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A Research Agenda to Examine the Efficacy and Relevance of the Transtheoretical Model for Physical Activity Behavior

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Abstract

Regular physical activity (PA) decreases the risk of several chronic diseases including some cancers, type II diabetes, obesity, and cardiovascular disease; however, the majority of US adults are not meeting the recommended levels to experience these benefits. To address this public health concern, the underlying mechanisms for behavior change need to be understood, translated and disseminated into appropriately tailored interventions. The Transtheoretical Model (TTM) provides a framework for both the conceptualization and measurement of behavior change, as well as facilitating promotion strategies that are individualized and easily adapted. The purpose of this manuscript is to present the constructs of the TTM as they relate to PA behavior change. We begin with a brief synopsis of recent examinations of the TTM constructs and their application. Subsequent to its introduction, we specifically present the TTM within the PA context and discuss its application and usefulness to researchers and practitioners. Criticisms of the TTM are also noted and presented as opportunities for future research to enhance the valid application of the TTM. We offer general study design recommendations to appropriately test the hypothesized relationships within the model. With further examinations using appropriate study design and statistical analyses, we believe the TTM has the potential to advance the public health impact of future PA promotion interventions.

Increasing Physical Activity (PA) has been designated high priority in Healthy People 2010 Objectives (U.S. Department of Health and Human Services (USDHHS), 2000). PA has the

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potential to reduce the risk of coronary heart disease (CHD) (J. Lee, Sparrow, Vokonas, Landsberg, & Weiss, 1995; Manson, et al., 1999; Morris, Clayton, Everitt, Semmence, & Burgess, 1990; Paffenbarger & Hyde, 1984; Paffenbarger, Hyde, Hsieh, & Wing, 1986; Powell, Thompson, Caspersen, & Kendrick, 1987), hypertension, type 2 diabetes mellitus, obesity (Albright, et al., 2000; Grundy, et al., 1999; Hu, et al., 1999; Paffenbarger, Wing, Hyde, & Jung, 1983), various cancers (Lee, 2003), and overall mortality (I. M. Lee & Skerrett, 2001). Furthermore, physical inactivity accounts for an estimated 200,000 deaths annually (Powell & Blair, 1994) and is a key contributor to the 50% increase in obesity prevalence among US adults during the past decade (Mokdad, et al., 1999).

Considering this evidence, the USDHHS developed the 2008 Physical Activity Guidelines for Americans, recommending adults aged 18 years or older engage in at least 150 minutes a week of moderate-intensity, or 75 minutes a week of vigorous-intensity PA (2008). Unfortunately, despite widespread attempts to increase PA in the general population, 39% of adults are considered inactive and 61% never engage in any periods of vigorous-intensity PA (Pleis & Lucas, 2009). In reflection of the numerous health benefits associated with PA, this low occurrence among US adults is a clear public health concern.

In order to address this concern, the underlying mechanisms for behavior change (i.e., increased PA) need to be clarified and translated into interventions that can then be disseminated. In addition to providing a framework for both the conceptualization and measurement of behavior change, the Transtheoretical Model of Behavior Change (TTM) (Prochaska & DiClemente, 1983; Prochaska, Redding, & Evers, 1996) facilitates intervention strategies that are both individually tailored and easily modified to fit diverse populations.

Several approaches to health behavior have examined whether individuals were at a criterion or not (e.g., Courneya, 1995); however, behavior change is dynamic and experts recommend a more complex framework (Dishman, 1988; Sallis & Hovell, 1990; Sonstroem, 1988). A model used to explain and to motivate individuals to engage in health behaviors should include a range of mechanisms appropriate for those not ready for change, those habitually involved, and those regressing or relapsing. Further, there are many aspects of motivation. For example, incentives to engage in a health behavior may be self-centered, socially focused, intrinsic (i.e., enjoyment) and/or achievement oriented. The TTM is appealing because it categorizes individuals according to their readiness to change and then provides practitioners with concrete strategies on how to intervene for a specific individual (e.g., Riebe & Nigg, 1998).

Overall, translation of the TTM research into practice has facilitated efforts to prevent disease, prolong of life, and promote good health. The remaining sections of this paper present the TTM constructs as mechanisms for behavior change applied specifically to PA. We begin by offering a description of research evaluating the interplay between TTM constructs and overview its major advantages and criticisms. Next, we present recent citations for the operationalization of the TTM constructs within the PA context, suggesting optimal approaches to critically evaluate the hypothesized relationships within the model. In general, the purpose of this paper is to describe the mechanisms of the TTM and suggest a research agenda to future research in hopes of advancing the appropriate and effective application of the TTM in future PA interventions.

Constructs of the TTM

The TTM was developed as a comprehensive model of behavior change, incorporating cognitive, behavioral, and temporal aspects into a unified approach for behavior change. The constructs outlined in the TTM consist of the stages of change, the processes of change,

decisional balance, self-efficacy and temptation. Stage of change classifies individuals regarding their progression towards habitual PA and is hypothesized to relate with the other TTM constructs. Thus, individuals' processes of change, decisional balance, self-efficacy, and temptation are expected to change as they move through the stages of change.

The stage of change construct characterizes the time or readiness dimension into five progressive stages along which behavior change occurs. The first stage is precontemplation and includes those individuals with no intention to engage in regular PA. The second stage is contemplation or the intent to engage in regular PA within the next 6 months, which is followed by individuals in the preparation stage who have immediate intentions and commitment to engage in regular PA (i.e., within the next 30 days). Individuals who have actually initiated regular PA behavior have advanced to the action stage. Finally, once an individual has persisted in habitual PA behavior for more than 6 months, he or she has entered the maintenance stage. It should be noted that habitual PA (maintenance) rarely occurs the first time and relapse to earlier stages is expected. Individuals respond to their environment and learn from their failures, eventually trying behavior change again.

The processes of change are the strategies used to progress along the stages of change and are labeled as either experiential or behavioral. Experiential processes are gathered through personal experiences while behavioral processes accumulate from the environment and through action. Research has demonstrated a relationship between a person's stage of change and the specific processes used in that stage (Marshall & Biddle, 2001; Prochaska & DiClemente, 1983; Rhodes, Plotnikoff, & Courneya, 2008), such that experiential processes benefit progression through the earlier stages of change while behavioral processes emerge during later stages. This interplay between the stages and processes of change is considerably constructive to PA promotion, providing information to more efficiently tailor unique, individualized interventions.

Decisional balance is an individual's evaluation regarding the costs (cons) and benefits (pros) of engaging in a behavior, and stage progression is suggested to occur as pros increase and cons decrease (Marshall & Biddle, 2001; Prochaska, et al., 1996). Self-efficacy (personal confidence) is reported to increase with stage progression (Marshall & Biddle, 2001), which was demonstrated for PA among diverse adult populations (Huang, Hung, Chang, & Chang, 2009; Mori, et al., 2009). Temptation (negative urges) has been validated in the PA context (Hausenblas, et al., 2001) and between gender and among ethnicities (Paxton, et al., 2008).

Figure 1 provides a pictorial display of how the TTM constructs are theoretically related. The processes of change theorized as most appropriate at each stage are listed, demonstrating more behavioral processes in advanced stages. Also, notice that decisional balance is expected to have the strongest relationship with the earlier stages of change, which has received strong support from a recent meta-analytics (Hall & Rossi, 2008). Thus, as individuals progress toward preparation, they evolve from perceiving greater cons related to PA (precontemplation) to rating the pros and cons more equally (contemplation, preparation). Also depicted in Figure 1 is the increase in self-efficacy and decrease in temptations that is expected to occur as individuals progress through the stages. In a recent examination of the intention-planning-action relationship related to PA behavior, Lippke and colleagues (2009) reported that self-efficacy moderated this relationship. In other words, the movement of an individual into action depends on higher levels of self-efficacy.

Research examining the TTM constructs has been numerous, ranging from measurement development and validation studies to more recent applications of intervention evaluations. In a recent meta-analytic examination, Hall and Rossi (2008) analyzed 120 separate studies

between 1984 and 2003 that examined the consistency of the TTM within and across 48 different health behaviors (approximately 50,000 participants from 10 different countries). The theoretical mechanisms for behavior change outlined in the TTM were reported as remarkably consistent despite the range of behaviors and populations (Hall & Rossi, 2008). Results implied a common pathway to behavior change (i.e., stages of change), which supports application of the TTM to multiple health behaviors, including PA, among diverse populations.

In addition to construct validation, recent research reports successful application of TTM-based interventions to promote a wide range of health behaviors among various populations. For instance, the stages concept was validated with moderate and strenuous PA among children during PA (Haas & Nigg, 2009), college-age athletes during injury rehabilitation (Clement, 2008), adult high-risk employees (Faghri, Blozie, Gustavesen, & Kotejoshyer, 2008), and among older adults during cardiac rehabilitation (Rivett, et al., 2009) and PA program enrollment (Hildebrand & Neufeld, 2009).

Another benefit of the TTM is its applicability to interventions targeting multiple-behaviors within a single program, suggesting potential for an increased public health impact. For example, Johnson and colleagues (2008) reported significant improvements in healthy eating, exercise, emotional distress management, and weight among overweight/obese adults randomly assigned to a fully tailored, TTM-based multiple behavior intervention. Moreover, significant treatment effects were reported for untreated fruit and vegetable intake, suggesting the potential of a TTM-based intervention to create a unique synergy among multiple health behaviors.

Application of the TTM: Why and for Whom?

A major strength of the TTM is the potential to tailor its constructs to appropriately fit an individual's readiness to begin PA behavior, making individually-based interventions applicable at the population level. Different people are going to be at different levels of readiness to begin PA. For example, some people are only thinking about beginning an exercise program, and others may be searching for ways to make maintenance of their morning walks easier. Both these types of individuals share the common goal of PA; however, they are clearly at different stages of change and require different intervention approaches. Stage-based interventions have successfully increased PA behavior among individuals in each of the stages of change (Daley, Fish, Frid, & Mitchell, 2009; Hildebrand & Neufeld, 2009; Huang, et al., 2009; Johnson, et al., 2008), demonstrating potential for future population-based approaches.

In addition to the potential of a population-based intervention approach, the TTM is clear enough to be used by virtually any type of practitioner or researcher. The TTM has the capacity to combine clinical and public health interventions, maximizing success in health behavior change (Prochaska, et al., 1996). In that sense, it may be feasible that doctors, nurses, social workers, psychologists, and other health-care professionals have future access to materials that bring the TTM model into their offices. For example, a health practitioner could quickly assess a client's stage of change status for PA and efficiently counsel him or her on specific techniques most beneficial to progress toward higher stages (e.g., Bolognesi, Nigg, Massarini, & Lippke, 2006).

Although the TTM has demonstrated numerous positive results, the direct application of the TTM and its measurement scales across health behaviors without preliminary scientific rigor is problematic (Joseph, Breslin, & Skinner, 1999; Nigg & Courneya, 1998). PA is a complex health behavior requiring the adoption rather than cessation of behavior (i.e., smoking) and must be performed above the metabolic equivalent of rest; thus, characteristics of the TTM

relevant to promoting PA may be different than conceptualized for the cessation of smoking. For example, the processes of change have demonstrated inconsistency across different health behaviors (Rosen, 2000) and the higher order processes are not apparent in the PA domain (Marshall & Biddle, 2001). Revised processes of change have been partially validated for PA (Paxton, et al., 2008); however, examinations of factor validity across time and the usefulness of the processes for predicting changes in stages and PA behavior are necessary to determine their relevance to PA behavior change.

One more popular criticism of the TTM involves its classification of behavior change into a series of five distinct stages as opposed to being understood as a continuous process (Armitage, 2009; Bandura, 1997; Brug, et al., 2005; Lippke, Ziegelmann, Schwarzer, & Velicer, 2009; Weinstein, Rothman, & Sutton, 1998). Although there is strong evidence to support the distinction between stages (Hall & Rossi, 2008; Lippke, Nigg & Maddock, 2007; Lippke, Ziegelmann, et al., 2009; Velicer, Redding, Sun, & Prochaska, 2007), ambiguity regarding the use of time-frames to operationalize stages remains a relevant concern. In a novel examination addressing the indicators of behavior change, Lippke and colleagues (2009) demonstrated significant differences between stages based on PA ease, habit and duration. The authors proposed potential value in the elimination of TTM time-frames, suggesting the integration of certain psychological variables (e.g., self-efficacy) for the purpose of classifying individuals along a behavior change continuum (Sutton, 2000).

One significant limitation of this argument, as well as other evaluations of the stage-based approach, is the general reliance on cross-sectional differences in PA levels (Nigg, et al., 2005). Cross-sectional research designs, although cost effective and widely used in research, provide no indication of the sequence of events or of causality and do not indicate whether stage change accompanies behavioral change. More elaborate research designs examining PA levels over time (i.e., longitudinal) are necessary to determine the validity of each stage and its assumed processes for change. Longitudinal study designs with multiple data points are needed to describe stage change across time at the individual level so that the entire outcome of stage transition can be evaluated, including whether progressions to action and maintenance stages are useful for predicting whether people meet a public health recommendation for regular PA (Dishman et al., 2009).

Additional TTM criticisms include incongruent philosophical perspectives, lack of temporal sequence examinations, and a need to examine hypothesized relationships between TTM constructs over longer time periods (i.e., > 1-year). First, the TTM integrates both behavioral and experiential components (i.e., processes of change) into an essentially cognitive model of decision making. On the other hand, the TTM recognizes that specific processes are appropriate at different places along the change continuum, which has been largely effective for PA promotion (e.g., Booth, 2000). Secondly, although presented conceptually, the specific temporal sequencing of the TTM constructs has not been delineated or tested empirically. The ordering is ultimately an empirical question that may depend on stage, which would have direct implications for future PA interventions. For instance, the temptation construct was recently found to be unrelated to PA controlling for self-efficacy (Nigg, et al., 2009), demonstrating the need to incorporate all TTM constructs when analyzing the model's potential to predict PA behavior. Finally, recent research reported variability in stage assessment based on 6 month, 1-year and 2-year time points (Lippke, Ziegelmann, et al., 2009), warranting further investigations.

When interpreting the strengths and weaknesses of the TTM to PA behavior change, there are several noteworthy points to consider. First, the TTM was adapted to PA behavior from its original development in the context of smoking cessation. Smoking and PA are distinct behaviors with contrasting intentions (e.g., nicotine withdrawal symptoms versus doctor

recommendations for PA) and goals (i.e., cessation versus promotion).Thus, it is important to recognize that TTM constructs are not directly generalizable to PA; thus, neither are its criticisms. Given this, critical analyses of the adapted measurement scales to the PA context are needed before we can accurately support or refute these criticisms, which have predominantly manifested from smoking cessation research. Secondly, comparisons and summaries from TTM research need to be cautious when drawling conclusions from studies applying unparallel study designs and/or ineffective intervention strategies (Armitage, 2009). Overall, these limitations offer constructive suggestions that, with appropriate method and study design in the PA context, have the opportunity to advance the valid application of an updated TTM.

Future TTM Examinations

To advance the successful application of TTM-based interventions we suggest three general types of study designs. The first is an exploratory approach to examine TTM and its constructs as a whole, relating it to the mechanisms underlying PA behavior change among diverse populations. Most of the research previously cited has investigated relationships between specific TTM components (e.g., stages of change and processes), discounting other potentially intricate relationships that may exist (e.g., moderation, mediation). Examination of the TTM in its entirety provides specific information regarding the temporal sequencing of its constructs, improving precision in understanding and predicting PA behavior.

Latent-growth modeling (LGM) with parallel change processes is an appropriate approach for examining changes in TTM constructs, excluding stages of change, as potential mediators of change in PA behavior (Chan, 1998; Lance, Vandenberg, & Self, 2000; Willett & Sayer, 1996). LGM with parallel change processes involves the simultaneous estimation of the longitudinal change processes for multiple continuous variables (e.g., self-efficacy, pros, and cons), and provides tests of initial status and change overtime as predictors of initial status and change on multiple other variables (Chan, 1998). Figure 2 depicts a basic LGM model with parallel growth processes. The model includes each measured variable (e.g., Y1) with its associated initial status variable (e.g., baseline status) and linear change variable (e.g., change in status following intervention) which are presented in pairs (η1 and η2; η3 and η4; η5 and 6) (see Lance, Meade, & Williamson, 2000; Willett & Sayer, 1994). With this type of model, researchers can examine the change in each continuous TTM construct across time and then test the capacity for change in the constructs simultaneously with change in PA levels. Note, this approach could be conducted within each stage of change and then within a multi-group framework for examining stage as a moderator of the associations between continuous TTM constructs and change in physical activity.

The second research design we suggest is thorough evaluations of TTM-based interventions with application of a mismatched stage approach. In general, appropriate intervention evaluation has the potential to identify those model constructs functioning in the casual process determining PA. Moreover, with strategic design, the effectiveness of TTM-based interventions can be directly examined. For instance, we suggest RCT designs comparing intervention effectiveness between a stage-matched program (TTM), a non stage-based program (other theory-based approach), and an intentionally mismatched stage-based program (Weinstein, et al., 1998). There are currently only a handful of studies applying this type of design, demonstrating mixed results across health behaviors (Armitage, 2009). Among these studies, only one examined changes in PA behavior and found no meaningfully differences (Blissmer & McAuley, 2002); however, further research using consistent methodology (Armitage, 2009) and valid measurement scales are warranted. Following the necessary preliminary evaluations in the PA context, we would hypothesize that the stage-based intervention would outperform the others based on its individualized

approach, tailoring intervention strategies that are specific to each person's readiness to change. With experimental evidence of this, the conceptualizations inherent to the TTM may or may not be supported.

The third, critical component of intervention evaluation is the process of examining its relevance to public health. The Reach, Effectiveness, Adoption, Implementation and Maintenance (RE-AIM) framework describes five dimensions that are critical to evaluating a potential public health impact (Glasgow, Lichtenstein, & Marcus, 2003; Glasgow, Vogt, & Boles, 1999). Reach of a program is determined by dividing the number of participants by those recruited and Effectiveness is the effect size on PA behavior. An individual level impact score can be created by multiplying Reach and Effectiveness, which balances the strengths and weaknesses of a program (Glasgow, Klesges, Dzewaltowski, Estabrooks, & Vogt, 2006). For example, a program may have large effectiveness but poor reach and vice versa. Adoption is represented by the proportion of setting and staff participation and should be analyzed with consideration for participant characteristics that may moderate program success (e.g., past experience, motivation). For an Implementation score, recommendations are to evaluate the extent to which program components were delivered compared to program protocol (Glasgow, et al., 2006). Finally, a Maintenance score should be created for long-term PA of the participants, as well as the long-term sustainability of the program. Each of the RE-AIM dimensions can be examined individually; however, combination of two or more dimensions provide further public health information for future policy decisions (see Glasgow, et al., 2006). Because the TTM structure facilitates individualized interventions and practical orientation, we hypothesize that TTM-tailored interventions outperform non-tailored approaches in terms of the RE-AIM components. This, however, needs to be empirically tested.

Progressing the Field of Physical Activity Interventions

Although recent TTM-based interventions have been successful in promoting PA, rigorous preliminary work and more thorough intervention evaluation is necessary in order to support, refute or modify the TTM constructs. First, we advocate for future longitudinal change examinations of the continuous TTM variables by means of LGM designs, empirically integrating the predictor variables of the TTM. These types of longitudinal designs will likely advance the TTM from a model that not only explains how, but also why people change their PA behavior. The RCT testing of stage matched versus mismatched intervention will either lend credibility or undermine the stage based approach, both having important theoretical implications and advancing this area of research. Lastly, an improvement in population-based health depends on the selection of the most beneficial health promotion programs. Application of the suggested RE-AIM dimensions in future TTM-based intervention evaluations provide impact information relevant to public health, affording policy makers the necessary information in order to make more informed judgments.

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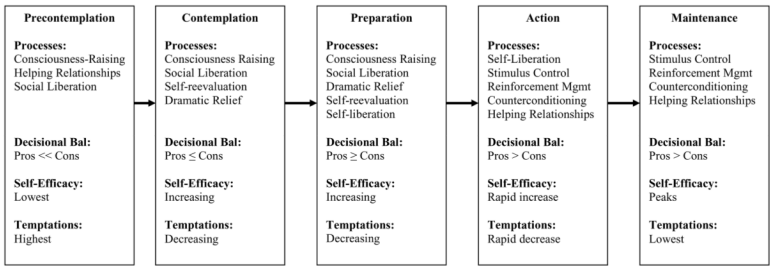

Figure 1.
Theoretical relationship between stages of change, processes of change, decisional balance, self-efficacy and temptation (adapted from Burkholder & Nigg, 2002)

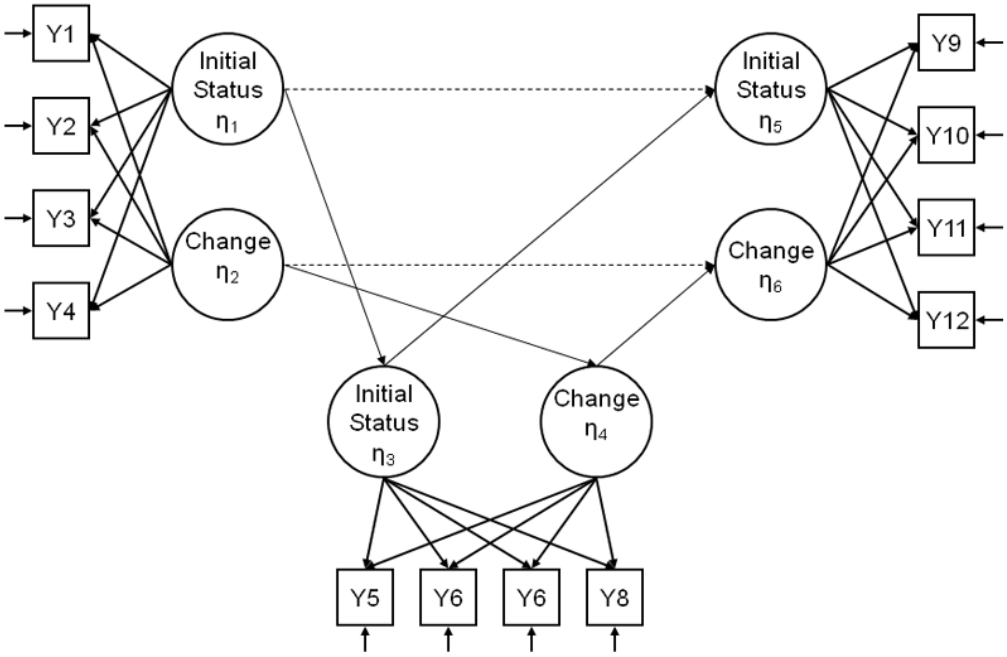

Figure 2.
Multivariate Latent Growth Modeling