
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-

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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?

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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.

TABLE 1
Identification of Studies
by Type of Study (Intervention, Population, Validation)

Intervention			
Stage matched			
Blalock et al. (2002)	Blissmer & McAuley (2002)	Bock, Marcus, Pinto, & Forsyth (2001)	Calfas et al. (1996)
Cardinal & Sachs (1995)	Dallow & Anderson (2003)	Dunn et al. (1997)	Frenn, Malin, & Bansal (2003)
Gold, Anderson, & Serxner (2000)	Goldstein et al. (1999)	Hager, Hardy, Aldana, & George (2002)	Harland et al. (1999)
Jarvis, Friedman, Heeren, & Cullinane (1997)	Jones, Della Corte, Nigg, Clark, & Burbank (2001)	Kao, Lu, & Huang (2002)	Kirk et al. (2001)
Marcus, Banspach, et al. (1992)	Marcus, Bock, et al. (1998)	Marcus, Emmons, et al. (1998)	Mutrie et al. (2002)
Naylor, Simmonds, Riddoch, Velleman, & Turton (1999)	Nigg et al. (2002)	Norris, Grothaus, Buchner, & Pratt (2000)	Peterson & Aldana (1999)
Pinto et al. (2002)	Pinto, Lynn, Marcus, DePue, & Goldstein (2001)	Renger, Steinfelt, & Lazarus (2002)	Riebe et al. (2003)
Simmonds, Naylor, Riddoch, & Velleman (1996)	Steptoe, Kerry, Rink, & Hilton (2001)	Steptoe, Rink, & Kerry (2000)	Woods, Mutrie, & Scott (2002)
Nonstage matched			
Cardinal, Jacques, & Levy (2002)	Cole, Leonard, Hammond, & Fridinger (1998)	Loughlan & Mutrie (1997)	Mau et al. (2001)
Mettler, Stone, Herrick, & Klein (2000)	Titze, Martin, Seiler, Stronegger, & Marti (2001)		
Population			
General U.S. populations			
Armstrong, Sallis, Melbourne, & Fostetter (1993)	Klein & Stone (2002)	Kohl, Dunn, Marcus, & Blair (1998)	LaForge et al. (1999)
LaForge, Velicer, Richmond, & Owen (1999)			
Non-U.S. populations			
Booth et al. (1993)	Burke et al. (2000)		
Callaghan, Eves, Norman, Chang, & Lung (2002)	Carnegie et al. (2002)	Doherty, Steptoe, Rink, Kendrick, & Hilton (1998)	Eves, Mant, & Clarke (1996)
Gonzalez & Jirovec (2001)	Kearney, deGraaf, Damkjaer, & Engstrom (1999)	Laffrey (2000)	Laforge et al. 1999
C. Lee (1993)	McKenna, Naylor, & McDowell (1998)	Nguyen, Potvin, & Otis (1997)	Omar-Fauzee, Pringle, & Lavallee (1999)
Potvin, Gauvin, & Nguyen (1997)	Ronda, Van Assema, & Brug (2001)	Wakui et al. (2002)	
Children, teens, and young adults			
Buckworth & Wallace (2002)	Cardinal, Engels, & Zhu (1998)	Leenders, Silver, White, Buckworth, & Sherman (2002)	Pinto & Marcus (1995)
Rosen (2000)	Sullum, Clark, & King (2000)	Suminski & Petrosa (2002)	
Van Vorst, Buckworth, & Mattern (2002)	Wallace & Buckworth (2001)	Wallace, Buckworth, Kirby, & Sherman (2000)	Walton et al. (1999)
Women			
Bull, Eyler, King, & Brownson (2001)	Diehl, Lewis-Stevenson, Spruill, & Egan (2001)	Heesch, Brown, & Blanton (2000)	Felton, Ott, & Jeter (2000)
Marcus et al. (1997)			
Work site			
Burn, Naylor, & Page (1999)	Campbell et al. (2000)	Cardinal (1997b)	Costakis, Dunnagan, & Haynes (1999)

TABLE 1 (continued)

Dunnagan, Haynes, & Smith (2001)	Hammermeister, Page, & Dolny (2000)	Herrick, Stone, & Mettler (1997)	Jaffee, Lutter, Rex, Hawkes, & Bucaccio (1999)
King, Marcus, Pinto, Emmons, & Abrams (1996)	Lechner & De Vries (1995)	Marcus, Simkin, Rossi, & Pinto (1996)	Marcus, Pinto, et al. (1994)
Medical patients			
Allison & Keller (2000)	Bock et al. (1997)	Boudreaux et al. (2003)	Boyle, O'Connor, Pronk, & Tan (1998)
Cowan, Logue, Milo, Britton, & Smucker (1997)	Hellman (1997)	Hilton et al. (1999)	Jue & Cunningham (1998)
Kieltka, Ziemer, & Thompson (1999)	Logue, Sutton, Jarjoura, & Smucker (2000)	Natajaran, Clyburn, & Brown (2002)	Nelson & Gordon (2003)
Parchman, Pugh, Noel, & Larme (2002)	Sullivan & Joseph (1998)		
Senior citizens			
Courneya (1995)	Davis (2000)	Nigg et al. (1999)	Rich & Rogers (2001)
Stevens, Lemmink, & de Greef (2000)	Tucker & Reicks (2002)	Walcott-McQuigg & Prohaska (2001)	
Validation			
Development of a staging algorithm			
Buxton, Mercer, Hale, Wyse, & Ashford (1994a)	Buxton, Mercer, Hale, Wyse, & Ashford (1994b)	Cardinal (1999)	Cardinal (1997a)
Cardinal (1995b)	Donovan, Jones, Holman, & Corti (1998)	Gebhardt, Dusseldorf, & Maes (1999)	Marcus & Simkin (1993)
Miilunpalo, Nupponen, Laitakari, Marttila, & Paronen (2000)	Reed, Velicer, Prochaska, Rossi, & Marcus (1997)	Sarkin, Johnson, Prochaska, & Prochaska (2001)	Schumann et al. (2002)
Wyse, Mercer, Ashford, Buxton, & Gleeson (1995)			
Development of other TTM measures; testing validity of staging mechanism with other measures			
Cardinal (1995a)	Cardinal (1998)	Christopolou, McKenna, & Naylor (1996)	Gorley & Gordon (1995)
Hausenblas et al. (2001)	Jordan, Nigg, Norman, Rossi, & Benisovich (2002)	Marcus, Eaton, Rossi, & Harlow (1994)	Marcus, Selby, Niaura, & Rossi (1992)
Applying TTM constructs to specific populations			
Cardinal, Tuominen, & Rintala (2003)	Clarke & Eves (1997)	Ingledew, Markland, & Medley (1998)	Marcus, Rossi, Selby, Niaura, & Abrams (1992)
Plotnikoff, Hotz, Birkett, & Courneya (2001)	Rodgers, Courneya, & Bayduza (2001b)	Stump & Olsheski (2001)	Wister & Romeder (2002)
Development of TTM measures for children and teens			
Goldberg et al. (1996)	R. E. Lee, Nigg, DiClemente, & Courneya (2001)	Nigg & Courneya (1998)	Nigg (2001)
Comparison of TTM constructs to other theories and models			
Faulkner & Biddle (2001)	Hausenblas et al. (2002)	Hellman (1997)	Mullan & Markland (1997)
Myers & Roth (1997)	Nguyen et al. (1997)	Resnick & Nigg (2003)	Wallace et al. (2000)

NOTE: TTM = transtheoretical model.

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.

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/](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-

TABLE 2
Key Recommendations for Policy Makers
and Practitioners

Use a clear and specific definition for the term <i>exercise</i>
Include all relevant components of the TTM, particularly the processes of change, when designing interventions
Use a valid and reliable staging mechanism that is specific to exercise
Remember that evidence for the application of the TTM to exercise is limited for adolescents, minorities, and populations who are underserved

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 of 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, Damkjaer, & 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 in preaction stages and the expected relation-

ships 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 (Kielka, Ziemer, & Thompson, 1999; Natarajan, Clyburn, & Brown, 2002; Parchman, Pugh, Noel, & Larme, 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 Greef, 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 clas-

sify 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 (Nguyen et al., 1997), attitudes toward exercise (Jordan, Nigg, Norman, Rossi, & Benisovich, 2002; Nguyen et al., 1997), self-determination (Mullan & Markland, 1997; Nguyen 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 (Miilunpalo, Nupponen, Laitakari, 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 a modified version 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 & Olscheski, 2001), older adults with chronic illnesses (Hellman, 1997; Wister & Romeder, 2002), Finnish adults (Cardinal, Tuominen, & Rintala, 2003; Miilunpalo et al., 2000), Greek adults (Christopoulou, 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-rung 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 document the transtheoretical nature of the TTM and identify 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

- Adams, J., & White, M. (2002). Are activity promotion interventions based on the transtheoretical model effective? A critical review. *British Journal of Sports Medicine*, 37, 106-114.
- Allison, M. J., & Keller, C. (2000). Physical activity maintenance in elders with cardiac problems. *Geriatric Nursing*, 21, 200-203.
- Anastassi, A. (1989). *Psychological testing*. New York: Macmillan.
- Anderson, D. R., & O'Donnell, M. P. (1994). Toward a health promotion research agenda: "State of the science" reviews. *American Journal of Health Promotion*, 8, 462-465.
- Armstrong, C. A., & Sallis, J. F. (1993). Stages of change, self-efficacy, and the adoption of vigorous exercise: A prospective analysis. *Journal of Sport and Exercise Psychology*, 15, 390-403.
- Blalock, S. J., DeVellis, B. M., Patterson, C. C., Campbell, M. K., Orenstein, D. R., & Dooley, M. A. (2002). Effects of an osteoporosis

- prevention program incorporating tailored educational materials. *American Journal of Health Promotion*, 16, 146-156.
- Blissmer, B., & McAuley, E. (2002). Testing the requirements of stages of physical activity among adults: The comparative effectiveness of stage-matched, mismatched, standard care, and control interventions. *Annals of Behavioral Medicine*, 24, 181-189.
- Bock, B. C., Albrecht, A. E., Traficante, R. M., Clark, M. M., Pinto, B. M., Tilkemeier, P., et al. (1997). Predictors of exercise adherence following participation in a cardiac rehabilitation program. *International Journal of Behavioral Medicine*, 4, 60-75.
- Bock, B. C., Marcus, B. H., Pinto, B. M., & Forsyth, L. H. (2001). Maintenance of physical activity following an individualized motivationally tailored intervention. *Annals of Behavioral Medicine*, 23, 79-87.
- Booth, M. L., Macaskill, P., Owen, N., Oldenburg, B., Marcus, B. H., & Bauman, A. (1993). Population prevalence and correlates of stages of change in physical activity. *Health Education Quarterly*, 20, 431-440.
- Boudreaux, E. D., Wood, K. B., Mehan, D., Scarinci, I., Carmack-Taylor, C. L., & Brantley, P. J. (2003). Congruence of readiness to change, self-efficacy, and decisional balance for physical activity and dietary fat reduction. *American Journal of Health Promotion*, 17, 329-336.
- Boyle, R. G., O'Connor, P. J., Pronk, N., & Tan, A. (1998). Stages of change for physical activity, diet, and smoking among HMO members with chronic conditions. *American Journal of Health Promotion*, 12, 170-175.
- Buckworth, J., & Wallace, L. S. (2002). Application of the transtheoretical model to physically active adults. *Journal of Sports Medicine and Physical Fitness*, 42, 360-367.
- Bull, F. C., Eyler, A. A., King, A. C., & Brownson, R. C. (2001). Stage of readiness to exercise in ethnically diverse women: A U.S. survey. *Medicine and Science in Sport and Exercise*, 33, 1147-1156.
- Burke, V., Richards, J., Milligan, R. A. K., Beilin, L. J., Dunbar, D., & Gracey, M. P. (2000). Stages of change for health-related behaviors in 18-year-old Australians. *Psychology and Health*, 14, 1061-1075.
- Burn, G. E., Naylor, P. J., & Page, A. (1999). Assessment of stages of change for exercise within a worksite lifestyle screening program. *American Journal of Health Promotion*, 13, 143-145.
- Buxton, K., Wyse, J., & Mercer, T. (1996). How applicable is the stages of change model to exercise behavior? A review. *Health Education Journal*, 55, 239-257.
- Buxton, K. E., Mercer, T. H., Hale, B. D., Wyse, J. P., & Ashford, B. (1994a). Evidence for the concurrent validity and measurement reliability of a stages of exercise behavior change instrument. *North American Society for Psychology of Sport and Physical Activity Abstracts*, 16, S35.
- Buxton, K. E., Mercer, T. H., Hale, B. D., Wyse, J. P., & Ashford, B. (1994b). Preliminary validation of a Stages of Physical Activity Behavior Change Scale (SPABC). *North American Society for Psychology of Sport and Physical Activity Abstracts*, 16, S36.
- Calfas, K. J., Long, B. J., Sallis, J. F., Wooten, W. J., Pratt, M., & Patrick, K. (1996). A controlled trial of physician counseling to promote the adoption of physical activity. *Preventive Medicine*, 25, 225-233.
- Callaghan, P., Eves, F. F., Norman, P., Chang, A. M., & Lung, C. Y. (2002). Applying the transtheoretical model of change to exercise in young Chinese people. *British Journal of Health Psychology*, 7, 267-282.
- Campbell, M. K., Tessaro, I., DeVellis, B., Benedict, S., Kelsey, K., Belton, L., et al. (2000). Tailoring and targeting a worksite health promotion program to address multiple health behaviors among blue-collar women. *American Journal of Health Promotion*, 14, 306-313.
- Cardinal, B. J. (1995a). Behavioral and biometric comparisons of the preparation, action and maintenance stages of exercise. *Wellness Perspectives*, 11, 36-43.
- Cardinal, B. J. (1995b). The Stages of Exercise Scale and Stages of Exercise Behavior in female adults. *Journal of Sports Medicine and Physical Fitness*, 35, 87-92.
- Cardinal, B. J. (1997a). Construct validity of stages of change for exercise behavior. *American Journal of Health Promotion*, 12, 68-74.
- Cardinal, B. J. (1997b). Predicting exercise behavior using components of the transtheoretical model of behavior change. *Journal of Sport Behavior*, 20, 272-284.
- Cardinal, B. J. (1998). Interaction between stage of exercise and history of exercise relapse. *Journal of Human Movement Studies*, 34, 175-185.
- Cardinal, B. J. (1999). Extended stage model of physical activity behavior. *Journal of Human Movement Studies*, 37, 37-54.
- Cardinal, B. J., Engels, H., & Zhu, W. (1998). Application of the transtheoretical model of behavior change to preadolescents' physical activity and exercise behavior. *Pediatric Exercise Science*, 10, 69-80.
- Cardinal, B. J., Jacques, K. M., & Levy, S. S. (2002). Evaluation of a university course aimed at promoting exercise behavior. *Journal of Sports Medicine and Physical Fitness*, 42, 113-119.
- Cardinal, B. J., & Sachs, M. L. (1995). Prospective analysis of stage-of-exercise movement following mail-delivered, self-instructional exercise packets. *American Journal of Health Promotion*, 9, 430-432.
- Cardinal, B. J., Tuominen, K. J., & Rintala, P. (2003). Psychometric assessment of Finnish versions of exercise-related measures of transtheoretical model constructs. *International Journal of Behavioral Medicine*, 10, 31-43.
- Carnegie, M. A., Bauman, A., Marshall, A. L., Mohsin, M., Westley-Wise, V., & Booth, M. L. (2002). Perceptions of the physical environment, stage of change for physical activity, and walking among Australian adults. *Research Quarterly in Exercise and Sport*, 73, 146-155.
- Centers for Disease Control and Prevention. (n.d.). *The Futures Initiative*. Retrieved June 15, 2004, from <http://www.cdc.gov/futures>
- Christopoulou, M., McKenna, J., & Naylor, P. J. (1996). Assessing self-efficacy and the stages of exercise behavior change [Abstract]. *Journal of Sport Science*, 14, S23-S24.
- Clarke, P., & Eves, F. (1997). Applying the transtheoretical model to the study of exercise prescription. *Journal of Health Psychology*, 2, 195-207.
- Cole, G., Leonard, B., Hammond, S., & Fridinger, F. (1998). Using "stages of behavioral change" constructs to measure the short-term effects of a worksite-based intervention to increase moderate physical activity. *Psychological Reports*, 82, 615-618.
- Costakis, C. E., Dunnagan, T., & Haynes, G. (1999). The relationship between the stages of exercise adoption and other health behaviors. *American Journal of Health Promotion*, 14, 22-30.
- Courneya, K. S. (1995). Perceived severity of the consequences of physical inactivity across the stages of change in older adults. *Journal of Sport and Exercise Psychology*, 17, 447-458.
- Cowan, R., Logue, E., Milo, L., Britton, P. J., & Smucker, W. (1997). Exercise stage of change and self-efficacy in primary care: Implications for intervention. *Journal of Clinical Psychology in Medical Settings*, 4, 295-311.
- Dallow, C. B., & Anderson, J. (2003). Using self-efficacy and a transtheoretical model to develop a physical activity intervention for obese women. *American Journal of Health Promotion*, 17, 373-381.

- Davis, L. (2000). Exercise and dietary behaviors in African American elders: Stages of change in efficacy expectancies. *Association of Black Nursing Faculty Journal*, 11, 56-58.
- Diehl, N. S., Lewis-Stevenson, S., Spruill, I., & Egan, B. (2001). Cardiovascular disease risk, physical activity, and self-efficacy in National Black Nurses Association Conference attendees. *Journal of the National Black Nurses Association*, 12, 10-17.
- Doherty, S. C., Steptoe, A., Rink, E., Kendrick, T., & Hilton, S. (1998). Readiness of change health behaviors among patients at high risk of cardiovascular disease. *Journal of Cardiovascular Risk*, 5, 147-153.
- Donovan, R. J., Jones, S., Holman, C. D., & Corti, B. (1998). Assessing the reliability of a stage of change scale. *Health Education Research*, 13, 285-291.
- Dunn, A. L., Andersen, R. E., & Jakicic, J. M. (1998). Lifestyle physical activity interventions: History, short- and long-term effects, and recommendations. *American Journal of Preventive Medicine*, 15, 398-412.
- Dunn, A. L., Marcus, B. H., Kampert, J. B., Garcia, M. E., Kohl, H. W., & Blair, S. N. (1997). Reduction in cardiovascular disease risk factors: Six-month results from Project Active. *Preventive Medicine*, 26, 883-892.
- Dunnagan, T., Haynes, G., & Smith, V. (2001). The relationship between the stages of change for exercise and health insurance costs. *American Journal of Health Behavior*, 25, 447-459.
- Eves, F., Mant, S., & Clarke, P. (1996). Barriers to exercise at different stages of exercise behavior [Abstract]. *Journal of Sport Science*, 14, S29.
- Faulkner, G., & Biddle, S. (2001). Predicting physical activity promotion in health care settings. *American Journal of Health Promotion*, 16, 98-106.
- Felton, G. M., Ott, A., & Jeter, C. (2000). Physical activity stages of change in African American women: Implications for nurse practitioners. *Nurse Practitioner Forum*, 11, 116-123.
- Frenn, M., Malin, S., & Bansal, N. K. (2003). Stage-based interventions for low-fat diet with middle school students. *Journal of Pediatric Nursing*, 18(1), 36-45.
- Gebhardt, W. A., Dusseldorp, E., & Maes, S. (1999). Measuring transitions through stages of exercise: Application of latent transition analysis. *Perceptual and Motor Skills*, 88, 1097-1106.
- Gold, D. B., Anderson, D. R., & Serxner, S. A. (2000). Impact of a telephone-based intervention on the reduction of health risks. *American Journal of Health Promotion*, 15, 97-106.
- Goldberg, J. M., Christopher, M. R. J., Aznar, S., Barnes, J. K., Simmonds, G. J., McKenna, J., et al. (1996). The processes of exercise behavior change used by years 7 and 17 adolescents [Abstract]. *Journal of Sport Science*, 14, S30.
- Goldstein, M. G., Pinto, B. M., Marcus, B. H., Lynn, H., Jette, A. M., Rakowski, W. M., et al. (1999). Physician-based physical activity counseling for middle-aged and older adults: A randomized trial. *Annals of Behavioral Medicine*, 21, 40-47.
- Gonzalez, B. C. S., & Jirovec, M. M. (2001). Elderly Mexican women's perceptions of exercise and conflicting role responsibilities. *International Journal of Nursing Studies*, 38, 45-49.
- Gorley, T., & Gordon, S. (1995). An examination of the transtheoretical model and exercise behavior in older adults. *Journal of Sport and Exercise Psychology*, 17, 312-325.
- Hager, R. L., Hardy, A., Aldana, S. G., & George, J. D. (2002). Evaluation of an Internet, stage-based physical activity intervention. *American Journal of Health Education*, 33, 329-335.
- Hammermeister, J. J., Page, R. M., & Dolny, D. (2000). Psychosocial, behavioral, and biometric characteristics of stages of exercise adoption. *Psychological Reports*, 87, 205-217.
- Harland, J., White, M., Drinkwater, C., Chinn, D., Farr, L., & Howel, D. (1999). The Newcastle Exercise Project: A randomised controlled trial of methods to promote physical activity in primary care. *British Medical Journal*, 319, 828-832.
- Harris, R. P., Helfand, M., Woolf, S. H., Lohr, K. N., Mulrow, C. D., Teutsch, S. M., et al. (2001). Current methods of the U.S. Preventive Task Force: A review of the process. *American Journal of Preventive Medicine*, 20, 21-35.
- Hausenblas, H. A., Nigg, C. R., Dannecker, E. A., Downs, D. S., Gardner, R. E., Fallon, E. A., et al. (2001). A missing piece of the transtheoretical model applied to exercise: Development and validation of the temptation to not exercise scale. *Psychology and Health*, 16, 381-390.
- Hausenblas, H. A., Nigg, C. R., Dannecker, E. A., Downs, D. S., Gardner, R. E., Fallon, E. A., et al. (2002). Perceptions of exercise stages, barrier self-efficacy, and decisional balance for middle-level school students. *Journal of Early Adolescence*, 22, 436-454.
- Health Promotion FIRST (S. 628). (n.d.) Retrieved June 29, 2005, from <http://www.senate.gov>
- Heesch, K. C., Brown, D. R., & Blanton, C. J. (2000). Perceived barriers to exercise and stage of exercise adoption in older women of different racial/ethnic groups. *Women and Health*, 30, 61-76.
- Hellman, E. A. (1997). Use of the stages of change in exercise adherence model among older adults with a cardiac diagnosis. *Journal of Cardiopulmonary Rehabilitation*, 17, 145-155.
- Herrick, A. B., Stone, W. J., & Mettler, M. M. (1997). Stages of change, decisional balance, and self-efficacy across four health behaviors in a worksite environment. *American Journal of Health Promotion*, 12, 49-56.
- Hilton, S., Doherty, S., Kendrick, T., Kerry, S., Rink, E., & Steptoe, A. (1999). Promotion of healthy behavior among adults at increased risk of coronary heart disease in general practice: Methodology and baseline data from the Change of Heart Study. *Health Education Journal*, 58, 3-16.
- Horowitz, S. (2003). Applying the transtheoretical model to pregnancy and STD prevention: A review of the literature. *American Journal of Health Promotion*, 17, 304-328.
- Improved Nutrition and Physical Activity Act (S. 1172). (n.d.) Retrieved June 15, 2004, from www.senate.gov
- Inglede, D. K., Markland, D., & Medley, A. R. (1998). Exercise motives and stages of change. *Journal of Health Psychology*, 3, 477-489.
- Jaffee, L., Lutter, J. M., Rex, J., Hawkes, C., & Bucaccio, P. (1999). Incentives and barriers to physical activity for working women. *American Journal of Health Promotion*, 13, 215-218.
- Janis, I. L., & Mann, L. (1977). *Decision making: A psychological Analysis of conflict, choice, and commitment*. New York: Free Press.
- Jarvis, K. L., Friedman, R. H., Heeren, T., & Cullinane, P. M. (1997). Older women and physical activity: Using the telephone to walk. *Women's Health Issues*, 7, 24-29.
- Jones, N. D., Della Corte, M. R., Nigg, C. R., Clark, P. G., & Burbank, P. M. (2001). Seniorcise: A print exercise intervention for older adults. *Educational Gerontology*, 27, 717-728.
- Jordan, P. J., Nigg, C. R., Norman, G. J., Rossi, J. S., & Benisovich, S. V. (2002). Does the transtheoretical model need an attitude adjustment? Integrating attitude with decisional balance as predictors of stage of change for exercise. *Psychology of Sport and Exercise*, 3, 65-83.
- Jue, N. H., & Cunningham, S. L. (1998). Stages of exercise behavior change at two time periods following coronary artery bypass graft surgery. *Progress in Cardiovascular Nursing*, 13, 23-33.

- Kao, Y., Lu, C., & Huang, Y. (2002). Impact of a transtheoretical model on the psychosocial factors affecting exercise among workers. *Journal of Nursing Research*, 10, 303-309.
- Kearney, J. M., deGraaf, C., Damkjaer, S., & Engstrom, L. M. (1999). Stage of change towards physician activity in a nationally representative sample in the European Union. *Public Health Nutrition*, 2, 115-124.
- Kieltka, R. L., Ziemer, D. C., & Thompson, N. J. (1999). The stages of change theory predicts relationship between exercise and glycemic control in African American patients with type 2 diabetes [Abstract]. *Diabetes*, 48, SA322.
- King, T. K., Marcus, B. H., Pinto, B. M., Emmons, K. M., & Abrams, D. B. (1996). Cognitive-behavioral mediators of changing multiple behaviors: Smoking and a sedentary lifestyle. *Preventive Medicine*, 25, 684-691.
- Kirk, A. F., Higgins, L. A., Hughes, A., Fisher, B. M., Mutrie, N., Hillis, S., et al. (2001). A randomized, controlled trial to study the effect of exercise consultation on the promotion of physical activity in people with Type 2 diabetes: A pilot study. *Diabetic Medicine*, 18, 877-882.
- Klein, D. A., & Stone, W. J. (2002). Stages of exercise behavior and caloric expenditure. *Journal of Sports Medicine and Physical Fitness*, 42, 95-102.
- Kohl, H. W., Dunn, A. L., Marcus, B. H., & Blair, S. N. (1998). A randomized trial of physical activity interventions: Design and baseline data from Project Active. *Medicine and Science in Sports and Exercise*, 30(2), 275-283.
- Laffrey, S. C. (2000). Physical activity among older Mexican American women. *Research in Nursing and Health*, 23, 383-392.
- Laforge, R. G., Rossi, J. S., Prochaska, J. O., Velicer, W. F., Levesque, D. A., & McHorney, C. A. (1999). Stage of regular exercise and health-related quality of life. *Preventive Medicine*, 28, 349-360.
- Laforge, R. G., Velicer, W. F., Richmond, R. L., & Owen, N. (1999). Stage distributions for five health behaviors in the United States and Australia. *Preventive Medicine*, 28, 61-74.
- Lechner, L., & De Vries, H. (1995). Starting participation in an employee fitness program: Attitudes, social influence, and self-efficacy. *Preventive Medicine*, 24, 627-633.
- Lee, C. (1993). Attitudes, knowledge, and stages of change: A survey of exercise patterns in older Australian women. *Health Psychology*, 12, 476-480.
- Lee, R. E., Nigg, C. R., DiClemente, C. C., & Courneya, K. S. (2001). Validating motivational readiness for exercise behavior with adolescents. *Research Quarterly in Exercise and Sport*, 72, 401-410.
- Leenders, N., Silver, L. W., White, S. L., Buckworth, J., & Sherman, W. M. (2002). Assessment of physical activity, exercise self-efficacy, and stages of change in college students using a street-based survey method. *American Journal of Health Education*, 33, 199-205.
- Logue, E., Sutton, K., Jarjoura, D., & Smucker, W. (2000). Obesity management in primary care: Assessment of readiness to change among 284 family practice patients. *Journal of the American Board of Family Practitioners*, 13, 164-171.
- Loughlan, C., & Mutrie, N. (1997). An evaluation of the effectiveness of three interventions in promoting physical activity in a sedentary population. *Health Education Journal*, 56, 154-165.
- Marcus, B. H., Banspach, S. W., Lefebvre, R. C., Rossi, J. S., Carleton, R. A., & Abrams, D. B. (1992). Using the stages of change model to increase the adoption of physical activity among community participants. *American Journal of Health Promotion*, 6, 424-429.
- Marcus, B. H., Bock, B. C., Pinto, B. M., Forsyth, L. H., Roberts, M. B., & Traficante, R. M. (1998). Efficacy of an individualized, motivationally tailored physical activity intervention. *Annals of Behavioral Medicine*, 20, 174-180.
- Marcus, B. H., Eaton, C. A., Rossi, J. S., & Harlow, L. L. (1994). Self-efficacy, decision-making, and stages of change: An integrative model of physical exercise. *Journal of Applied Social Psychology*, 24, 489-509.
- Marcus, B. H., Emmons, K. M., Simkin-Silverman, L., Linnan, L. A., Taylor, E. R., Bock, B. C., et al. (1998). Evaluation of motivationally tailored vs. standard self-help physical activity interventions at the workplace. *American Journal of Health Promotion*, 12, 246-253.
- Marcus, B. H., Goldstein, M. G., Jette, A., Simkin-Silverman, L., Pinto, B. M., Milan, F., et al. (1997). Training physicians to conduct physical activity counseling. *Preventive Medicine*, 26(3), 382.
- Marcus, B. H., Pinto, B. M., Simkin, L. R., Audrain, J. E., & Taylor, E. R. (1994). Application of the theoretical models to exercise behavior among employed women. *American Journal of Health Promotion*, 9, 49-55.
- Marcus, B. H., Rossi, J. S., Selby, V. C., Niaura, R. S., & Abrams, D. B. (1992). The stages and processes of exercise adoption and maintenance in a worksite sample. *Health Psychology*, 11, 386-395.
- Marcus, B. H., Selby, V. C., Niaura, R. S., & Rossi, J. S. (1992). Self-efficacy and the stages of exercise behavior change. *Research Quarterly in Exercise and Sport*, 63, 60-66.
- Marcus, B. H., & Simkin, L. R. (1993). The stages of exercise behavior. *Journal of Sports Medicine and Physical Fitness*, 33, 83-88.
- Marcus, B. H., & Simkin, L. R. (1994). The transtheoretical model: Applications to exercise behavior. *Medicine and Science in Sport and Exercise*, 26, 1400-1404.
- Marcus, B. H., Simkin, L. R., Rossi, J. S., & Pinto, B. M. (1996). Longitudinal shifts in employees' stages and processes of exercise behavior change. *American Journal of Health Promotion*, 10, 195-200.
- Marshall, S. J., & Biddle, S. J. H. (2001). The transtheoretical model of behavior change: A meta-analysis of applications to physical activity and exercise. *Annals of Behavioral Medicine*, 23, 229-246.
- Mau, M. K., Glanz, K., Severino, R., Grove, J. S., Johnson, B., & Curb, J. D. (2001). Mediators of lifestyle behavior change in Native Hawaiians. *Diabetes Care*, 24, 1770-1775.
- McKenna, J., Naylor, P., & McDowell, N. (1998). Barriers to physical activity promotion by general practitioners and practice nurses. *British Journal of Sports Medicine*, 32, 242-247.
- Messick, S. (1989). Validity. In R. L. Linn (Ed.), *Educational measurement* (3rd ed.) New York: American Council on Education, Macmillan.
- Mettler, M. M., Stone, W. H., Herrick, A. B., & Klein, D. A. (2000). Evaluation of a community-based physical activity campaign via the transtheoretical model. *Health Promotion Practice*, 1, 351-359.
- Migneault, J., Adams, T., & Read, J. (in press). The transtheoretical model to change and addictive substances: A review of the literature. *Drug and Alcohol Review*.
- Miilunpalo, S., Nupponen, R., Laitakari, J., Marttila, J., & Paronen, O. (2000). Stages of change in two modes of health-enhancing physical activity: Methodological aspects and promotional implications. *Health Education Research*, 15, 435-448.
- Mullan, E., & Markland, D. (1997). Variations in self-determination across the stages of change for exercise in adults. *Motivation and Emotion*, 21, 349-362.
- Mutrie, N., Carney, C., Blamey, A., Crawford, F., Aitchison, T., & Whitelaw, A. (2002). "Walk in to Work Out": A randomized controlled trial of a self help intervention to promote active commuting. *Journal of Epidemiology and Community Health*, 56, 407-412.

- Myers, R. S., & Roth, D. L. (1997). Perceived benefits of and barriers to exercise and stage of exercise adoption in young adults. *Health Psychology, 16*, 277-283.
- Natarajan, S., Clyburn, E. B., & Brown, R. T. (2002). Association of exercise stages of change with glycemic control in individuals with type 2 diabetes. *American Journal of Health Promotion, 17*, 72-75.
- National Institutes of Health. (n.d.). *Behavior Change Consortium. Seven-day physical activity recall*. Available at <http://www1.od.nih.gov/behaviorchange/measures/7dayPAR.htm>
- Naylor, P. J., Simmonds, G., Riddoch, C., Velleman, G., & Turton, P. (1999). Comparison of stage-matched and unmatched interventions to promote exercise behavior in the primary care setting. *Health Education Research, 14*, 653-666.
- Nelson, M. S., & Gordon, M. S. (2003). Physical activity determinants of military health care recipients. *Military Medicine, 168*, 212-218.
- Nguyen, M. N., Potvin, L., & Otis, J. (1997). Regular exercise in 30- to 60-year-old men: Combining the stages-of-change model and the theory of planned behavior to identify determinants for targeting heart health interventions. *Journal of Community Health, 22*, 233-246.
- Nigg, C. R. (2001). Explaining adolescent exercise behavior change: A longitudinal application of the transtheoretical model. *Annals of Behavioral Medicine, 23*, 11-20.
- Nigg, C. R., Burbank, P. M., Padula, C., Dufresne, R., Rossi, J. S., Velicer, W. F., et al. (1999). Stages of change across ten health risk behaviors for older adults. *The Gerontologist, 39*, 473-482.
- Nigg, C. R., & Courneya, K. S. (1998). Transtheoretical model: Examining adolescent exercise behavior. *Journal of Adolescent Health, 22*, 214-224.
- Nigg, C. R., English, C., Owens, N., Burbank, P., Connolly-Belanger, A., Dufresne, R., et al. (2002). Health correlates of exercise behavior and stage change in a community-based exercise intervention for the elderly: A pilot study. *Health Promotion Practice, 3*, 421-428.
- Norris, S. L., Grothaus, L. C., Buchner, D. M., & Pratt, M. (2000). Effectiveness of physician-based assessment and counseling for exercise in a staff model HMO. *Preventive Medicine, 30*, 513-523.
- Omar-Fauzee, M. S., Pringle, A., & Lavalley, D. (1999). Exercise behavior change and the effect of lost resources. *Journal of Personal and Interpersonal Loss, 4*, 281-291.
- Parchman, M. L., Pugh, J. A., Noel, P. H., & Larme, A. C. (2002). Continuity of care, self-management behaviors, and glucose control in patients with type 2 diabetes. *Medical Care, 40*, 137-144.
- Peterson, T. R., & Aldana, S. G. (1999). Improving exercise behavior: An application of the stages of change model in a worksite setting. *American Journal of Health Promotion, 13*, 229-232.
- Pinto, B. M., Friedman, R., Marcus, B. H., Kelley, H., Tennstedt, S., & Gillman, M. W. (2002). Effects of a computer-based, telephone-counseling system on physical activity. *American Journal of Preventive Medicine, 23*, 113-120.
- Pinto, B. M., Lynn, H., Marcus, B. H., DePue, J., & Goldstein, M. G. (2001). Physician-based activity counseling: Intervention effects on mediators of motivational readiness for physical activity. *Annals of Behavioral Medicine, 23*, 2-10.
- Pinto, B. M., & Marcus, B. H. (1995). A stages of change approach to understanding college students' physical activity. *Journal of American College Health, 44*, 27-31.
- Plotnikoff, R. C., Hotz, S. B., Birkett, N. J., & Courneya, K. S. (2001). Exercise and the transtheoretical model: A longitudinal test of a population sample. *Preventive Medicine, 33*, 441-452.
- Potvin, L., Gauvin, L., & Nguyen, N. M. (1997). Prevalence of stages of change for physical activity in rural, suburban and inner-city communities. *Journal of Community Health, 22*, 1-13.
- Prochaska, J. O., & DiClemente, C. C. (1984). Self-change processes, self-efficacy and decisional balance across five stages of smoking cessation. *Advances in Cancer Control: Epidemiological Research, 131-140*.
- Prochaska, J. O., DiClemente, C. C., & Norcross, J. C. (1992). In search of how people change: Applications to addictive behaviors. *American Psychologist, 47*, 1102-1114.
- Reed, G. R., Velicer, W. F., Prochaska, J. O., Rossi, J. S., & Marcus, B. H. (1997). What makes a good staging algorithm: Examples from regular exercise. *American Journal of Health Promotion, 12*, 57-66.
- Renger, R., Steinfelt, V., & Lazarus, S. (2002). Assessing the effectiveness of a community-based media campaign targeting physical inactivity. *Family and Community Health, 25*(3), 18-30.
- Resnick, B., & Nigg, C. (2003). Testing a theoretical model of exercise behavior of older adults. *Nursing Research, 52*, 80-88.
- Rich, S. C., & Rogers, M. E. (2001). Stage of exercise change model and attitudes toward exercise in older adults. *Perceptual Motor Skills, 93*, 141-144.
- Riebe, D., Greene, G. W., Ruggiero, L., Stillwell, K. M., Blissmer, B., Nigg, C. R., et al. (2003). Evaluation of a healthy-lifestyle approach to weight management. *Preventive Medicine, 36*, 45-54.
- Rodgers, W. M., Courneya, K. S., & Bayduza, A. L. (2001a). Examination of the transtheoretical model and exercise in 3 populations. *American Journal of Health Behavior, 25*, 33-41.
- Rodgers, W. M., Courneya, K. S., & Bayduza, A. L. (2001b). Utility of the transtheoretical model for understanding lifestyle versus traditional exercise behavior change. *Avante, 7*(3), 28-40.
- Ronda, G., Van Assema, P., & Brug, J. (2001). Stages of change, psychological factors and awareness of physical activity levels in the Netherlands. *Health Promotion International, 16*, 305-314.
- Rosen, C. S. (2000). Integrating stage and continuum models to explain processing of exercise messages and exercise initiation among sedentary college students. *Health Psychology, 19*, 172-180.
- Sarkin, J. A., Johnson, S. S., Prochaska, J. O., & Prochaska, J. M. (2001). Applying the transtheoretical model to regular moderate exercise in an overweight population: Validation of a stages of change measure. *Preventive Medicine, 33*, 462-469.
- Schumann, A., Nigg, C. R., Rossi, J. S., Jordan, P. B., Norman, G. J., Garber, C. E., et al. (2002). Construct validity of the stages of change of exercise adoption for different intensities of physical activity in four samples of differing age groups. *American Journal of Health Promotion, 16*, 280-287.
- Simmonds, G. J., Naylor, P. J., Riddoch, C. J., & Velleman, G. (1996). Stage-based counseling for exercise in primary care: A controlled trial [Abstract]. *Journal of Sports Science, 14*, 45-46.
- Snelling, S., & Adams, T. (2004). *The transtheoretical model to change and dietary behavior: A review of the literature*. Manuscript submitted for publication.
- Spencer, L. S., Pagell, F., Hallion, M. E., & Adams, T. B. (2002). Applying the transtheoretical model to tobacco cessation: A review of literature. *American Journal of Health Promotion, 17*(1), 7-71.
- Spencer, L. S., Pagell, F. L., & Adams, T. B. (2005). Applying the transtheoretical model to cancer screening behavior: A review of literature. *American Journal of Health Behavior, 29*(1), 36-56.
- Steptoe, A., Kerry, S., Rink, E., & Hilton, S. (2001). The impact of behavioral counseling on stage of change in fat intake, physical activity, and cigarette smoking in adults at increased risk of coronary heart disease. *American Journal of Public Health, 91*, 265-269.

- Steptoe, A., Rink, E., & Kerry, S. (2000). Psychosocial predictors of changes in physical activity in overweight sedentary adults following counseling in primary care. *Preventive Medicine, 31*, 183-194.
- Stevens, M., Lemmink, F., & de Greef, N. (2000). Groningen active living model (GALM): Stimulating physical activity in sedentary older adults: First results. *Preventive Medicine, 31*, 547-553.
- Stump, E., & Olsheski, J. (2001, October). Predicting patient adherence in cardiac rehabilitation programs. *Care Management, 7*(5), 27-31.
- Sullivan, E. D., & Joseph, D. H. (1998). Struggling with behavior changes: A special case for clients with diabetes. *Diabetes Educator, 24*, 72-77.
- Sullum, J., Clark, M. M., & King, T. K. (2000). Predictors of exercise relapse in a college population. *Journal of American College Health, 48*, 175-180.
- Suminski, R. R., & Petosa, R. (2002). Stages of change among ethnically diverse college students. *Journal of American College Health, 51*, 26-31.
- Sutton, S. (2000). Interpreting cross-sectional data on stages of change. *Psychology and Health, 15*, 163-171.
- Titze, S., Martin, B. W., Seiler, R., Stronegger, W., & Marti, B. (2001). Effects of a lifestyle physical activity intervention on stages of change and energy expenditure in sedentary employees. *Psychology of Sport and Exercise, 2*, 103-116.
- Tucker, M., & Reicks, M. (2002). Exercise as a gateway behavior for healthful eating among older adults: An exploratory study. *Journal of Nutrition Education and Behavior, 34*(Suppl 1), S14-S19.
- Van Vorst, J. G., Buckworth, J., & Mattern, C. (2002). Physical self-concept and strength changes in college weight training classes. *Research Quarterly in Exercise and Sport, 73*, 113-117.
- Wakui, S., Shomomitsu, T., Odagiri, Y., Inoue, S., Takamiya, T., & Ohya, Y. (2002). Relation of the stages of change for exercise behaviors, self-efficacy, decisional balance, and diet-related psycho-behavioral factors in young Japanese women. *Journal of Sports Medicine and Physical Fitness, 42*, 224-232.
- Walcott-McQuigg, J. A., & Prohaska, T. R. (2001). Factors influencing participation of African American elders in exercise behavior. *Public Health Nursing, 18*, 194-203.
- Wallace, L. S., & Buckworth, J. (2001). Application of the transtheoretical model to exercise behavior among nontraditional college students. *American Journal of Health Education, 32*, 39-47.
- Wallace, L. S., Buckworth, J., Kirby, T. E., & Sherman, W. M. (2000). Characteristics of exercise behavior among college students: Application of social cognitive theory to predicting stage of change. *Preventive Medicine, 31*, 494-505.
- Walton, J., Hoerr, S., Heine, L., Frost, S., Roisen, D., & Berkimer, M. (1999). Physical activity and stages of change in fifth and sixth graders. *Journal of School Health, 69*, 285-289.
- Weinstein, N. D., Rothman, A. J., & Sutton, S. R. (1998). Stage theories of health behavior: Conceptual and methodological issues. *Health Psychology, 17*, 290-299.
- Wister, A., & Romeder, Z. (2002). The chronic illness context and change in exercise self care among older adults: A longitudinal analysis. *Canadian Journal on Aging, 21*, 521-534.
- Woods, C., Mutrie, N., & Scott, M. (2002). Physical activity intervention: A transtheoretical model-based intervention designed to help sedentary young adults become active. *Health Education Research, 17*, 451-460.
- Wyse, J., Mercer, T., Ashford, B., Buxton, K., & Gleeson, N. (1995). Evidence for the validity and utility of the Stages of Exercise Behaviour Change Scale in young adults. *Health Education Research, 10*, 365-377.