Applying the Transtheoretical Model to Exercise: A Systematic and Comprehensive Review of the Literature

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Three questions guided a literature review of the transtheoretical model (TTM) as applied to exercise to address the evidence for stage-matched interventions, the description of priority populations, and the identification of valid TTM measurement tools. One-hundred-and-fifty studies were reviewed. Results indicate preliminary support for the use of stage-matched exercise interventions. Most studies have focused on White, middle-class, female populations, limiting the generalizability of their findings. Valid and reliable measures exist for stage of change, decisional balance, processes of change, self-efficacy, and temptations to not exercise; however, more research is needed to refine these measures. Evidence for the construct validity of the TTM as applied to exercise is mixed. When designing and implementing TTM-based exercise interventions, practitioners and policy makers are encouraged to clearly define the term exercise, choose a valid and reliable staging tool, and employ all TTM constructs and not just stage membership.

Keywords: transtheoretical model; stage of change; exercise; fitness

The transtheoretical model (TTM) has been applied to many health behaviors since its introduction in the early 1980s (Prochaska & DiClemente, 1984) and has become one of the most widely used program planning models in health promotion. Given its tremendous popularity, it is important to examine the evidence for the effectiveness of the TTM for the primary health behaviors to which it has been applied. This is one in a series of literature reviews on the TTM as applied to health behavior. Others include applications of the TTM to tobacco use (Spencer, Pagell, Hallion, & Adams, 2002), sexually transmitted diseases (STD) and/or pregnancy prevention (Horowitz, 2003), cancer screening behavior (Spencer, Pagell, & Adams, 2005), addictive substances (Migneault, Adams, & Read, in press), and dietary habits (Snelling & Adams, 2004).

Exercise has been the focus of the greatest number of published studies on the TTM, except for tobacco use and prevention. The exercise-related TTM literature has been previously reviewed (Adams & White, 2002; Buxton, Wyse, & Mercer, 1996; Marshall & Biddle, 2001), but not in its entirety nor using the systematic approach employed in the current study. Given the interest in exercise and the TTM, a comprehensive, systematic, practitioner-friendly review is warranted.

Several sources provide an excellent discussion of the TTM and its constructs in detail (Marcus & Simkin, 1994; Prochaska, DiClemente, & Norcross, 1992); however, they are briefly presented here in the context of exercise behavior. The components of the TTM that have been applied to exercise are stage of change, processes of change, decisional balance, self-efficacy, and temptation to not exercise. Stage of change refers to a person’s readiness to engage in regular exercise. Someone in precontemplation does not exercise and is not planning to start exercising within 6 months. A contemplator does not exercise but is planning to start within 6 months. A person in preparation is planning to start exercising within 1 month and has taken some initial steps toward it. Someone in action has been exercising for less than 6 months. A person in maintenance has been exercising for 6 months or more. The processes of change include five behavioral and five cognitive strategies that a person uses as they move from precontemplation to maintenance (Marcus, Rossi, Selby, Niaura, & Abrams, 1992). Examples of behavioral processes are the use of a support partner or rewards. Cognitive processes include dramatic relief and self-
reevaluation. Decisional balance refers to the process of weighing the pros against the cons, or costs, of adopting and/or increasing exercise (Marcus, Eaton, Rossi, & Harlow, 1994). As the pros increase and the cons decrease, a person will move forward from contemplation into preparation and action. Self-efficacy is the degree of confidence a person has that she or he can exercise regularly (Marcus, Eaton, et al., 1994). Temptation to not exercise refers to the frequency and urgency of barriers that can prevent one from exercising (Hausenblas et al., 2001).

It is also important to define what is meant by the term exercise, as this has been the subject of debate in recent years (Dunn, Andersen, & Jakicic, 1998; Rodgers, Courneya, & Bayduza, 2001a). Traditionally, regular exercise has been defined as 20 minutes or more of continuous physical activity performed at a vigorous pace 3 or more times per week. More recently, the concept of lifestyle physical activity has been used to measure and describe participants, in which the accumulation of 30 minutes of a wide range of activities during the course of a day are considered in determining activity level. Both definitions of exercise were used in the studies included in this literature review. In this article, the terms traditional exercise and lifestyle physical activity are used to differentiate between the two definitions when appropriate.

The purpose of this literature review is to identify, summarize, and qualitatively analyze all of the published research on the TTM as applied to exercise behavior so that the following questions may be answered:

What is the evidence to support the use of stage-matched interventions for exercise behavior? Which intervention formats have been the most successful? For what priority populations have stage-matched interventions been successful?

How have TTM constructs described priority populations regarding exercise? What can be learned about the exercise behavior of specific populations from these studies?

Which instruments for assessing stage membership, decisional balance, and self-efficacy for exercise have demonstrated validity and reliability? How can a practitioner discern among the many staging mechanisms to choose an appropriate one for his or her priority population?

As the TTM has become increasingly popular in designing exercise interventions and evaluating individual participants and communities, it is important to explore these questions. Policy makers need to know the evidence for using TTM-based interventions and which instruments are best for assessing priority populations. Practitioners need to know how best to create and implement stage-matched interventions for their participants. Several recent developments at the national level will lead to significant increases in the resources available to health promotion policy makers and practitioners, including funding for exercise interventions. The Centers for Disease Control (n.d.) has undergone a major reorganization that will change its primary focus to public health and health promotion. Included in the top priority list of health concerns is obesity. A second important development is the recent passage of Improved Nutrition and Physical Activity Act (IMPACT, S. 1172, n.d.) by the U.S. Senate in February 2004. IMPACT will provide new funding to practitioners for fitness and nutrition programs through communities, schools, and work sites. A third development is legislation titled Health Promotion FIRST (S. 628, n.d.), was introduced in the U.S. Senate in March 2005. If passed, this legislation will provide more than U.S.$30 million in new funding to explore the design and implementation of the most effective programming strategies to reduce leading health risks, including obesity.

As major funding sources, such as the National Institutes of Health and the CDC, continue to focus more resources on health promotion programming and research, it will be very important for policy makers and practitioners to know the most effective methods of creating health-promoting climates and motivating positive health behavior for priority populations. A defining feature of the TTM is its applicability to large-scale community interventions through public health venues. As new resources for such interventions become available during the next 5 years, it is likely that many practitioners and policy makers will devote these resources to TTM-based interventions. Knowing the strengths and limitations of applying the TTM to exercise interventions and assessments of communities using TTM constructs is important in determining how to best use these new resources.

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<table>
<thead>
<tr>
<th>Stage matched</th>
<th>Intervention</th>
<th>Population</th>
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</table>

### General U.S. populations
- Armstrong, Sallis, Melbourne, & Fostetter (1993)
- LaForge, Velicer, Richmond, & Owen (1999)

### Non-U.S. populations
- Booth et al. (1993)
- Gonzalez & Jirovec (2001)
- C. Lee (1993)
- Potvin, Gauvin, & Nguyen (1997)

### Children, teens, and young adults
- Buckworth & Wallacé (2002)
- Rosen (2000)
- Sullum, Clark, & King (2000)
- Van Vorst, Buckworth, & Mattern (2002)

### Women
- Bull, Eyler, King, & Brownson (2001)
- Marcus et al. (1997)
- Diehl, Lewis-Stevenson, Spruill, & Egan (2001)

### Work site
- Burn, Naylor, & Page (1999)
- Campbell et al. (2000)
- Cardinal (1997b)
- Costakis, Dunnagan, & Haynes (1999)
METHOD

The following databases were searched for the initial pool of studies: CINAHL-Allied Health, Medline, ERIC, Current Contents, and Academic Search Premier. Search terms included combinations of the words transtheoretical model, stage of change, readiness to change, decisional balance, processes of change, physical activity, and exercise. Next, the reference lists of each article were manually reviewed to identify additional studies for inclusion. This yielded 179 studies. A decision was made to retain only original, peer-reviewed studies in English that were published before August 1, 2003. Papers presented at conferences, dissertations, books or chapters in edited books, and commentaries and/or editorials were not included. After removing studies not meeting these criteria, the final literature review included 150 studies.

### Validation

<table>
<thead>
<tr>
<th>Development of a staging algorithm</th>
<th>Development of other TTM measures: testing validity of staging mechanism with other measures</th>
<th>Applying TTM constructs to specific populations</th>
<th>Development of TTM measures for children and teens</th>
<th>Comparison of TTM constructs to other theories and models</th>
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NOTE: TTM = transtheoretical model.
The studies were divided into three categories. Interventions included studies in which stage-matched interventions were evaluated to determine their effectiveness or non-stage-matched (i.e., “action-oriented”) interventions were evaluated using TTM constructs. Population studies included those in which priority populations were described using TTM constructs. Validation studies included those in which instruments for measuring TTM constructs were developed and/or tested for reliability and validity.

Each study was systematically summarized and evaluated to identify common themes and allow for comparisons. Participation rates, retention rates, and sample size and selection (random vs. convenience), all measures of external validity, were examined for each study to determine its quality and the subsequent weight given to its findings. Intervention studies were categorized as experimental, quasi-experimental, or preexperimental (i.e., having no control group) and given an internal validity rating of good, fair, or poor based on established criteria (Harris et al., 2001). The body of intervention studies was then rated for the degree to which they supported the use of stage-matched interventions using criteria developed by Anderson and O’Donnell (1994). Finally, the entire body of literature was evaluated to determine its construct validity using criteria synthesized from Anastassi (1989) and Messick (1989).

A summary and analysis of the three categories of studies (intervention, population, and validation) are presented in the Results section. The three research questions guiding this review are addressed in the Discussion section. Finally, conclusions relevant to practitioners and policy makers are presented.

**RESULTS**

Of the 150 studies included in this review, 38 were interventions, 70 were population studies, and 42 were validation studies. Table 1 includes the author(s) and year of publication for each study and is organized by category, so that the reader may locate the studies on a particular topic. Additional tables were created that include a summary of each study and a rating for interventions; however, the extensive length of these tables prevented their publication with this article. They are available on the Web at http://users.rowan.edu/~spencer/.

The results of this review are organized and discussed by category. First, the stage-matched and non-stage-matched interventions are reviewed. Next, the population studies are reviewed, with each priority population discussed separately. Finally, the validation studies are reviewed.

**Intervention Studies**

There were 32 stage-matched interventions and 6 non-stage-matched interventions. Among the stage-

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**TABLE 2**

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<th>Key Recommendations for Policy Makers and Practitioners</th>
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<td>Use a clear and specific definition for the term exercise</td>
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<td>Include all relevant components of the TTM, particularly the processes of change, when designing interventions</td>
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<tr>
<td>Use a valid and reliable staging mechanism that is specific to exercise</td>
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<td>Remember that evidence for the application of the TTM to exercise is limited for adolescents, minorities, and populations who are underserved</td>
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NOTE: TTM = transtheoretical model.

matched interventions, 15 used an experimental design (i.e., had random assignment and control group), 11 were quasi-experimental (i.e., no random assignment, used control group), and 6 were preexperimental (i.e., no random assignment and no control group). Ten studies received a good internal validity rating. This means that they had comparable participant groups (intervention vs. control participants), high retention rates during the duration of the study, valid and reliable measures, clearly defined interventions, and recognition of potential confounders and addressed all important findings (Harris et al., 2001). Sixteen studies received a fair internal validity rating because they were weak in one of the above areas. Five studies received a poor internal validity rating, indicating a weakness in more than one area, and one study was not rated because of insufficient information.

Participant group sizes ranged from 26 to 1,741, with most studies (n = 11) having between 100 and 300 participants. Some diversity was evident among participant groups, as they included senior citizens, employees, medical patients, sedentary and/or obese adults, and non-U.S. populations. Many included 75% or more females (n = 13), although four studies included 50% or more males. Most populations were White. There was one study of each of the following priority populations: Hispanic Americans, African Americans, children, a Taiwanese workforce, and Scottish adults.

The interventions ranged in length from 2 weeks to 2 years, with the majority (n = 15) between 6 to 12 months. Sixteen interventions used print-based materials with participants, including brochures, posters, reports, and manuals that were mailed to the home, handed out in class, distributed through lobbies of physician offices and senior centers, given in person during an individual consultation, or distributed through interoffice mail. Some interventions provided for the staging of participants in advance so that each participant received only information relevant to her or his stage, while others provided information pertaining to all stages to each participant. Eleven interventions were delivered in person, either through brief individual counseling (such as in a physician’s office) or a class.
Nine interventions were conducted over the telephone, using either a live, trained counselor or a computer-generated counseling system. One work-site intervention was delivered solely by e-mail, one used an interactive, computerized Web site, and one community-wide intervention was based on public service announcements through newspapers and television. Several interventions incorporated more than one method of delivery, and some also included personal exercise prescriptions, vouchers for fitness centers, maps for area hiking trails, and other incentives to exercise.

Each intervention was evaluated for the degree to which the use of a stage-matched approach was supported by its findings. Seventeen studies demonstrated positive outcomes with the use of stage-matched interventions, although three of these studies were less than 8 weeks in duration. Eight studies demonstrated a short-term positive effect of a stage-matched intervention; however, it was not maintained during the duration of the current study. Five studies provided inconclusive results, three did not support the use of a stage-matched intervention, and one provided insufficient information to make a judgment.

The interventions were divided into three groups, and a qualitative comparison was performed to determine if potential themes or trends were apparent among the groups. The three groups were interventions that were completely supportive of stage matching, those that provided short-term support that was not maintained throughout the current study, and those that did not support stage matching or provided inconclusive results. Clearly, well-designed studies offering complete or short-term support of a stage-matched intervention outnumbered those that did not, although two of the seven nonsupportive interventions were of high quality. One theme was noted, though, among the studies offering less-than-complete support for stage matching. These studies often had single-contact, single-strategy interventions, while completely supportive studies tended to include multiple strategies with either single or multiple contacts. In four of the nonsupportive studies, a primary finding was the need for longer term, multiple-contact interventions to achieve and maintain increases in exercise stage membership or behavior (Goldstein et al., 1999; Harland et al., 1999; Norris, Grothaus, Buchner, & Pratt, 2000; Pinto, Lynn, Marcus, DePue, & Goldstein, 2001).

A subgroup of the intervention studies was created next to specifically examine those that compared a stage-matched intervention to a standard (i.e., action-oriented) intervention as opposed to studies that offered no alternative exercise intervention for the control group. It would not be surprising to find that a stage-matched intervention led to significantly more change than no intervention at all; a non-stage-matched intervention might also achieve the same result. What is important to examine is not simply if stage matching is effective but if it is more effective than interventions that are already being offered. Fifteen interventions were part of this subgroup, as they compared stage-matched interventions to standard (i.e., action-oriented) interventions. Of those, nine demonstrated that stage-matched interventions are more effective than action-oriented interventions offered to all participants regardless of stage. The outcome of one of these studies is particularly noteworthy. Blissmer and McAuley (2002) randomly assigned participants to a control group, a stage-matched intervention, or a mismatched intervention (in which contemplators were deliberately given action-oriented messages and materials). They found that those receiving the mismatched materials had poorer outcomes in terms of stage progression and exercise behavior than those in either the stage-matched condition or the control condition. This type of study design lends support to the validity of the existence of the stages as defined by the TTM and the use of stage-matched interventions.

Five stage-matched interventions assessed the use of processes of change, three assessed decisional balance, and six assessed self-efficacy. Given that a fundamental tenet of the TTM is in the interaction between the constructs, it is important to note that the majority of studies evaluated the stage of change measure in isolation from the other constructs.

The non-stage-matched interventions can be useful in assessing the use of stage change, processes of change, decisional balance, and self-efficacy as evaluation tools for action-oriented exercise programs. Of the six non-stage-based interventions, four were quasi-experimental designs, and one received a good internal validity rating. As with the stage-matched studies, stage of change was measured in isolation from the other constructs in all but one study. In each study, stage of change appeared to be useful in tracking participants’ progress and distinguishing among participants postintervention. Of the 38 interventions, 29 used self-reported exercise measures. The most popular (n = 13) was the Seven-Day Physical Activity Recall (7-Day PARQ; National Institutes of Health, n.d.). The 7-Day PARQ requires participants to remember and/or record the amount (in minutes) of moderate, hard, and very hard activity performed for 10 minutes or more during 7 consecutive days. It is a highly detailed account and includes a range of lifestyle activities in addition to traditional exercise. The self-reported exercise surveys used in the remaining 15 studies varied in the level of detail they captured, and in many cases it was not possible if lifestyle activities were included. Five studies used biometric measurements of physical fitness, such as maximal oxygen uptake and electrocardiogram readings (three in addition to self-reported measures), and seven did not measure exercise level.

**Population Studies**

The 70 cross-sectional, population studies were further divided for analysis into specific priority popula-
tions. The subdivisions are general U.S. populations, non-U.S. populations, children/teens/college students, women, work site, medical patients, and senior citizens. A few studies fit into more than one category and have been included in the analysis and discussion.

Five studies applied the stage-of-change construct to general U.S. adult populations drawn from the community. Two of these studies also assessed self-efficacy, and one assessed decisional balance. All but two included fewer than 1,000 adult participants who were predominantly White, female, and in their 40s. Most used convenience samples and had moderate (approximately 70%) response rates. These studies suggested that stage membership is predictive of exercise level (Armstrong & Sallis, 1993; Klein & Stone, 2002) and that adults in later stages tend to report a higher quality of life (LaForge, Rossi, et al. 1999).

Seventeen studies measured non-U.S. populations using the stage-of-change construct. Of these, five also addressed self-efficacy, two measured processes of change, and one measured decisional balance. Five studies were conducted in Australia, two in Mexico, two in Canada, two in England, and one each in the United Kingdom, the 15 European Union states, the Netherlands, China, Malaysia, and Japan. Eight studies used random sampling. Response rates ranged from 50% to 90%, although one half of the studies did not report one. Seven studies had more than 1,000 participants, although one had only 30 participants. Generally, non-U.S. populations were similar to U.S. populations in stage distribution, with more Scandinavians (Kearney, de Graaf, Damkjær, & Engstrom, 1999), Canadians (Nguyen, Potvin, & Otis, 1997), and Australians (Booth et al., 1993) in later stages and more Mexican women in lower stages (Gonzalez & Jirovec, 2001). Barriers to exercise were similar to those of Americans, with Mexican women citing the care of their homes and families (Gonzalez & Jirovec, 2001) and Europeans citing a dislike of physical activity (Eves, Mant, & Clarke, 1996) most frequently. Self-efficacy and use of processes of change were similar to American populations. One study of primary care providers showed a significant relationship between personal exercise stage membership and willingness to promote exercise among patients (McKenna, Naylor, & McDowell, 1998).

Twelve studies used the TTM to describe the exercise behavior and perceptions of children, teens, or college students. All measured stage of change, three assessed self-efficacy, three assessed processes of change, and two measured decisional balance. Most studies were of White students, and many were conducted in classrooms. All but two samples of college students were convenience samples, with response rates ranging from 27% to 100% (classroom surveys had higher response rates than did general campus surveys). TTM constructs appeared to apply to college students as they do to general adult populations, with more than one half preaction stages and the expected relationships among decisional balance, processes of change, self-efficacy, and stage membership. TTM constructs may not apply to children in a predictable manner, though, as one well-designed study showed no significant relationships among the constructs for elementary school children (Cardinal, Engels, & Zhu, 1998).

Five studies addressed exclusively female populations, including patients, employees, and those from the general community. The studies varied in sample size and selection but were of good quality. Heesch, Brown, and Blanton (2000) found that ethnicity did not account for differences among participants’ perceived barriers; however, Bull, Eyler, King, and Brownson (2001) found that women who were younger, White, and healthy were most likely to be in later stages. The most common barriers to exercise for women were lack of energy and time (Heesch et al., 2000), inactivity as a teenager (Felton, Ott, & Jeter, 2000), and having one or more children living at home (Marcus et al., 1997).

Twelve studies addressed work-site populations. Sample sizes ranged from 47 to 1,269, although most studies had between 300 and 859 participants. Three used random samples, two were of predominantly African Americans, and two were of European populations. Seven had response rates of 68% or higher. Most of the studies reported participants to be in either precontemplation or contemplation. A positive relationship was found between membership in later stages and self-efficacy (Herrick, Stone, & Mettler, 1997; Lechner & De Vries, 1995; Marcus, Pinto, Simkin, Andrain, & Taylor, 1994), use of processes of change (Marcus, Simkin, Rossi, & Pinto, 1996), identification of benefits of exercise (Jaffee, Lutter, Rex, Hawkes, & Bucaccio, 1999; Lechner & De Vries, 1995), the presence of other good health habits (Burn, Naylor, & Page, 1999; Costakis, Dunnagan, & Haynes, 1999; Hammermeister, Page, & Dolny, 2000), and lower health insurance costs (Dunnagan, Haynes, & Smith, 2001).

Fourteen studies examined the TTM as applied to medical patients. Medical conditions included cardiovascular disease (n = 5), diabetes (n = 4), and obesity (n = 1). Four studies included primary care patients. The four studies using random selection had larger participant populations, while the 10 convenience samples contained fewer than 100 in most cases. When provided, response and/or retention rates ranged from 60% to 98%. These studies demonstrated a positive relationship between forward stage progression and receiving cardiac surgery or therapy (Bock et al., 1997; Jue & Cunningham, 1998), adherence to an exercise program (Hellman, 1997), and effective diabetes management (Kielkta, Ziener, & Thompson, 1999; Natarajan, Clyburn, & Brown, 2002; Parchman, Pugh, Noel, & Larne, 2002). Primary care patients were frequently not in the same stage for exercise and diet, though. Weight management programs addressing both behaviors simultaneously may need to use different processes for each behavior (Boudreaux et al., 2003).
Seven studies applied the TTM to senior citizens. All used convenience samples, most having between 100 and 400 participants. In one large study, seniors were most likely to be in either precontemplation or maintenance, suggesting that as they age, they may be less open to adopting exercise if they are not already active (Nigg et al., 1999). Stage membership was positively related to self-efficacy (Davis, 2000; Stevens, Lemmink, & de Groot, 2000), stress levels (Rich & Rogers, 2001), social support (Rich & Rogers, 2001; Stevens et al., 2000), better diets (Tucker & Reicks, 2002), and positive attitudes toward exercise (Courneya, 1995; Walcott-McQuigg & Prohaska, 2001).

Validation Studies

Of the 42 validation studies, the primary purpose of 25 was the construct and/or concurrent validation of TTM measures specific to exercise. Construct validation refers to the ability of a measure, such as a staging algorithm, to meaningfully and accurately differentiate among participants. Concurrent validation refers to the comparison of one measure to another (i.e., a staging algorithm to self-reported activity) to determine if the outcomes for one can be predicted by the outcomes of the other.

Marcus and Simkin (1993) were the first to model an exercise-specific stage of change measure based on the standard staging measure created by Prochaska et al. (1992). Called the Stage of Exercise Behavior Change (SEBC) algorithm, it included precontemplation, contemplation, preparation, action, and maintenance and used the time frames associated with the Prochaska et al. (1992) measure (i.e., contemplators were planning to exercise regularly within the next 6 months, preparers were taking initial steps toward exercise and planned to do it regularly within 1 month, and those in action had been exercising regularly for 6 months or less). They also tested a four-stage model that excluded preparation; however, it did not define the study population as well as the five-stage model did. Relapse did not appear to be a distinct stage in this study; however, Cardinal (1998) found that relapsers were different from those who had never relapsed in that their progress was not as steady and continuously improving as was the progress of the never relapsers. Marcus, Selby, Niaura, and Rossi (1992) followed their initial work with a study of the concurrent validity of the SEBC and the 7-Day PARQ. The 7-Day PARQ distinguished among three stages: precontemplation/contemplation, preparation, and action/maintenance, supporting the concurrent validity of the SEBC. As stage progressed, participants reported exercising more frequently and with greater intensity.

In three separate studies, Cardinal (1995a, 1995b, 1997a) slightly changed the SEBC to visually represent a ladder with five numbered rungs, called the Stages of Exercise Scale (SOES). He chose a ladder format to minimize the problem of participants being unable to classify themselves using an algorithm. He demonstrated the concurrent validity of the SOES with self-reported and biometric exercise measures. Marcus, Eaton, et al. (1994) also developed an 11-rung Stage of Change Ladder for exercise and demonstrated construct validity for it, although they continued to use the SEBC in most of their research. Cardinal (1999) identified a potential sixth stage—transformed—representing those in maintenance who have made a lifelong commitment to regular exercise. Gebhardt, Dusseldorp, and Maes (1999) demonstrated that stage transition occurs in exercise behavior, and that most change is linear and sequential, supporting the existence of true stages in exercise behavior.

Several studies examined the ability of various psychosocial factors to predict stage membership. For example, extrinsic motivators, such as appearance, were predictive of participants in earlier stages, while intrinsic motivators, such as enjoyment, were predictive of those in action and maintenance (Ingledew, Markland, & Medley 1998). In addition, as exercise behavior becomes more established and individuals move into maintenance, benefits and barriers to exercise became less influential (Myers & Roth, 1997). Support was also related to stage membership with family social support being a strong predictor of stage for women and support of friends similarly predicting stage membership for men (Wallace, Buckworth, Kirby, & Sherman, 2000). Finally, perceived behavioral control (Nguyan et al., 1997), attitudes toward exercise (Jordan, Nigg, Norman, Rossi, & Benisovich, 2002; Nguyan et al., 1997), self-determination (Mullan & Markland, 1997; Nguyan et al., 1997) and the perception of subjective norms for exercise were also predictive of stage membership.

Buxton, Mercer, Hale, Wyse, and Ashford (1994a) also contributed evidence to the concurrent validity and test-retest reliability of the SEBC; however, Donovan, Jones, Holman, and Corti (1998) found its test-retest reliability to be low. A weakness of the Donovan et al. (1998) study may have been the lack of a precise definition for exercise. Marcus et al. (Marcus, Selby, et al., 1992; Marcus & Simkin, 1993) and Cardinal (1995b, 1997a) clearly defined exercise as occurring 3 times a week for 20 minutes or more, which may have accounted for the higher reliability coefficients in those studies.

Two studies compared the use of a traditional definition for exercise to a lifestyle activity definition (Mihlumpalo, Nupponen, Laitukari, Marttila, & Paronen, 2000; Rodgers, Courneya, & Bayduza 2001b). In both studies, participants were staged differently for each definition, underscoring the need to clearly define the term exercise when staging participants. Schumann et al. (2002) demonstrated good construct validity of modified versions of the SEBC for moderate and strenuous intensity levels of exercise but not for mild exercise. Reed, Velicer, Prochaska, Rossi, and Marcus (1997) compared eight types of exercise-staging algorithms and...
found that the most accurate one utilized an explicit definition of traditional exercise using a five-item algorithm in which participants selected the statement that best described them. The validity of the SEBC has been demonstrated with overweight adults (Sarkin, Johnson, Prochaska, & Prochaska, 2001), cardiac patients (Stump & Olshefski, 2001), older adults with chronic illnesses (Hellman, 1997; Wister & Romeder, 2002), Finnish adults (Cardinal, Tuominen, & Rintala, 2003; Miilunpalo et al., 2000), Greek adults (Christopoulos, McKenna, & Naylor, 1996), British young adults (Wyse, Mercer, Ashford, Buxton, & Gleeson, 1995), and British primary care patients (Clarke & Eves, 1997).

Other TTM measures related to exercise have also been developed and tested for validity. Marcus and colleagues developed an exercise-specific process of change questionnaire (Marcus, Rossi, et al., 1992), decisional balance measure (Marcus, Eaton, et al., 1994), and self-efficacy measure (Marcus, Eaton, et al., 1994). Employing a solid research design and sophisticated analysis, they provided evidence of the construct validity of these TTM constructs to exercise. Processes of change appeared to be used by participants in predictable ways (Rodgers et al., 2001b), with precontemplators using few processes, and those in action or maintenance using behavioral processes. In a study of the relationships between stage of change, decisional balance, processes of change, and self-efficacy, Gorely and Gordon (1995) found that self-efficacy was most predictive of stage membership. Hausenblas et al. (2001) developed and tested the Temptations to Not Exercise Scale (TTNES) with college students. They found that two primary temptations, affect (how one feels) and competing demands (being too busy), were most predictive of not exercising.

Two studies contributed to the construct validity of the TTM by examining its relationship with other health behavior theories. The theory of planned behavior was predictive of stage membership (Faulkner & Biddle, 2001), but social cognitive theory was not (Resnick & Nigg, 2003). Several studies examined the application of the TTM to adolescents, with mixed results overall. R. E. Lee, Nigg, DiClemente, and Courneya (2001) developed a stage of change measure for adolescents that was able to assign participants to the appropriate stage. Decisional balance (Nigg & Courneya, 1998), processes of change (Goldberg et al. 1996; Nigg & Courneya, 1998), and self-efficacy (Nigg & Courneya, 1998) have also been shown to be predictive of stage membership in adolescents. A later study found that decisional balance and self-efficacy, but not processes of change, were related to exercise behavior of adolescents (Nigg, 2001). Hausenblas et al. (2002) developed self-efficacy and decisional balance scales specific to adolescents. Although the scales demonstrated good construct validity (i.e., they measured what they were supposed to measure), the differences in outcomes between adolescents in different stages were marginal.

Finally, one validation study is particularly noteworthy, as it was the only one found that measured changes in the same population over time, as opposed to using a cross-sectional design (Plotnikoff, Hotz, Birkett, & Courneya, 2001). As applied to exercise, self-efficacy was strongly supported; however, decisional balance and processes of change were only partially supported. Pros did not increase, and cons did not decrease at the expected cross-over point (preparation). Experiential processes, which are expected to be used by precontemplators and contemplators, were used by participants in action and maintenance in this study.

DISCUSSION

The literature in this review suggests that the TTM can be applied to exercise behavior. Valid and reliable measures are available to assess stage of change, processes of change, decisional balance, and temptations to not exercise. These measures have been used to describe a variety of priority populations. Stage-based interventions also appear to be effective in promoting exercise. The following is a discussion of the three research questions guiding this review.

What is the evidence to support the use of stage-matched interventions for exercise behavior? Which intervention formats have been the most successful? For what priority populations have stage-matched interventions been successful?

There is a growing body of evidence suggesting that stage-matched interventions lead to forward stage progression and/or increased exercise behavior. Both outcomes are important, given the large percentages of the general population who are in precontemplation or contemplation for exercise. Thus, interventions that did not produce higher exercise levels among precontemplators or contemplators, but did lead them into preparation, can be considered successful. Of the 31 stage-matched interventions reviewed, 25 demonstrated their success in motivating participants toward higher stages and amounts of exercise. An important consideration, though, is whether stage-matched interventions are superior to non-stage-matched interventions specifically, as opposed to control group situations in which no alternate exercise intervention is provided. Slightly more than one half of the 15 studies that compared a stage-matched intervention to a traditional (i.e., action-oriented) intervention found the stage-matched intervention to have a better outcome. Using the criteria established by Anderson and O’Donnell (1994), the body of interventions studies was rated as indicative of supporting stage-matched interventions. Although there is evidence in support of stage-matched interventions, it is far from conclusive that they are the best choice in exercise programming.
This body of literature does not suggest that one intervention format is preferable over the others. The use of print materials, computer- and Web-based interaction, brief physician counseling, class meetings, telephone counseling, and mass media channels all appeared to be useful strategies in promoting forward stage movement for exercise. The use of multiple strategies during a longer time period (possibly 6 months or more), as opposed to a single intervention format, was found in the most successful studies and was a primary recommendation for future interventions in several studies that were minimally effective.

Given that all but a handful of interventions addressed middle-class, White, and predominantly female populations, the application of stage-based exercise interventions to diverse populations is inconclusive. The four studies that focused on more diverse populations (African American children, Taiwanese workers, and Scottish adults) all demonstrated support for stage-matched interventions, though.

How have TTM constructs described priority populations regarding exercise? What can be learned about the exercise behavior of specific populations from these studies?

Descriptive studies form the bulk of published research on the TTM and exercise. Although their utility is limited, they contribute to the validation of the TTM by demonstrating its ability to describe the exercise behavior and attitudes of a variety of priority populations. Specific to exercise, stage of change, and, to a lesser extent, self-efficacy, processes of change and decisional balance have been used to describe a diverse range of populations based on age, ethnicity, culture, and health condition.

Generally speaking, the TTM described adult populations in predictable ways. The majority of studies using adult populations found that advanced stage membership was associated with many other positive attributes, including higher self-efficacy, increased use of the processes of change, a stronger perception of the benefits of exercise, improved disease management habits, fewer health-related costs, and other positive health habits. This was true for U.S. and non-U.S. populations, work-site populations, exclusively female populations, college students, senior citizens, and adults with medical concerns (diabetes, heart disease, and/or obesity). The one priority population for which this did not hold true was children and teenagers. Although an attempt has been made to develop exercise-related TTM measures specific to children, the standard measures used with adults did not appear to effectively describe children and teenagers.

There are three notable observations from the populations studies as a whole. First, the large majority of U.S. studies were with primarily or exclusively White, middle-class populations. Little can be said about U.S. populations who are low income or ethnically diverse.

Second, a significant number of high-quality studies of populations outside the United States \( n = 17 \) have been conducted. These have included European, Asian, and Mexican populations, allowing for the observation that the TTM appears to apply to populations outside the United States as it does to those within. Third, stage of change was often assessed in isolation from the other TTM constructs. Given the importance of the relationship between stage membership, self-efficacy, the use of processes of change, and decisional balance, this has left a significant gap in our understanding of how the TTM in its entirety can be used to describe priority populations.

Which instruments for assessing stage membership, decisional balance, and self-efficacy for exercise have demonstrated validity and reliability? How can a practitioner discern among the different staging mechanisms to choose an appropriate one for his or her priority population?

This literature review identified 13 different exercise staging mechanisms; however, most appeared in the population studies, had little or no evidence for their validity or reliability, and were slight modifications of the five-item staging algorithm developed by Marcus, Rossi, et al. (1992), called the Stages of Exercise Behavior Change (SEBC) scale. The majority of the studies in this review used the SEBC scale, and it is for this algorithm that the strongest evidence for reliability and validity were found. One well-designed construct validation study (Schumann et al., 2002) suggested that the SEBC might be improved by expanding the definition of the preparation stage to also include intention to exercise and not just exercise behavior. Cardinal (1995a, 1995b, 1997a) developed the Stage of Exercise Scale (SOES) that uses the same definitions of exercise and of each stage as does the SEBC but employs a five-rung ladder on which participants place themselves to determine their stage membership. Evidence also exists for the validity and reliability of the SOES, although it has not been as extensively used in research.

Measures have also been developed for the processes of change (Marcus, Rossi, et al. 1992), decisional balance (Marcus, Eaton, et al. 1994), self-efficacy (Marcus, Eaton, et al., 1994), and temptations to not exercise (Hausenblas et al., 2001). Although there is evidence to support the validity of these measures, it is sparse, given the small number of validation studies for them.

The application of TTM constructs and measures to a variety of adult populations is supported by this literature; however, the application to adolescents may not be valid. Two studies supported the validity of TTM measures with adolescents, and three provided either limited or marginal support at best.

Practitioners should consider three guidelines as they select a staging tool appropriate for their priority populations. First, it is important to clearly define the term exercise for participants (Reed et al., 1997).
Although it is beyond the scope of this review to compare the merits of using a traditional definition versus a lifestyle physical activity definition, practitioners should remember that the use of a lifestyle definition will place greater numbers of participants in the later stages (action and maintenance) than will a traditional definition (Miilunpalo et al., 2000; Reed et al., 1997; Rodgers et al., 2001a). Second, the use of a ladder format may reduce the number of nonstaged participants (Cardinal, 1995b). Practitioners should consider whether their population might have difficulty responding to the layout of a fixed-choice response algorithm, such as found in the SEBC. The SOES (Cardinal, 1995b) and an 11-run Stage of Change Ladder (Marcus, Eaton, et al. 1994) might be preferable over the SEBC. Third, there is some evidence to support the existence of a relapse stage and a transformed stage (indicating a lifelong commitment to exercise). Practitioners might consider including these additional stages if it seems appropriate to their populations. This review found only one measure to assess each of the other TTM constructs at this time.

As a final, comprehensive evaluation of the validity of the application of the TTM to exercise, five criteria were applied to the entire body of literature. Based on the work of Anastassi (1989) and Messick (1989), Spencer et al. (2001) developed these criteria and used them to evaluate the entire body of TTM-related tobacco literature. The criteria are (a) the degree to which the construct is based on an already established theory, (b) the reliability (i.e., test/retest or internal consistency) of the construct, (c) the number and quality of studies that demonstrate changes in participants over time in expected ways, (d) the number and quality of studies providing evidence that the construct can be used across populations and intervention conditions, and (e) whether other theories provide better explanations or results than the one under consideration.

Spencer et al. (2001) addressed the first criterion thoroughly in their review of the TTM-related tobacco literature, and the interested reader is referred to this article for more information. In summary, they documented the transtheoretical nature of the TTM and identified its basis on the health belief model, the importance of self-efficacy, and Janis and Mann’s (1977) decision-making model. Initial evidence was found in the validation literature for the second criterion, the reliability of the TTM constructs as applied to exercise behavior. Few studies addressed reliability, though, and provided mixed results. The stage-matched intervention studies provided good preliminary evidence in support of the third criterion (change in participants over time in expected ways); however, it was not conclusive. Evidence was inconclusive for the fourth criterion, or the application of TTM constructs to a variety of populations in different settings, as most of the population studies addressed White, middle-class, female populations.

The fifth criterion (whether other theories offer better explanations of exercise behavior than does the TTM) has been the subject of some debate in recent years. Specifically, there has been controversy over the validity of the existence of true stages of behavior change. Sutton (2000) identified three criteria essential in a true stage theory: the stages must not overlap, clear differences must exist between participants in each stage, and participants should progress through each stage in order. The use of cross-sectional research designs to validate the existence of stages has also been criticized, as it cannot provide evidence of changes over time within an individual (Weinstein, Rothman, & Sutton, 1998). Since the publication of these two articles, at least one exercise-specific study has been published in which a longitudinal study design was used to test a stage of change measure (Plotnikoff et al., 2001), offering partial support for the application of stage of change to exercise. The findings of Gebhardt et al. (1999) also provide evidence to the contrary, demonstrating that true stages exist and that movement through them is sequential.

This review is limited primarily by its qualitative nature. Although an effort was made to use established criteria to systematically evaluate the studies, the conclusions were ultimately based on our judgment. A second limitation is that an appropriate study may have been unintentionally excluded from this review, although significant efforts were made to identify all relevant literature. Several conclusions can be drawn that are relevant to policy makers and practitioners regarding the TTM as applied to exercise. First, it is important to apply the entire model and not the stage of change measure in isolation. Ensuring that participants use the appropriate processes of change as they move through the stages is essential for their success. Second, the model should be used cautiously with adolescents and populations who are underserved, given the limited amount of evidence that it applies to these groups. Third, it is important to use measures for each of the constructs that have been shown to be valid and reliable. Finally, a clear definition of exercise is essential for the accurate staging of participants.

REFERENCES


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