, 1999 | 3/11 | N/S | N/S | N/A | N/S | N/A | N/S | N/S | No | N/S | Yes | No | Yes | No | Yes |
| <i>Dietary change</i> | | | | | | | | | | | | | | | |
| Lutz, 1996 | 9/12 | Yes | N/S | N/A | N/S | N/A | Yes | N/A | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Brug et al., 1998 | 7/13 | N/S | N/S | N/S | N/S | No | Yes | N/A | Yes | N/S | Yes | Yes | Yes | Yes | Yes |
| Havas et al., 1998 | 7/13 | Yes | N/S | N/S | N/S | No | N/S | Yes | No | Yes | No | Yes | Yes | Yes | Yes |
| Kristal, Glanz, Tilley & Li, 2000 | 3/12 | N/S | N/S | N/A | N/S | No | No | No | No | N/S | No | No | Yes | Yes | Yes |
| Baker and Wardle, 1999 | 3/12 | N/S | N/S | N/A | N/S | No | Yes | N/A | Yes | N/S | N/S | N/S | N/S | N/S | Yes |
| <i>Multiple changes</i> | | | | | | | | | | | | | | | |
| Scales, 1998 | 8/13 | Yes | Yes | No | N/S | No | Yes | N/A | Yes | Yes | Yes | Yes | Yes | N/S | No |
| Step toe et al., 1999 | 7/13 | Yes | N/S | N/S | N/S | No | Yes | N/A | No | Yes | Yes | No | Yes | Yes | Yes |
| Glasgow, Terborg, Hollis, Severson & Boles, 1995 | 6/12 | N/S | N/S | N/A | N/S | No | Yes | N/A | No | Yes | Yes | No | Yes | Yes | Yes |
| Gritz et al., 1998 | 5/12 | N/S | N/S | N/A | N/S | No | N/S | N/S | No | Yes | Yes | No | Yes | Yes | Yes |
| Woollard et al., 1995 | 5/13 | N/S | N/S | N/S | N/S | No | N/S | N/S | Yes | Yes | Yes | N/S | Yes | N/S | Yes |
| Oliansky, Wildenhaus, Manlove, Arnold & Schoener, 1997 | 4/13 | Yes | N/S | N/S | N/S | No | N/S | N/S | No | Yes | No | No | Yes | N/S | Yes |
| <i>Screening</i> | | | | | | | | | | | | | | | |
| Rakowski et al., 1998 | 6/12 | Yes | Yes | N/A | Yes | No | N/S | N/S | No | Yes | No | No | Yes | No | Yes |
| Crane et al., 1998 | 4/13 | N/S | N/S | N/S | N/S | No | No | Yes | No | Yes | No | No | Yes | N/S | Yes |
| <i>Treatment adherence</i> | | | | | | | | | | | | | | | |
| Swanson, Pantalon & Cohen, 1999 | 6/13 | Yes | N/S | N/S | N/S | No | Yes | N/A | Yes | Yes | No | N/S | Yes | N/S | Yes |
| <i>Prevention</i> | | | | | | | | | | | | | | | |
| Aveyard et al., 1999 | 9/13 | Yes | N/S | N/S | N/S | No | Yes | N/A | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Werch, Pappas, Carlson, & DiClemente, 1999 | 7/13 | Yes | N/S | N/S | N/S | No | Yes | N/A | No | Yes | Yes | Yes | Yes | N/S | Yes |
| Werch et al., 1996 | 6/12 | Yes | N/S | N/A | N/S | No | Yes | N/A | Yes | N/S | No | Yes | Yes | N/S | Yes |

† The maximum score for the 13 methodological quality items is 11 or 12 if 'blinding of care providers' and/or 'blinding of participants' is not applicable.

N/S: Not stated; N/A: Not applicable.

Table II. Behavior change results.

| Study details by target behavior | Comparator | | | | | |
|-----------------------------------|-----------------|----------|-----------|-----------------|----------|-----------|
| | Non-stage-based | | | No intervention | | |
| | ++ | +/- | - | ++ | +/- | - |
| <i>Smoking cessation</i> | 1 | 2 | 5 | 3 | 0 | 3 |
| Butler et al., 1999 | | ✓ | | | | |
| Lennox et al., 1998 | | | ✓ | | | |
| Resnicow et al., 1997 | | | ✓ | | | |
| Dijkstra et al., 1999 | | | ✓ | | | ✓ |
| Pallonen et al., 1998 | | | ✓ | | | |
| Wang, 1994 | | ✓ | | ✓ | | |
| DiClemente et al., 1991 | ✓ | | | | | |
| Morgan et al., 1996 | | | | ✓ | | |
| Velicer et al., 1999 | | | | | | |
| Berman et al., 1995 | | | ✓ | | | |
| Gritz et al., 1993 | | | | | | ✓ |
| Sinclair et al., 1999 | | | | | | ✓ |
| Pallonen et al., 1994 | | | | ✓ | | |
| <i>Physical exercise</i> | 0 | 1 | 1 | 1 | 2 | 3 |
| Harland et al., 1999 | | | | | ✓ | |
| Cardinal and Sachs, 1996 | | | | | ✓ | |
| Cash, 1997 | | | ✓ | | | ✓ |
| Goldstein et al., 1999 | | | | | | ✓ |
| Braatz et al., 1999 | | | | | | |
| Graham-Clarke and Oldenburg, 1994 | | | | | | ✓ |
| Peterson and Aldana, 1999 | | ✓ | | ✓ | | |
| <i>Dietary change</i> | 1 | 1 | 1 | 1 | 1 | 1 |
| Lutz, 1996 | | | ✓ | | ✓ | |
| Brug et al., 1998 | | ✓ | | | | |
| Havas et al., 1998 | ✓ | | | | | |
| Kristal et al., 2000 | | | | | | ✓ |
| Baker and Wardle, 1999 | | | | ✓ | | |
| <i>Multiple lifestyle changes</i> | 1 | 1 | 1 | 0 | 2 | 2 |
| Scales, 1998 | | | ✓ | | | |
| Steptoe et al., 1999 | ✓ | | | | | |
| Glasgow et al., 1995 | | | | | | ✓ |
| Gritz et al., 1998 | | ✓ | | | ✓ | |
| Woollard et al., 1995 | | | | | ✓ | |
| Oliansky et al., 1997 | | | | | | ✓ |
| <i>Mammography screening</i> | 1 | 0 | 0 | 1 | 0 | 1 |
| Crane et al., 1998 | | | | | | ✓ |
| Rakowski et al., 1998 | ✓ | | | ✓ | | |
| <i>Treatment adherence</i> | 1 | 0 | 0 | 0 | 0 | 0 |
| Swanson et al., 1999 | ✓ | | | | | |
| <i>Prevention</i> | 0 | 0 | 2 | 0 | 1 | 0 |
| Aveyard et al., 1999 | | | ✓ | | | |
| Werch et al., 1996 | | | | | ✓ | |
| Werch et al., 1999 | | | ✓ | | | |
| <i>All interventions</i> | 5 | 5 | 10 | 6 | 6 | 10 |

++: Mainly significant outcomes in favor of the stage-based intervention.

+/-: Mixed outcomes.

--: No significant differences between groups.

with usual care. Similarly, three comparisons showed no differences between groups, two of which were compared with usual care.

Screening mammography

Two trials, reporting three comparisons, attempted to promote screening mammography. Two comparisons in one trial both favored the stage-based intervention when compared with a non-stage-based intervention and with usual care. The remaining comparison showed no difference between the stage-based intervention and the usual care control.

Treatment adherence

The one trial aimed at the promotion of treatment adherence among psychiatric and dually diagnosed patients, found statistically significant results in favor of the stage-based intervention when compared with a non-stage-based intervention.

Prevention

Three trials, reporting three comparisons, attempted to prevent the uptake of unhealthy behaviors; smoking and alcohol consumption among school-aged adolescents. None of the comparisons showed effects favoring the stage-based intervention. One comparison was inconclusive when compared with usual care, and two comparisons showed no differences between groups when compared with a non-stage-based intervention.

Potential sources of heterogeneity

As can be seen from Table II, there was no evidence to suggest that intervention effect was influenced by the type of behavior being targeted. Regarding smoking cessation, for example, overall four comparisons revealed effects favoring the TTM intervention, two were mixed or inconclusive, and eight comparisons revealed no difference between the intervention and control groups. The remaining behaviors demonstrate a similarly mixed pattern of results regarding the effectiveness of TTM interventions, irrespective of the type of comparator.

Additional potential sources of effect heterogeneity were investigated by comparing trials reporting positive effects with the remaining trials. These included methodological quality, sample size, participant characteristics, year of publication, intervention setting, and type of outcome measure. As can be seen from Table III, no clear source of heterogeneity can be identified. However, it should be borne in mind that with so few studies and comparisons in each category, interpretation is not only difficult but that potential sources of heterogeneity are likely to remain hidden even if they exist.

Stage movement

Fifteen out of the 37 included trials reported data on stage movement for 18 comparisons (Table IV). Overall, six comparisons favored the stage-based intervention, seven showed no difference between groups, and five were inconclusive. When stage based interventions were compared to non-stage-based interventions, three comparisons favored the stage-based intervention, one was inconclusive, and four showed no difference. Similarly, when

Table III. Study differences related to effectiveness.

| Study difference | N | Comparator | | | | | | | | |
|-------------------------|----|-----------------|-----|----|-----------------|-----|----|-----------------|-----|----|
| | | Non-stage-based | | | No intervention | | | All comparators | | |
| | | ++ | +/- | -- | ++ | +/- | -- | ++ | +/- | -- |
| <i>Quality</i> | | | | | | | | | | |
| <4 | 6 | 0 | 1 | 0 | 3 | 0 | 3 | 0 | 4 | 3 |
| 4-7 | 25 | 5 | 3 | 6 | 3 | 4 | 7 | 8 | 7 | 13 |
| >7 | 6 | 0 | 1 | 4 | 0 | 2 | 0 | 0 | 2 | 4 |
| <i>Sample size</i> | | | | | | | | | | |
| <100 | 4 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 2 |
| 100-500 | 10 | 1 | 0 | 3 | 1 | 2 | 3 | 2 | 2 | 6 |
| 500-1000 | 12 | 1 | 3 | 3 | 3 | 3 | 3 | 4 | 6 | 6 |
| >1000 | 11 | 3 | 1 | 3 | 1 | 1 | 3 | 4 | 2 | 6 |
| <i>Publication year</i> | | | | | | | | | | |
| <1995 | 5 | 1 | 1 | 0 | 2 | 0 | 2 | 3 | 1 | 2 |
| 1995-1998 | 18 | 2 | 2 | 7 | 2 | 5 | 4 | 4 | 7 | 11 |
| >1998 | 14 | 2 | 2 | 3 | 2 | 1 | 4 | 4 | 3 | 5 |
| <i>Setting</i> | | | | | | | | | | |
| Community | 13 | 4 | 1 | 5 | 2 | 1 | 2 | 6 | 2 | 7 |
| Clinic | 12 | 1 | 2 | 1 | 2 | 2 | 5 | 3 | 4 | 6 |
| Workplace | 7 | 0 | 2 | 1 | 1 | 2 | 3 | 1 | 2 | 4 |
| School | 4 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 1 | 3 |
| Home | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| <i>Age (mean)</i> | | | | | | | | | | |
| <30 years | 6 | 1 | 0 | 3 | 0 | 1 | 1 | 1 | 1 | 4 |
| 30-60 years | 19 | 3 | 3 | 5 | 2 | 4 | 5 | 5 | 7 | 10 |
| >60 years | 5 | 0 | 0 | 1 | 1 | 0 | 2 | 1 | 0 | 3 |
| <i>Participant type</i> | | | | | | | | | | |
| Patients | 8 | 2 | 0 | 1 | 0 | 1 | 4 | 2 | 1 | 5 |
| Low income | 5 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 4 |
| Volunteers | 3 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 2 |
| <i>Sex</i> | | | | | | | | | | |
| >60% female | 12 | 3 | 3 | 3 | 2 | 2 | 3 | 5 | 5 | 6 |
| >60% male | 9 | 1 | 2 | 2 | 2 | 1 | 3 | 3 | 3 | 5 |
| <i>Measurement type</i> | | | | | | | | | | |
| Self-report | 29 | 2 | 5 | 8 | 5 | 4 | 9 | 7 | 9 | 17 |
| Objective measures | 5 | 2 | 0 | 1 | 1 | 1 | 1 | 3 | 1 | 2 |
| Self + objective | 3 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |

++: Mainly significant outcomes in favor of the stage-based intervention(s).

+/-: Mixed outcomes.

--: No significant differences between groups.

stage-based interventions were compared to no intervention controls, three favored the stage-based intervention, four were inconclusive, and three showed no difference.

Discussion

The aims of this review were: (1) to evaluate the methodological quality of interventions based on the TTM, (2) to determine whether TTM interventions were effective in promoting health behavior change, (3) to examine whether some behaviors are more suitable for TTM interventions, and (4) to investigate whether TTM interventions were more effective in bringing about forward stage movement.

Table IV. Stage movement results.

| Study | Comparator | | | | | |
|---------------------------|-----------------|----------|----------|-----------------|----------|----------|
| | Non-stage-based | | | No intervention | | |
| | ++ | +/- | -- | ++ | +/- | -- |
| Aveyard et al., 1999 | | | ✓ | | | |
| Braatz et al., 1999 | | | | ✓ | | |
| Butler et al., 1999 | ✓ | | | | | |
| Cardinal and Sachs, 1996 | | | | | | ✓ |
| Crane et al., 1998 | | | | | | ✓ |
| Dijkstra et al., 1999 | | ✓ | | | ✓ | |
| Glasgow et al., 1995 | | | | | | ✓ |
| Goldstein et al., 1999 | | | | | ✓ | |
| Havas et al., 1998 | ✓ | | | | | |
| Kristal et al., 2000 | | | | ✓ | | |
| Lennox et al., 1998 | | | ✓ | | | |
| Lutz, 1996 | | | ✓ | | ✓ | |
| Pallonen et al., 1998 | | | ✓ | | | |
| Pallonen et al., 1994 | | | | | ✓ | |
| Peterson and Aldana, 1999 | ✓ | | | ✓ | | |
| <i>All interventions</i> | 3 | 1 | 4 | 3 | 4 | 3 |

++: Mainly significant outcomes in favor of the stage-based intervention.

+/-: Mixed outcomes.

--: No significant differences between groups.

Regarding the first aim, the methodological quality of studies was mixed, with a number of common limitations, particularly those relating to randomization, blinding, and data analysis. Concerning the second aim, there was only limited evidence for the effectiveness of interventions based on the TTM. Specifically, in only 11 comparisons did the effects favor the TTM intervention, 20 comparisons yielded no differences between groups, and in 11 comparisons the effects of the intervention were inconclusive. Furthermore, the type of comparator seemed not to influence effectiveness.

Third, there was no evidence to support the claim that the effectiveness of TTM interventions is influenced by the behavior being targeted. Whilst it is recognized that there were differing amounts of evidence for the different behaviors examined, there was no evidence of a more positive relationship between a specific behavior and intervention effectiveness.

Finally, there was little evidence to support the proposition that TTM interventions would be more effective in promoting stage progression, and this holds true when compared to other types of intervention as well as to no intervention or usual care. In particular, of the 18 comparisons made, only six reported significantly more forward stage movement for the TTM intervention, whilst seven comparisons found no difference, three of which were compared with usual care or no intervention controls.

Despite the widespread popularity of the stage-based approach to behavior change in both practice and research, the findings of this systematic review suggest that more caution is necessary. Not only was the methodological quality of research variable, and in some cases poor, but across a range of health behaviors there was only limited evidence for the effectiveness of interventions based on the TTM. This was irrespective of whether *effectiveness* was assessed as behavior change or stage progression, and irrespective of whether those interventions were compared with other types of intervention, or with no intervention, or usual care controls.

Although the results of this review have been interpreted as demonstrating a lack of evidence for the effectiveness of TTM interventions, another interpretation exists. Under the null hypothesis that there is no difference in effectiveness between TTM interventions and, for example, non-stage-based interventions, one would expect to find approximately 5 in 100 trials reporting statistically significant differences at the $p < 0.05$ level, with about half favoring TTM interventions and the other half favoring other interventions. However, of the 20 trials that compared a TTM intervention with a non-stage-based intervention, five reported effects favoring the TTM intervention whilst none reported significant results in the other direction. That five statistically significant positive results were obtained purely by chance seems unlikely.

It is important to note that TTM interventions are generally more intensive and more personalized than the conditions to which control participants are exposed, and it may thus be intervention intensity, rather than the TTM intervention, that explains why more studies than expected by chance showed favorable TTM effects. Better reporting of TTM interventions and, in particular, the design of more comparable control conditions, would help to determine the extent to which effective TTM interventions are a product of intervention content rather than intervention contact.

Our interpretation of the results as showing a lack of evidence for the effectiveness of TTM interventions is also pragmatically driven. It is reasonable to suggest that for a health intervention to be described as effective, one would expect positive effects to be reported in more than one in four trials or, in the absence of more favorable results, that sources of heterogeneity would be easily identifiable. Since approximately three quarters of all trials failed to report positive effects favoring TTM interventions, and since a clear source of heterogeneity was lacking, our interpretation of the results as showing a lack of evidence seems appropriate.

Two distinct but inter-related issues may contribute to the lack of evidence regarding the effectiveness of interventions based on the TTM: (1) lack of model specification and (2) poor application. Regarding the former: although a central proposition of the model is that stage-specific processes of change enable people to overcome stage-specific barriers to change, the model fails to specify precisely the processes that relate to particular stages. Instead, a more general heuristic is offered in terms of experiential and behavioral processes of change being more influential in the earlier and later stages, respectively (Velicer et al., 1998). Contrary to a hypothesis concerning stage-specific processes of change, baseline measures of change processes have failed to be predictive of subsequent stage progression (Herzog, Abrams, Emmons, Linnan & Shadel, 1999), and discontinuity patterns in the differential use of processes across stages has not been detected (Armitage & Arden, 2002).

The theoretical specification underlying the TTM not only fails to make precise predictions about the processes involved in overcoming the barriers to stage progression, but also the nature of the barriers themselves. For example, although 'consciousness raising' is an experiential process of change that should inform intervention design, there is no theory-driven specification concerning the target of this consciousness raising, which could include the health risk, normative actions, precaution options, family responsibility, self-efficacy, or any other potentially important target.

At a conceptual level, it has been argued that the evidence is more consistent with continuous models of change than with models that conceptualize behavior change in terms of discrete stages (Sutton, 1996; Bandura, 1998; Weinstein, Rothman & Sutton, 1998). For example, there is evidence that people are *simultaneously involved* in multiple, and

sometimes non-adjacent, stages (Littell & Girvin, 2002), which clearly is inconsistent with a stage-based conceptualization of behavior change.

A lack of model specification may have contributed to the design of inappropriate interventions. For example, many of the studies included in this review reported interventions that were tailored only to stage of change and neglected other important components such as the processes of change, decisional balance, and self-efficacy. Partial rather than full intervention tailoring may reflect a more general confusion in the way in which stages of change is conceptualized. Whilst stages of change is conceptualized as the central organizing construct of the model, in the context of intervention it is often treated as if it were a theory in and of itself. For example, many of the studies reviewed only used the single variable of *stage* in the design, delivery and assessment of the TTM intervention and in so doing reduced a theory to a single variable. The stages of change construct is a variable, not a theory, and it is unclear why some researchers would assume that a variable could facilitate consistent intervention effects. Many of the studies included in this review are, therefore, conceptually flawed as they are characterized by variable-driven rather than theory-driven interventions.

Although a lack of evidence for effectiveness may reflect incomplete intervention content, it may also reflect a more general inappropriate intervention delivery. For example, a theory-driven intervention derived from a stage theory of behavior change should incorporate several key elements. It is necessary first to accurately identify an individual's readiness to change so that interventions, based on stage-specific processes of change, can be fully tailored to not only stage, but all theoretical variables that the TTM conceptualizes as necessary to facilitate stage progression. Stage of change and the other theoretical variables need to be reassessed frequently, and the intervention should reflect changes in the individual's readiness to change. These elements of the intervention should be repeated until the individual achieves and maintains behavior change. In this way, interventions evolve and adapt in response to the individual's movement through the different stages of change and are thus truly tailored. Interventions in this review typically assessed stage of change at baseline, delivered an ill-defined and non-specific intervention, and then collected follow-up outcome data. Thus, most interventions were static and incomplete, being only partially tailored to only one point in time.

One might anticipate that with static rather than evolving interventions there would at least be evidence of stage progression, if not behavior change. However, whilst there was evidence of stage movement, there was little evidence to suggest that tailored interventions were superior in facilitating stage progression. In any case, although many researchers regard stage progression as a demonstration of intervention effectiveness (Martin, Velicer & Fava, 1996), it should be borne in mind that stage movement is a proxy measure of behavior change, and it should thus be regarded as a secondary rather than primary outcome, not least because stage progression does not necessarily equate ultimately to behavior change. It has been suggested, for example, that stage movement, particularly through the earlier stages, merely reflects a change in one's *intention* to change (Clarke & Eves, 1997; Armitage & Arden, 2002) and it is an axiom that people often fail to translate their intentions into behavior, hence the growth in research that has sought to identify factors that moderate the relationship between intention and behavior (Sheeran, 2002).

From both a theoretical and pragmatic perspective, the effectiveness of any stage-based intervention is dependent upon accurate classification of one's stage of change. Whilst only a few previously validated instruments were used in the included studies, in many cases these instruments were adapted by the researchers for use with a particular target

behavior and/or participant population, with some items being changed, dropped, or added. In the few studies that did report information about the validity of the instruments, the level of validation was limited. These issues are important because effective stage-based intervention is necessarily dependent upon accurate stage assessment, and recent reviews have raised serious concern about the reliability and validity of stages of change measures based on the TTM (Carey, Purnine, Maisto & Carey, 1999; Littell & Girvin, 2002).

Future research

Although there is a substantial research literature investigating the TTM as a viable basis from which to develop health behavior interventions, this evidence-base is not only methodologically weak, but is also characterized by equivocal results and conclusions concerning effectiveness. There is clearly a need for well-designed and appropriately implemented RCTs that are based on appropriately tailored interventions derived from accurate stage measurement, and which involve frequent reassessment of readiness to change in order to provide evolving, stage-specific and truly tailored interventions. However, additional research evaluating the effectiveness of the TTM may not be the most useful avenue to pursue.

An important goal for future research should be to establish an evidence base not in terms of effectiveness, but rather with respect to the central propositions of the TTM. Indeed, there is a need for stronger evaluations of theory-based interventions more generally (Michie & Abraham, 2004). With particular reference to the TTM, however, there is little or mixed evidence concerning stage-specific processes of change, the validity of a stage-based conceptualization of behavior change and, if discrete stages exist, the extent to which they are amenable to accurate measurement. Until these issues have been clarified empirically, there seems little point in pursuing the question of effectiveness, since interventions may well be built upon unfounded methodological, theoretical, and conceptual assumptions. Greater model specification is required, and this specification should reflect methodologically rigorous evidence.

Future research should also endeavor to report sufficient details regarding both methodology and intervention. Regarding the former, better reporting of methods will improve either the actual or the appraised quality of the evidence base and in so doing allow reviewers to draw more useful conclusions. Regarding the latter, there is a need for more thorough descriptions of interventions, especially in terms of content. Despite a large evidence base, important questions concerning intervention content remain unanswered. For example, what interventions were provided for precontemplators in studies of smoking cessation? How did these interventions vary across smoking cessation studies, i.e., were precontemplators treated differently in different smoking cessation studies? Similarly, did same-stage interventions vary across different health behavior studies, i.e., were precontemplators treated differently in, for example, smoking cessation and dietary change studies? To what extent did interventions vary across stages within the same study, i.e., were stage-matched interventions truly distinct, or was there some overlap in the intervention content across different stages? Better reporting of intervention content would provide answers to these and other important questions and thus help to clarify theoretical and conceptual ambiguity, whilst also serving to elucidate the mechanisms through which TTM interventions may or may not form an effective basis for changing health-related behaviors.

Conclusion

This review used systematic review methodology to provide an evidence-based evaluation of the effectiveness of health behavior interventions based on the TTM. The best available evidence is, however, limited not only in terms of methodological quality, but also with regard to the effectiveness of TTM interventions to either facilitate health behavior change or to promote stage progression. Lack of evidence may be due in part to poor model specification, and in part to the inappropriate way in which interventions have been developed and delivered. Thus, although methodologically sound and theoretically consistent intervention studies are required to assess the effectiveness of TTM interventions, there is much to be gained from prior studies that are designed explicitly to test the key theoretical proposition of the TTM, and to determine the conceptual validity of stage-based models more generally.

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