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Investigating the Effectiveness of Physical Activity Interventions for Older Adults

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ACCEPTANCE

This dissertation, INVESTIGATING THE EFFECTIVENESS OF PHYSICAL ACTIVITY INTERVENTIONS FOR OLDER ADULTS, by IINA ANTIKAINEN, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements of the degree Doctor of Philosophy in the College of Education, Georgia State University.

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ABSTRACT

INVESTIGATING THE EFFECTIVENESS OF
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Regular physical activity can help prevent chronic conditions and it is positively linked to health-related quality of life (United States Department of Health and Human Services [USDHHS], 2000). Unfortunately, many older adults do not engage in leisure time activity (USDHHS, 2000); making it important to design and test physical activity interventions for this population. The purpose of this dissertation was to review the external validity of theory-based physical activity interventions and to examine the efficacy of a mail-based physical activity intervention. The review included 54 theory-based interventions and overall the studies focused on internal rather than external validity. The hypotheses of the experimental study were that the psychological mediators and physical activity participation would significantly increase among the treatment group as compared to the control group, and that the changes in the mediators would be related to the changes in activity levels. The intervention included 4 weekly stage-matched packages targeting population specific physical activity beliefs (Antikainen et al., 2009) and weekly phone calls to reassess stages of change. Physical activity participation, stages of change, and theory of planned behavior constructs were assessed at baseline and follow-up. Differences in activity levels and theory-based constructs were assessed with repeated measures mixed analysis of variance. Stage of change progression

was examined with chi-square analysis. Measured variable path analysis was used to determine associations between the theory constructs, stages of change, and physical activity participation. The participants were 55 older adults, ages 54 to 96 years. Most of the participants were female, Black, and reported low levels of education and income. The treatment group reported statistically significantly greater physical activity after the intervention than the control group that reported lower levels of activity at follow-up. Although not statistically significant, there was a trend in SOC progression after the intervention in the treatment group. Finally, the integrated model was found to have a good fit at follow-up and perceived behavioral control emerged as a significant predictor of physical activity. This research provides important information for the design of physical activity interventions based upon the integrated framework for translation to community-based organizations.

INVESTIGATING THE EFFECTIVENESS OF PHYSICAL ACTIVITY INTERVENTIONS FOR OLDER ADULTS

by

Iina Antikainen

A Dissertation

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ABBREVIATIONS

ATT	Attitude
INT	Intention
PASE	Physical Activity Scale for the Elderly
PBC	Perceived Behavioral Control
SCT	Social Cognitive Theory
SN	Subjective Norm
SOC	Stages of change
USDHHS	U.S. Department of Health and Human Services
TPB	Theory of Planned Behavior
TTM	Transtheoretical model

CHAPTER 1

GENERAL INTRODUCTION

Lack of physical activity and poor diet are currently the second leading cause of death in the United States (Mokdad, Marks, Stroup, & Gerberding, 2000). Lifelong activity, even at moderate levels, is associated with longer life expectancy, and regular physical activity among older adults reduces the chance of illness, maintains or increases strength, controls weight gain, and reduces the risk of falling (U.S. Department of Health and Human Services [USDHHS], 2000). Furthermore, maintaining a physically active lifestyle facilitates independent functioning in activities of daily living, enhances quality of life, and it is associated with more years lived without complications and limitations because of acute or chronic illnesses (USDHHS, 2000).

Despite the benefits of physical activity throughout the lifespan, the majority of adults in the United States do not achieve the recommended amount of physical activity and the proportion of adults who do not participate in any leisure-time physical activity has remained close to 40% for the past decade (USDHHS, 2009). In addition, specific populations including older adults, women, and certain minority groups appear to be the most sedentary. Almost two thirds of individuals over the age of 75, 50% of African-Americans and Hispanics, and over 40% of women report that they participate in no leisure-time physical activity (USDHHS, 2009). One of the objectives of Healthy People 2010 was to reduce the proportion of adults who participate in no leisure-time physical activity to 20%, (USDHHS, 2000) making designing and evaluating intervention

programs an important public health initiative, especially in the populations most at risk. As the fastest growing segment of the U.S. population and the group that carries the greatest proportion of chronic disease burden (Bureau of the Census, 1996), people over the age of 65 are a particularly important target population for physical activity interventions.

Physical Activity Interventions

Unlike exercise training studies, the goal of physical activity interventions is not to determine the specific physiological effects of an exercise regimen, but rather to help participants change their behavior (i.e., increase their physical activity participation) by modifying their beliefs, attitudes, knowledge of the behavior, or other cognitive and psychological variables (Marcus & Forsyth, 2009). An intervention is a planned and systematically applied set of actions, delivered at a specified site and time, and designed to elicit physical activity behavior change (Marcus & Forsyth, 2009). Interventions are often based on behavioral theory with the ultimate goal of helping the participant maintain an active lifestyle during and after the program.

Dishman and Buckworth (1996) conducted a meta-analysis in which they reviewed 127 community, worksite, school, home, and health-care setting physical activity interventions and they found that across settings and populations, interventions have a moderate effect on physical activity behavior (r = .34). In terms of practical significance, adherence rates increased in these studies from about 50% to 70-88%. The effect sizes when weighed by sample size were larger when the intervention strategies included behavioral modification techniques (r = 0.92) rather than health education, risk appraisal, exercise prescription, or physical education curriculum strategies. Interventions that used

a mediated approach by delivering the intervention materials via mail or telephone were associated with a larger effect size ($r = 0.91$) than those delivered face-to-face. Other factors that were associated with large effect sizes included interventions that incorporated active leisure activities ($r = 0.85$), were not supervised ($r = 0.78$), and targeted relatively low intensity activity ($r = 0.94$). Dishman and Buchworth (1996) suggested that more physical activity interventions targeting racial and ethnic minorities and older adults are warranted. They also recommended examining the way cognitive behavioral modification strategies can be consistently applied to physical activity interventions instead of the more common, but less effective strategies of health education, health risk appraisal, and exercise prescription, and using theories of behavior change to guide intervention design.

Several behavior change theories including the health belief model, protection motivation theory, theories of reasoned action and planned behavior, social cognitive and self-efficacy theories, self-determination theory, and the transtheoretical model have been used to predict and to explain physical activity behavior (Biddle & Nigg, 2000). Biddle and Nigg (2000) report that the most validated theories in the physical activity domain include the transtheoretical model (TTM; Proschaska & DiClemente, 1984), social cognitive theory (SCT; Bandura, 1986), and the theory of planned behavior (TPB; Azjen, 1991). These three theories have been used successfully to predict and explain exercise behavior in various populations (Biddle & Nigg, 2000), and they have also been used successfully in physical activity interventions (Biddle & Nigg, 2000; Jones, Courneya, Fairey, & Mackey, 2005; McAuley, Courneya, Rudolph, & Lox, 1994). Although there is mixed evidence about the superiority of interventions based on behavioral theory versus

those not based on behavioral theory with regards to improving physical activity participation (Conn, Valentine, & Cooper, 2002; Dishman & Buckworth, 1996), one specific benefit of using a theory is that behavioral strategies can be used to target the specific constructs of a theory for change. Changing a theoretical construct in an attempt to change behavior can explain why people think or act a certain way (Biddle & Nigg, 2000). The theoretical constructs then become mediators, which are the factors that lead to or mediate change in behavior, and thus represent a mechanism for evaluating the effectiveness of an intervention (Marcus & Forsyth, 2009).

Physical Activity Interventions Targeting Older Adults

Reviews of physical activity interventions among older adults have generally found them to be effective for increasing physical activity participation (Conn, Minor, Burks, Rantz, & Pomeroy, 2003; Conn et al., 2002). Conn et al. (2002) reviewed 46 intervention studies targeting older adults and found that the overall effect size of interventions was small (d_w = .26). Conn et al. (2003) conducted a narrative review of 17 interventions and found that ten of the 17 interventions reported higher physical activity behavior in the intervention group than control. Both reviews indicated that although a significant number of older adults increased their physical activity levels in response to the interventions, the amount of activity still rarely met the recommended amount needed for health benefits (Conn et al., 2003; Conn et al., 2002).

Intervention parameters that were examined for the effect on physical activity behavior change included center-based vs. home-based programs, delivery approach, and the physical activity intensity level. Conn et al. (2003) found that center-based programs (d_{wc} = .47) had higher effect sizes than home-based programs (d_{wc} = .24) and Conn et al.

(2002) found that three out of five supervised center-based programs were effective in increasing physical activity as compared to seven of the twelve non-supervised programs. Interventions that used a mediated delivery approach were found to be similar to (d_{wc} = .27 vs. d_{wc} = .21; Conn et al., 2002) and superior to face-to-face approaches (King et al., 1998) for increasing physical activity participation, and interventions that recommended moderate intensity physical activity (d_{wc} = .58) compared to low intensity activities (d_{wc} = .26) or those without recommendations (d_{wc} .25) were most effective (Conn et al., 2002).

The results of these reviews of physical activity interventions for older adults also underscore the recommendations of Dishman and Buckworth (1996) concerning the need for the inclusion of ethnic/racial minority participants, emphasis on cognitive-behavioral modification strategies, and more theory-based interventions. For instance, few interventions among older adults included information about the race/ethnicity, income, and educational status of participants (Conn et al., 2002; King et al. 1998). Conn et al. (2002) reported that only 10 out of 43 interventions reported the ethnic composition of participants and in those that did report ethnicity, 81% of participants were Caucasian. Similarly, Conn et al. (2003) found that only 6 of 17 studies reported on participant ethnicity and they recommended that future research should explore the effectiveness of interventions among diverse older adults.

Similar to the results of Dishman and Buckworth (1996), older adults may also benefit most from interventions that include behavioral and cognitive-behavioral modification techniques rather than health education and exercise instruction alone (Conn et al., 2002; King et al., 1998). Specifically, Conn et al. (2002) found that the interventions that employed self-monitoring, a cognitive-behavioral modification

strategy, had significantly larger effects (d_{wc} = .39) on physical activity participation than interventions without self-monitoring (d_{wc} = .30). However, few studies report specifics about the intervention strategies and therefore, the most effective strategies for producing physical activity behavior change are unknown.

Finally, when examining the impact of behavioral theory for improving the effectiveness of physical activity interventions among older adults, the evidence is equivocal. Only 15 of the 43 interventions reviewed by Conn et al. (2002) were based on a behavioral theory and they found no statistical differences in effect sizes for physical activity behavior between theory-based and non theory-based interventions. However, Conn et al. (2003) found that 70% of the interventions that were based on theory were effective for increasing physical activity among older adults as compared to only 43% of the interventions not based on theory. In both reviews, the authors noted that a smaller number of interventions used behavioral theory and Conn et al. (2003) suggested that theoretical fidelity of studies should be improved by clearly reporting on the link between theoretical constructs and the specific attributes of the intervention.

Physical Activity Interventions and Public Health Impact

To date, the focus of most scientific inquiry in the health promotion field has been on statistically significant results under highly controlled conditions. Although these studies have been useful for determining what health benefits a specific behavior can produce, testing physical activity interventions under highly controlled conditions is less meaningful because in real life settings physical activity interventions cannot be implemented with only highly motivated, healthy participants under ideal circumstances. Testing a physical activity intervention has no practical significance if the planned

intervention has no potential for implementation on a community or population level. Therefore, more translational research, where the goal is to translate theories, strategies, and interventions that have shown promise to produce behavior change in controlled studies into real world settings, is warranted. Translational research should focus and report on issues of external validity to assist researchers and clinicians with the evaluation of the potential public health impact of an intervention (Sorrensen, Emmons, & Dobson, 1998).

The RE-AIM framework was designed to address the issue of external validity in health promotion programs (Glaskow, Vogt, & Boles, 1999). This framework divides external validity into five dimensions including reach, efficacy, adoption, implementation, and maintenance (Estabrooks, Dzewaltowski, Russell, Glaskow, & Klesges, 2003) and it has been used to evaluate various health promotion programs and policies (Estabrooks et al., 2003; Glasgow, Nelson, Strycker, & King, 2006; Jilcott, Ammerman, Sommers, & Glasgow, 2007; Klesges, Dzewaltowski, & Glasgow, 2008). Within the physical activity literature, the RE-AIM model has only been used to evaluate school based health promotion programs that included seven physical activity interventions (Estabrooks et al., 2003). However, to date the RE-AIM model has not been used to evaluate the existing literature on physical activity interventions, and thus, the public health impact of the physical activity interventions that have been conducted to date remains unknown.

Purpose of the Dissertation

The overall purpose of this dissertation was to design and test a theory-based, motivational physical activity intervention targeting older adults recruited from

community-based settings. The specific objectives were: (a) to review the published literature on theory-based physical activity interventions by evaluating the external validity of the existing intervention studies based on the RE-AIM framework, and (b) to test the effectiveness of a motivational physical activity intervention for older adults.

Specifically, the purpose of the literature review (Chapter 2) was to determine how well the extant literature on physical activity interventions reported on issues of external validity. Studies were included in this review if they included a measure of physical activity, and were based on the TTM, TPB, or SCT. The studies were evaluated according to the five dimensions of external validity as outlined by the RE-AIM framework and the percentage of studies that reported on reach, efficacy, adoption, implementation, and maintenance were reported. The studies were also evaluated based on whether they targeted, assessed, or changed specific theory-based mediators. All of the information collected was then used to design a brief, motivational physical activity intervention for older adults.

The purpose of the experimental study (Chapter 3) was to test the efficacy of a 4-week mail-based physical activity intervention that was designed according to an integrative theoretical framework that incorporates variables from the TPB and TTM. The participants were recruited from various senior centers, community centers, and YMCAs and assigned to an intervention or a wait-list-control group. The following hypotheses were tested: (a) the ATT, SN, and PBC would significantly increase among participants in the treatment group compared to the control group; (b) physical activity participation would significantly increase among participants in the treatment group as compared to the control group; (c) a significantly greater percentage of participants in the

treatment group would progress through the SOC compared to the participants in the control group; and (d) the changes in the psychological mediators (ATT, SN, PBC, SOC) would be significantly related to the changes in physical activity participation.

CHAPTER 2

RE-AIM EVALUATION OF THEORY-BASED PHYSICAL ACTIVITY INTEVENTIONS: A REVIEW OF THE RESEARCH LITERATURE

Despite the numerous health benefits of physical activity and increased focus on physical activity interventions, activity levels in the United States remain low with only about 15% of adults achieving the recommended amount of activity (United States Department of Health and Human Services [USDHHS], 2000). An estimated 70% of Americans are considered sedentary based on no leisure time activity or inadequate levels of activity (President's Council on Physical Fitness and Sports, 2002), and the direct and indirect costs of sedentary living for 1987 incidences were estimated at over $150 billion (Pratt, Macera, & Wang, 2000). Lack of physical activity along with poor nutrition and associated weight gain also affect mortality rates and they are now considered the second leading cause of preventable death in the United States (Mokdad, Marks, Stroup, & Gerberding, 2000).

Programs that promote physical activity vary from simple knowledge-based programs and exercise prescription to theory-based behavior modification programs. Results of a meta-analytic review by Dishman and Buckworth (1996) showed that exercise adherence can be improved by intervention strategies. Some of the characteristics of an effective intervention included those based on behavior modification techniques, targeting groups rather than individuals, utilizing a mediated approach, and emphasizing lower intensity,

leisure activities. Since the review, more emphasis has been placed on the use of theory in guiding intervention design in physical activity promotion as opposed to health education, risk appraisal, and exercise prescription (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003; Biddle & Nigg, 2000).

According to a review by Biddle and Nigg (2000), the most supported theories in the physical activity domain include the transtheoretical model (TTM; Proschaska & DiClemente, 1984), the social cognitive theory (SCT; Bandura, 1986), and the theory of planned behavior (TPB; Azjen, 1991). Each of these theories provides a framework of constructs for understanding behavior. Furthermore, the constructs can be targeted as mediators, which can be manipulated to produce the desired behavior and explain the mechanism by which the intervention is believed to be effective (Marcus & Forsyth, 2009). Mediator analysis helps determine if the intervention is actually affecting the variables that are hypothesized to influence behavioral change (Lewis, Marcus, Pate, & Dunn, 2002). To design the most effective intervention, Marcus and Forsyth (2009) suggest using several theories, building the intervention around several mediators, and measuring several possible theory-based mediators.

Theories of Behavior Change

Transtheoretical Model

The transtheoretical model has been used successfully in physical activity interventions (Biddle & Nigg, 2000) and includes the following five construct: stages of change (SOC), decisional balance, processes of change, self-efficacy, and temptation (Prochaska & DiClemente, 1984). The main hypothesis of the model is that behavior change does not occur all at once, but rather it is a dynamic and gradual process with

individuals progressing or relapsing through five SOC including precontemplation, contemplation, preparation, action, and maintenance. Decisional balance refers to the perceived benefits, as well as the perceived cons of changing the behavior. It is hypothesized that as people progress across SOC, they report more perceived benefits and less perceived cons of that behavior.

Processes of change are the specific strategies that people use as they move through the SOC. Processes of change include cognitive and behavioral processes and it is hypothesized that individuals at lower levels of SOC rely more on cognitive processes and those at higher levels use more behavioral processes. Self-efficacy or the confidence that people have about their ability to participate in a behavior is hypothesized to increase as they progress through the SOC. Finally, temptation reflects the desire to participate in less healthful behaviors, particularly during difficult situations such as injury, illness, work stress, and travel. As people advance in their SOC, it is hypothesized that they are less likely to let these barriers keep them from being physically active.

Spencer, Adams, Malone, Roy, and Yost (2006) reviewed 38 TTM based interventions and found that 25 stage-matched interventions showed positive changes in physical activity. The interventions that were not effective used a single contact, single-strategy approach. Fifteen of the studies reviewed by Spencer et al. (2006) compared a stage-matched intervention to a non-stage-matched intervention and in nine studies the stage-matched fared better than the non-stage-matched for increasing physical activity. The authors concluded that the use of TTM in intervention design was effective for physical activity behavior change and they further suggested the use of multiple strategies over a longer time period, rather than single contact interventions (Spencer et al., 2006).

Another review of 26 TTM-based interventions studies found that 73% of short-term studies,(i.e., interventions lasting less than 6 months) showed improvement in physical activity levels or SOC whereas only 29% of studies lasting 6 months or longer were effective (Adams & White, 2003). Additionally, a study by Blissmer and McAuley (2002) found that a stage-matched physical activity intervention led to more positive results than a control intervention, and a mismatched intervention during which participants were intentionally given materials that did not correspond to their stage of readiness performed worse than either the stage-matched or the control intervention.

Social Cognitive Theory

The hypotheses of the SCT are that each of the three main constructs including personal factors (internal thoughts and feelings about a behavior such as self-efficacy and outcome expectations), behavioral factors (knowledge and skills related to a health behavior), and environmental factors (perceptions of and the actual physical and social environment) are reciprocally related (Bandura, 1986). The reciprocal nature of the relationship among the constructs indicates that they can each influence the other and be influenced by the other. For instance, when an individual adopts physical activity (behavioral factor), self-efficacy will increase (personal factors), and as self-efficacy increases, the individual will continue to successfully adhere to the physical activity regimen.

Bandura explained that self-efficacy beliefs are a major basis of action and without these beliefs there is little incentive to act (Bandura, 2000). Self-efficacy beliefs develop from performance or mastery experiences with the behavior, vicarious experiences or observations of similar others engaged in the behavior, verbal persuasion or

encouragement from others that they possess the skills to successfully execute the behavior, the interpretation of physiological states that refer to the bodily responses to the behavior, and the interpretation of affective states or the emotional feelings associated with the behavior (Bandura, 1997).

In a review of 13 SCT based physical activity interventions targeting individuals with type 2 diabetes, Allen (2004) found that self-efficacy accounted for 15-33% of the explained variance in exercise in nine studies that used a predictive design. Another review of physical activity interventions for older adults found that SCT was the most commonly used behavioral theory in interventions and that 71% of the programs based on the SCT were effective in changing physical activity behavior (Conn, Minor, Burks, Rantz, & Pomeroy, 2003).

Theory of Planned Behavior

The hypotheses of the TPB are that participation in a behavior is determined by an individual's intention (i.e., motivation), as well as their perceived behavioral control over the activity. The person's intention (INT), in turn, is determined by the person's attitude, subjective norm, perceived behavioral control and their underlying beliefs. Attitude (ATT) reflects the overall evaluation of the behavior and is formed from its underlying behavioral beliefs that refer to how the individual evaluates the benefits or disadvantages of participating in a behavior. Subjective norm (SN) is the perceived pressure to participate or not participate in the behavior and is determined by its underlying normative beliefs that reflect the individual beliefs about whether people important to them think that they should or should not participate in a behavior, as well as how much the individual values the opinion of others. Finally, perceived behavioral control (PBC)

incorporates the person's estimation about their ability to perform a given task (self-efficacy) and the amount of control they feel they have over participation and is formed from the underlying control beliefs that represent beliefs about the availability of resources, opportunities, and barriers to the participation in a behavior and how powerful those factors are in relation to the behavior (Ajzen, 1991).

According to a review of 111 theory of reasoned action and TPB studies by Symons Downs and Hausenblas (2005), the TPB is a useful theory for guiding exercise intervention research. Symons Downs and Hausenblas (2005) examined the strength of the associations between the TPB constructs and found large effect sizes (ES) for the ATT-INT (ES = 1.07), PBC-INT (ES = 0.90), and INT-exercise behavior (ES = 1.01) relationships, and moderate effect sizes for the SN-INT (ES = 0.59) and PBC-exercise behavior (ES = 0.51) relationships. The results also indicated that all of the TPB constructs, except for subjective norm, were significant predictors of exercise behavior. Specifically, INT and PBC accounted for 21.0% of the variance in exercise behavior with INT being a significant predictor of behavior (β = .42, $P < 0.001$). In a second model, ATT, PBC, and SN accounted for 30.4% of the variance in INT with ATT (β = 0.27, P = < 0.01) and PBC (β = 0.27, P = < 0.01) adding unique contributions to the model.

Evaluating the Impact of Behavioral Interventions

In addition to the recent emphasis on theory-based physical activity interventions, evaluating the public health impact of an intervention with an increased focus on external validity has been recommended (Estabrooks, Dzewaltowski, Russell, Glaskow, & Klesges, 2003). In the past, based on a medical research model, physical activity research has focused on clinically significant results leading to highly controlled, short-term

interventions with healthy, motivated participants. These types of programs are difficult and costly to maintain and virtually impossible to adopt in real world settings where participants are more likely to have a variety of health issues, be less motivation to engage in physical activity, and cannot be monitored continuously. One framework that was developed and has been used to evaluate the external validity of health promotion programs is the RE-AIM model (Glaskow, Vogt, & Boles, 1999). The RE-AIM framework allows for the evaluation of the potential of a program for translational research in real world settings rather than just immediate impact of programs (Eakin et al., 2007). The framework assesses five dimensions of an intervention including reach, efficacy, adoption, implementation, and maintenance to determine the impact of an intervention on the population and community level (Estabrooks et al., 2003).

Reach is a measure of individual-level participation including the proportion of the population targeted that are affected by the intervention, as well as the representativeness of the participants to the target population based on variables such as age, gender, race, and income distribution (Glaskow et al., 1999). Efficacy measures should include the effectiveness of the intervention, as well as other positive or negative consequences of the intervention (Glasgow et al., 1999). The negative outcomes of an intervention may include unintended harm to participants, low cost-effectiveness, or misplaced effort on a program with little effect on the intended behavior. Behavioral, quality of life, and participant satisfaction outcomes should also be considered as a part of the efficacy evaluation (Glaskow et al., 1999).

Adoption is concerned with the proportion of existing or available settings that offer the interventions. Similar to reach, this measure should include an evaluation of the types

of settings that offer the program and how representative these settings are of the community as a whole in regard to demographic factors such as socioeconomic status, race, ethnicity, gender, and age (Glaskow et al., 1999). Adoption, therefore, is reach on the organizational level.

Implementation refers to the degree to which the intervention is delivered as intended or as designed, and it is evaluated based on the faithfulness of the program administrators to the design of the intervention through proper process evaluation (Glaskow et al., 1999). The process evaluation may include data on intervention delivery such as observations or recordings, a scripted delivery to maintain standardization, or participant feedback on whether materials were received and read.

Finally, maintenance includes an individual and an institutional level component. On the individual level, maintenance refers to long term (> 6 months) change in behavior, and on the institutional level it refers to the extent that the new intervention becomes an established program in the organization (Glaskow et al., 1999).

One of the barriers to proper evaluation of the public health impact of physical activity interventions is that in order to evaluate individual and organizational maintenance, behavior must be assessed a minimum of 6 months to 1 year after intervention completion (Glasgow et al., 1999); however, researchers are rarely interested in evaluation beyond program efficacy (Glaskow et al., 1999). Even when such an assessment is done, authors rarely provide the information necessary to complete an evaluation of the public health impact of the intervention. Dishman and Buckworth (1996) found that many studies did not report on maintenance and of those that did include this information, they found that participants' activity levels had returned to near

or pre-intervention levels a few weeks after intervention completion. These findings suggest that for sustained public health impact, more effective interventions that affect permanent change in behavior or continued programming are necessary.

To date, few studies have used the RE-AIM framework to review the reporting of dimensions important to the external validity of physical activity interventions. Estabrooks et al. (2003) evaluated 32 school health promotion studies (programs included physical activity, good nutrition, and smoking cessation or prevention) and found that efficacy was the only component of RE-AIM that all studies reported. Although most studies reported number of participants, few reported the number of all eligible participants or participant characteristics, and reporting in the areas of adoption and maintenance was equally poor. They also found that implementation was often described in separate manuscripts (Estabrooks et al., 2003). The authors concluded that health promotion studies rarely reported on the RE-AIM dimensions concerned with external validity, which limits the translation of such results into practice. To assist future researchers, the authors developed a template to standardize the reporting of the characteristics of internal and external validity and they made specific recommendations about how to clearly describe participation and implementation on the individual and organizational levels to design interventions with a potential for large scale adoption (Glaskow et al., 1999).

The physical activity literature includes several meta-analytic and narrative reviews that focus on the efficacy of physical activity interventions, but none have specifically addressed the public health impact and external validity of these programs. Therefore, the overall purpose of this literature review was to evaluate theory-based physical activity

interventions designed according to the TTM, TPB, and SCT. The specific objectives were to: (a) determine the extent that current literature reports on issues of external validity using the RE-AIM framework and criteria established by previous researchers (Glaskow et al., 1999) and (b) evaluate the proportion of studies that report targeting specific psychological mediators, that measure such mediators, and whether changes in those mediators after the intervention were reported. The three behavior change theories were chosen for this review because they were identified as the most supported in previous physical activity literature (Biddle & Nigg, 2000).

Method

Search and Inclusion Criteria

A comprehensive search of the PsychInfo database, EBSCOhost, and reference lists of retrieved articles and review articles identified 73 physical activity intervention studies using the selected behavioral theories reported in 81 journal articles (results of some studies were reported in several articles). Key words used for the search included physical activity, exercise, theory of planned behavior, social cognitive theory, transtheoretical model, theory-based, and intervention. Articles published between 1996 and July of 2009 were included in the review. The year 1996 was selected as the starting point because of the increased emphasis on theory-based interventions since that time point (Biddle and Nigg, 2000; Dishman & Buckworth, 1996).

The inclusion criteria for articles were: (a) articles written in English, (b) publication in peer-reviewed journals, (c) a physical activity intervention, which as defined by the authors, was based on the TTM, SCT, TPB, or a combination of these three theories, (d) at least one intervention arm that included a behavioral component including behavior

modification, cognitive behavior modification, health education, or exercise prescription strategies, and (e) one of the main dependent variables was a measure of physical activity. Any study that was not based on the TTM, TPB, or SCT was excluded from this review. Of the original 81 articles, 20 were dropped because following a more thorough review they did not utilize a behavioral theory for the physical activity component of the study (n = 9), they used a theory not covered by this evaluation (n = 8), change in physical activity behavior was not reported (n = 2), or the study compared two interventions based on a different theory (n = 1). The final review included 54 interventions that were reported in 63 journal articles (some interventions were reported in more than one article and one article covered two different intervention programs). When the results from one intervention were reported in multiple publications, RE-AIM evaluation was based on all available data on the intervention.

Coding Protocol

The publications were scored based on whether they reported on the dimensions of the RE-AIM as outlined in the definitions for each dimension below. Any information that was reported was recorded for further analysis. *Reach* was coded on the following levels: (a) participation rate was the percentage of eligible people from the targeted population who completed the intervention, (b) inclusion criteria, exclusion criteria and percentage of people excluded, and (c) representativeness of the participants as compared to the targeted population. *Efficacy* was evaluated based on the following criterion: (a) assessment of physical activity rate, (b) attrition rate at the completion of the intervention, (c) use of intent-to-treat strategies, (d) inclusion of a quality of life measure, and (e) reporting of any negative consequences of the intervention. *Adoption* was

assessed on the following levels: (a) percentage of eligible organizations or sites that offered the intervention, (b) eligibility criteria and percentage of eligible sites participating, (c) reporting of the exclusion criteria and rate at the organizational level, and (d) representativeness of the participating sites as compared to those that selected not to offer the intervention or similar sites in the region that were not asked to offer the program. *Implementation* was assessed based on whether the researchers reported data on the faithfulness of intervention delivery or process evaluation. *Maintenance* was reported on the following levels: (a) whether the study included at least a 6-month follow-up on individual behavior following last contact in the intervention, (b) if change in physical activity was maintained at follow-up, and (c) if the intervention continued on the organizational level after study completion.

A second analysis was performed to evaluate how well the reviewed studies reported on the psychological mediators that were targeted for change in the intervention and the specific behavioral strategies used. The studies were also reviewed to determine if mediators or use of behavioral strategies changed as a result of the program, and if the programs targeting mediators were more successful at changing behavior than those not specifying which mediators were targeted.

Results

Of the 54 interventions reviewed, 27 were based on the TTM (see Table 1), 5 were based on the TPB (see Table 2), 9 were based on the SCT (see Table 3), and 13 used a combination of 2 or more of these theories (see Table 4). The interventions were designed for a variety of populations including sedentary adults (n = 13), employees (n = 8), older adults (n = 9), people with diabetes (n = 7), children or adolescents (n = 5),

primary care patients (*n* = 5), cancer patients (*n* = 4), and other (*n* = 3). Across the majority of the studies physical activity was assessed solely by self-report questionnaires (*n* = 38, 70.4 %), followed by a combination of self-report and an objective measure (*n* = 14), and objective measures such as pedometers or accelerometers only (*n* = 2). The length of the interventions varied greatly, with most of the studies being single contact interventions (*n* = 12). The second most common were interventions lasting for 3 months (*n* = 9), followed by those lasting 6 months (*n* = 7), and 1 year (*n* = 7). The majority of the interventions lasted for 6 months or less (*n* = 43, 79.6%).

The interventions that recommended home-based activities were coded as home-based and those that offered physical activity classes or programs were coded as center-based. All but one intervention targeted home-based physical activity or home and center-based activity and one study targeted active commuting behavior. The interventions included phone delivered interventions (*n* = 22, 40.7%), mail or email based interventions (*n* = 16), interventions delivered in person at a center or clinic (*n* = 15), mass media (*n* = 1), and a combination of these strategies (*n* = 1).

Table 1

Intervention Studies Based on the Transtheoretical Model

Author	Intervention strategy	N	Population/Setting	PA Measure	Conclusions
Basler, Bertalanffy, Quint, et al. (2007)	TTM counseling administered prior to physical therapy treatment vs. placebo	170	Physical therapy patients	1-week activity diary, self-reported functional capacity	Counseling based on TTM was no more effective than standard care for increasing PA.
Blissmer & McAuley (2002)	Compared efficacy of four 16 week PA interventions. The interventions were stage-matched, mismatched, standard care and control.	196	Male and female college personnel	The Aerobic Center Longitudinal Study PAQ	Stage matched and standard care resulted in greater levels of PA than the control and mismatched groups.
Dallow & Anderson (2003)	A 24-week behavior change program vs. traditional exercise setting	58	Sedentary, obese women	7-day PA recall and a bicycle fitness test	Positive changes in PA and TTM constructs were found in the behavior change participants at follow-up.
Dinger, Heesch, Cipriani, & Qualls (2007) Dinger, Heesch, & McClary (2005)	A 6 week minimal contact intervention on walking behavior through brochures, pedometers and emails designed to change TTM constructs.	36	Insufficiently active women	International PAQ	Total walking minutes were increased significantly in both groups.
Faghri, Omokaro, Parker et al. (2008)	10-week pedometer walking program and internet-based motivational messages	206	Worksite program for employees	Self-report (not specified) and pedometer	Significant improvement found in number of steps per week, level of PA, and movement through SOC.
Fahrenwald, Atwood, Walker, et al. (2004) Fahrenwald & Sharma, (2002)	Compared TTM derived PA intervention program to a control (self-breast exam)	44	Sedentary, low-income mothers on Women Infants and Children Program (WIC)	7-day PA recall and pedometer	Treatments group advanced in SOC more than control and had greater PA behavior, weekly minutes of PA, daily energy expenditure, and weekly moderate PA
Findorff, Stock, Gross, & Wyman (2007)	Exercise group was compared to a control receiving health education over 28 weeks and with a follow-up at 1 year.	272	Sedentary women over the age of 70.	Exercise logs	Exercise adoption was higher among the intervention group. After one year 60% of the intervention group were in action phase as compared to 16% of the controls

(Table continues)

Author	Intervention strategy	N	Population/Setting	PA Measure	Conclusions
Frenn, Malin, Brown, et al. (2005)	Eight-session health promotion intervention to promote PA and reduced fat intake delivered via internet video.	103	Culturally diverse, low-income seventh grade students	Child and Adolescent Activity Log	Those who completed more than half of the sessions increased PA.
Greaney, Riebe, Garber et al. (2008)	24 month study comparing a print and telephone group vs. contact group intervention tailored to stage of change	966	Older adults	Yale Physical Activity Survey for older adults	There was no change in PA at 12 or 24 mos. However, SOC did increase in those participants who were not already in maintenance stage.
Green, McAfee, Hindmarsh, et al. (2002)	Three sessions of telephone delivered motivational counseling based on the TTM	316	Sedentary patients aged 18-65 recruited from a mailed health risk assessment.	11-item Physician-based assessment and counseling for exercise	There was a higher level of exercise reported among the intervention group at 6-month follow-up.
Hooker, Seavey, Weidmer, et al. (2005)	One year counseling and telephone program	447	Healthy community dwelling older adults aged 50 or older	CHAMPS physical activity questionnaire for seniors	Physical activity and caloric expenditure increased
Hasler, Fisher, MacIntyre, & Mutrie (2000)	Exercise consultation was compared to an informational leaflet.	34	Patients with type 1 diabetes	Scottish PA Questionnaire	The intervention group had significantly higher PA levels than the control group at 3-week follow-up
Ishii, Nakiri, Magatomi, et al. (2007)	Intervention group received TTM based assistance. Subjects were asked to wear a calorie counter and record daily exercise.	22	Male workers at a communications system company	Pedometer	No. of steps peaked and was maintained 1 mo. after the intervention in the treatment group. In control group, steps peaked immediately after the intervention and then declined.
Jackson, Asimakopoulou, & Scammell (2007)	Exercise consultation interview vs. control. All participants received a PA leaflet. Intervention group received a one-on-one interview with a dietitian	34	People with type 2 diabetes	PA questionnaire adopted from the Scottish PAQ	Both groups showed an increase in PA levels. However, the change was significant for the intervention group only.
Jimmy & Martin (2005)	Treatment group received advice and stage matched pamphlets and were offered a 45 minute counseling session	161	Sedentary people contacted in primary care setting	7-day PA recall	35% of feedback group & 38% of the treatment group categorized as active at follow-up
Kim, Hwang, & Yoo (2004)	Evaluation of a stage matched program vs. usual care	45	Korean participants with type 2 diabetes	7-day PA recall	The stage matched group showed significant improvements in SOC and PA levels.

(Table continues)

Author	Intervention strategy	N	Population/Setting	PA Measure	Conclusions
Kirk, Higgins, Hughes, et al. (2001)	Standard exercise information was compared to a TTM based exercise consultation and information.	26	Sedentary adults with type 2 diabetes	Scottish PA 7-day recall questionnaire.	Physical activity counts & behavior increased in the experimental group and decreased in the standard information group.
Kirk, Mutrie, Macintyre, & Fisher (2004)	Individual counseling based on TTM, motivational theory, and cognitive behavioral strategies	70	Sedentary people with diabetes	7-day PA recall and accelerometers	Total activity increased in treatment group; control participants showed no significant change.
Kosma, Cardinal, & McCubbin (2005)	Four week web-based leisure-time PA motivational program	75	Inactive adults with physical disabilities	13-item five-factor PA scale for individuals with disabilities	There were no significant differences between treatment and control groups at post-test.
Marcus, Bock, Pinto, et al., (1998)	Compared a stage-matched, tailored program to a standard self-help intervention.	150	Healthy, sedentary men and women, recruited through a newspaper ad.	7-day PA recall	The individualized program showed significantly greater increases in PA levels than the standard program
Marcus, Napolitano, King, et al. (2007)	Compared a phone and a print mediated PA program and a control group	239	Healthy, sedentary adults	7-day recall, random sample of accelerometers, and graded exercise test	Both treatment groups increased PA significantly as compared to the control group with no difference between the intervention arms.
Marshall, Bauman, Owen, et al. (2003)	Single mailing of a letter and a stage-targeted booklet with follow-up interviews at 2 and 6 months.	462	Population based survey of 40-60 year old adults contacted by mail.	2-week PA recall	Participants in the intervention group were significantly more likely to meet recommended levels of PA.
Mutrie, Carney, Blamey, et al. (2002)	Self-help intervention through interactive written materials including behavior change strategies, local info on routes, and safety information for active commuting behavior	295	Employees who had indicated some interest in walking or cycling to work	7-day PA recall	Intervention group was almost twice as likely to increase walking to work as the control at 6 months. The intervention had no effect on cycling.
Naylor, Simmonds, Riddoch, et al. (1999)	Compared four levels of stage-matched PA counseling delivered by primary care nurses.	180	Recruited patients attending 30 minute health checks. Counseling delivered in primary care setting.	7-day PA recall from North Ireland children's health survey	None of the programs had an effect on PA levels.

(Table continues)

Author	Intervention strategy	N	Population/Setting	PA Measure	Conclusions
Pinto, Frierson, Rabin, Trunzo, & Marcus (2005) Rabin, Pinto, & Frierson (2006) Rabin, Pinto, Trunzo, et al. (2006)	12 week PA counseling via phone and weekly exercise tip sheets vs. control	86	Home based program for sedentary breast cancer patients	7-day PA recall, pedometers, accelerometer, and fitness test	Intervention group reported significantly more total minutes of moderate-intensity PA, and higher energy expenditure per week than control.
Proper, Hildebrandt, Van der Beek, et al. (2003)	Individual face-to-face counseling based on SOC.	299	Worksite program	7 day recall, PA in sports, Heart rate, and Baecke PA questionnaire	Positive effects on total energy expenditure, physical activity during sports, and cardiovascular fitness levels
Purath, Miller, McCabe, & Wilbur (2004)	Brief intervention including health screening, brief intervention, and a booster telephone call vs. counseling only	287	Worksite program for sedentary women	Paffenbarger PA Questionnaire	Treatment group increased their level of PA and walking behavior.
Smith, Bauman, Bull, et al. (2000)	Written PA prescription given by a physician was compared with the same prescription and materials about PA via mail.	1142	Routine care patient's 25-65-years old.	Self-report (not specified)	Written PA prescription with mailed materials lead to modest improvement in PA levels. Prescription only did not affect PA levels.

Note. PA = physical activity, PAQ = Physical activity questionnaire, SOC = Stages of change, TTM = Transtheoretical model.

Table 2

Intervention Studies Based on the Theory of Planned Behavior

Author	Intervention strategy	N	Population/Setting	PA Measure	Conclusions
Chatzisarantis, & Hagger (2005)	A persuasive communication based on salient PA beliefs compared to a message based on non-salient beliefs	83	Adolescents	Godin leisure time PA Questionnaire	Salient beliefs based message out-performed the non-salient message in positive attitudes and stronger intentions but neither intervention lead to changes in PA behavior
Jones, Courneya, Fairley & Mackey (2004)	Two oncologist-based exercise interventions compared to a usual care intervention	450	Newly diagnosed breast cancer survivors	Godin leisure time PAQ	Recommendation was successful at changing behavior; recommendation and referral was not.
Kelley, & Abraham (2004)	Healthy living booklet with persuasive arguments for PA and diet	252	Adults over age 65 attending hospital out-patient clinics	Single question self-report	34% of participants set an activity goal and 51%of them reported 100% success in enacting the goals.
Hardeman, Kinmonth, Michie, et al. (2009) Kinmoth, Wareham, Hardeman, et al. (2008) Williams, Prevost, Griffin et al. (2004)	A 1 year at home behavior change program and leaflet was compared to a behavior change program over the phone, and a standard leaflet only group.	321	Sedentary adults with parental history of diabetes	Self-report (not specified) and heart rate monitor	The theory based interventions were no more effective than the information leaflet in increasing PA participation
Vallance, Courneya, Plotnikoff, & Mackey (2008) Vallance, Courneya, Plotnikoff, et al. (2007)	Standard public health recommendation, a step pedometer alone, or one of two TPB-based behavior change interventions were compared	377	Breast cancer survivors	Godin Leisure-time PAQ	The TPB-based behavior change intervention resulted in small improvements in the TPB constructs and partially mediated the effects of the intervention on PA behavior
Vandelanotte & Bourdeaudhuij, (2005)* Vandelanotte, Bourdeaudhuij, & Brug (2007)*	Interactive computer PA and fat intake intervention delivered sequentially or simultaneously with a wait list control group.	392	20-60 year old Belgian adults without medical complaints	International PAQ	The sequential mode was slightly more effective than the simultaneous mode in maintaining intervention effects at 2 year follow-up.

Note. PA = physical activity, PAQ = Physical activity questionnaire.

* Combines Theory of Planned Behavior with Stages of Change theory.

Table 3

Intervention Studies Based on the Social Cognitive Theory

Author	Intervention strategy	N	Population/Setting	PA Measure	Conclusions
Cramp & Brawley (2006)	Compared the effects of a group mediated cognitive behavior modification program to a standard care postnatal exercise program	57	Sedentary mothers participating in a community fitness center	7-day PA recall	The treatment group reported greater change in PA frequency and volume than standard care group
DuVall, Dinger, Taylor, et al. (2004)	Compared three minimal contact 8-week lifestyle interventions. Pedometer only, pedometer and behavior modification, and standard care.	50	Sedentary women between 25 & 54 yrs, recruited from a community & campus	Accelerometer	All participants increased their PA levels and step counts. No differences were found between the groups.
Elbel, Aldana, Boswick, et al. (2003)	Compared a peer led and a professional led educational courses based on the SCT	120	Three worksite sites with blue-collar workers participated in the study.	7-day PA recall	Peer led intervention enhanced self-efficacy and self-reported PA but returned to baseline activity levels at 8-week follow-up.
Hallam & Petosa (2004)	A four session program designed to target SCT constructs was compared with a usual exercise prescription.	76	Adults participating in a worksite intervention program	7-day PA recall	Treatment group increased PA up to 6 months and then stayed steady. Comparison group decreased in PA.
Ransdell, Dratt, Kennedy et al. (2001)	Intervention included PA and classroom sessions based on the SCT twice a week for 12 weeks with 6 monthly newsletters	20	Mothers and daughters recruited through newspaper ads and through girl scouts.	Two item self-report and a submaximal fitness test	PA and fitness levels did not change significantly over time.
Resnick, Louisi, and Vogel (2008)	Tested the efficacy and feasibility of a PA and self-efficacy enhancing intervention for seniors.	166	Urban minority older adults	YALE physical activity Interview	Improvements found on outcome expectations, time spent on exercise, and depressive symptoms; PA outcomes minimally supported
Rovniak, Howell, Wojcik, et al. (2005)	Compared two 12-week walking programs, one designed to follow SCT recommendations for operationalizing mastery procedures	51	Sedentary adult women	Self-report walking from the National Health Interview Survey & 1 mile walk test	The high fidelity group improved more than twice as much as the low fidelity group on 1-mile walk test time.

(Table continues)

Author	Intervention strategy	N	Population/Setting	PA Measure	Conclusions
Stewart, Gillis, Grossman, et al. (2006)	CHAMPS III, an individual level research-based PA promotion program implemented at three sites.	321	Lower income and minority seniors at three community organizations	CHAMPS physical activity questionnaire.	Two of the sites showed a trend towards increased physical activity

Note. PA = physical activity, PAQ = Physical activity questionnaire.

Table 4

Mixed Theory Physical Activity Intervention Studies

Authors	Theories	Intervention strategy	N	Population/Setting	PA Measure	Conclusions
Albright, Pruitt, Castro, et al. (2005)	TTM SCT	Two months of weekly 1 hr classes followed by 10 months of either home-based telephone counseling and newsletter or newsletter only	72	18-65 year old women, recruited from vocational training courses to a group and home based activity program.	7-day PA recall	The phone plus mail group had significantly greater increases in PA than the mail only group.
Bock, Marcus, Pinto, & Forsyth (2001)	TTM SCT	Individually tailored motivation-matched intervention compared to standard print materials delivered by mail	150	Sedentary adults recruited through newspaper ads into a home-based, mailed intervention.	7-day PA recall	Significantly more participants in the intervention group met or exceeded exercise goals at the end of the intervention period and maintained the activity through 12 month follow-up.
Calfas, Sallis, Nichols, et al. (2000)	TTM SCT	A semester long cognitive-behavioral intervention class with phone and mail follow-up was compared to a knowledge-oriented health course	338	University seniors taking a semester long class	7-day PA recall	The students taking the intervention class were more likely to increase PA than those in the control condition.
Carmack, Demoor, Smith, et al. (2006)	TTM SCT	6 month group-based lifestyle PA program compared to a group-based educational support program and a control	134	Prostate cancer patients	7 day recall and 6 minute walk	No significant changes were found for most PA measures
Goldstein, Pinto, Marcus, et al. (1999)	TTM SCT	Intervention group received brief stage matched activity counseling, a patient manual and appointment with physician. Control received standard care	355	Middle aged and older adult patient population	PASE	The intervention had no effect on PA or stages of change level
Napolitano, Fotheringham, Tate, et al. (2003)	SCT TTM	Internet intervention with web site and 12 weekly email tips compared to a wait-list control with 1 and 3-month follow-ups.	52	Employees of several large hospitals	Self-report PA measure	Participants in the intervention group were more likely to move up in SOC. At 1 month, they exhibited more minutes of moderate activity. At 3 months the two groups did not differ in activity levels

(Table continues)

Authors	Theories	Intervention strategy	N	Population/Setting	PA Measure	Conclusions
Patrick, Sallis, Prochaska, et al. (2001)	TTM SCT	Intervention based on TTM and SCT. Participants were divided to no treatment, mail only, brief telephone and mail and frequent telephone and mail.	117	Adolescents 11 to 18 years in primary care setting.	Self-report (not specified)	All outcomes, except vigorous activity improved
Pinto, Friedman, Marcus, et al. (2002)	TTM SCT	A fully automated 6 month PA counseling system to increase moderate level PA delivered through telephone was compared with control.	298	Sedentary adults	7-day recall	Intervention group was more likely to meet recommendation at 3 months and reported higher energy expenditure. Results were not maintained at 6 months.
Reger, Cooper, Booth-Butterfield, et al. (2002)	TTM TPB	TTM and TPB based multimedia messages, public relations, and public health activities targeting walking behavior in the community	1472	Community based program targeting one West Virginia city. Target population: sedentary 50-65-year-old adults	Surveys and observations in the community	Number of walkers increased by 23%in the intervention community vs. no change in the comparison community and 32.2% of the intervention community met PA guidelines after the intervention vs.18% in the comparison community
Wilcox, Dowda, Leviton, et al. (2008) Wilcox, Dowda, Griffin, et al. (2006)	TTM SCT	Comparison of a 6-month phone based community behavior change program and a 20-week group-based behavior change program.	2503	Community based physical activity program for older adults	CHAMPS physical activity questionnaire for the elderly	Both programs lead to significant increases in moderate to vigorous PA, and total PA.

Note. PA = physical activity, PAQ = Physical activity questionnaire, SOC = Stages of change, SCT = Social Cognitive Theory, TTM = Transtheoretical model, TPB = Theory of Planned Behavior.

RE-AIM Evaluation

Reach. Only 20.4% (*n* = 11; see table 2.5) of the interventions reviewed reported participation rate as a percentage of those eligible to participate (Dishman et al., 2004; Faghri et al., 2008; Green et al., 2002; Goldstein et al., 1999; Hallam & Petosa, 2004; Hardeman, 2009; Jones et al., 2004; Kelley, & Abraham, 2004; Mutrie et al., 2001; Proper et al, 2003; Purath et al., 2004). Many studies did not include information about the specific target population or researchers were using convenience samples with various recruitment methods within a community. When participation rate was reported, it was between .86% and 66.7% of the population with a median reach of 18.7% (Dishman et al., 2004; Faghri et al., 2008; Green et al., 2002; Goldstein et al., 1999; Hallam & Petosa, 2004; Hardeman et al., 2009; Jones et al., 2004; Kelley & Abraham, 2004; Mutrie et al., 2001; Proper et al., 2003; Purath et al., 2004) with only two interventions being able to attract more than 50% of the target population (Jones et al., 2004; Dishman et al., 2004).

Exclusion criteria were reported in 83.3% of the studies (Albright et al., 2005; Basler et al., 2007; Blissmer & McAuley, 2002; Bock et al., 2001; Calfas et al., 1999; Carmack Taylor et al., 2006; Cramp & Brawley, 2006; Dallow & Anderson, 2003; Dinger et al., 2007; DuVall et al., 2004; Faghri et al., 2008; Fahrenwald et al., 2004; Findorff et al., 2007; Greaney et al.¸2008; Green et al., 2002; Goldstein et al., 1999; Hallam & Petosa, 2004; Hardeman et al., 2009; Hasler et al., 2000; Hooker et al., 2005; Jackson et al., 2007; Jimmy & Martin, 2005; Jones et al., 2005; Kelley, & Abraham, 2003; Kim et al., 2004; Kirk et al., 2001; Kirk et al., 2004; Kosma et al. 2005; Marcus et al., 1998; Marcus et al., 2007; Marshall et al.¸2003; Napolitano et al., 2003; Patrick et al., 2001; Pinto et al.,

2002; Pinto et al., 2005; Proper et al., 2003; Purath et al., 2004; Ransdell et al., 2001; Resnick et al., 2008; Rovniak et al., 2005; Smith et al., 2000; Vallance et al., 2008; Vandelanotte et al., 2007; Wilcox et al., 2008); however, only 27.8% of the studies (n = 15) that specified exclusion criteria reported the proportion of people excluded from the study (Cramp & Brawley, 2006; Dinger et al., 2007; Green et al., 2002; Goldstein et al., 1999; Hardeman et al., 2009; Jimmy & Martin, 2005; Jones et al., 2004; Kelley, & Abraham, 2004; Marshall et al., 2003; Napolitano et al., 2003; Pinto et al., 2002; Pinto et al., 2005; Purath et al., 2004; Resnick et al., 2008; Rovniak et al., 2005). In addition, 86.8% (n = 47) of the studies reported inclusion criteria (Albright et al., 2005; Basler et al., 2007; Blissmer & McAuley, 2002; Bock et al., 2001; Calfas et al., 1999; Carmack Taylor et al., 2006; Chatzisarantis & Hagger, 2005; Cramp & Brawley, 2006; Dallow & Anderson, 2003; Dinger et al., 2007; DuVall et al., 2004; Elbel et al., 2003; Fahrenwald et al., 2004; Findorff et al., 2007; Greaney et al., 2008; Green et al., 2002; Goldstein et al., 1999; Hallam & Petosa, 2004; Hardeman et al., 2009; Hasler et al., 2000; Hooker et al., 2005; Jackson et al., 2007; Jimmy & Martin, 2005; Jones et al., 2004; Kelley & Abraham, 2004; Kim et al., 2004; Kirk et al., 2001; Kirk et al., 2004; Kosma et al., 2005; Marcus et al., 1998; Marshall et al., 2003; Mutrie et al., 2001; Napolitano et al., 2003; Naylor et al., 1999; Patrick et al., 2001; Pinto et al., 2004; Pinto et al., 2005; Proper et al., 2003; Purath et al., 2004; Reger et al., 2002; Resnick et al., 2008; Rovniak et al., 2005; Smith et al., 2000; Vallance et al., 2008; Vandelanotte et al., 2007; Wilcox et al., 2008). Finally, only one study reported on the representativeness of the participants to the total target population (Hallam & Petosa, 2004).

The low reach (.87%) in the intervention by Hallam and Petosa (2004) was caused by a limitation on the number of participants that could be accommodated by this worksite program. Specifically, their study was limited to 60 participants with a total eligible work force of 7000. With so few studies reporting participation rate, it is difficult to make any conclusions about trends, but some of the more successful programs in reference to reach were one single contact intervention (66.7%; Jones et al, 2004), a school physical education intervention (51.6%; Dishman et al., 2004), and an intensive face-to-face intervention (49.8%; Proper et al., 2003).

Efficacy. All articles included in this review had physical activity behavior as one of the outcome measures; therefore, all of the studies selected reported on change in physical activity with 75.9% (n = 41) of the studies reporting an increase in physical activity levels (Albright et al., 2005; Blissmer & McAuley, 2002; Bock et al., 2001; Calfas et al., 1999; Carmack Taylor et al., 2006; Chatzisarantis & Hagger, 2005; Cramp & Brawley, 2006; Dallow & Anderson, 2003; Dinger et al., 2007; Dishman et al., 2004; DuVall et al., 2004; Faghri et al., 2008; Fahrenwald et al., 2004; Findorff et al., 2007; Frenn et al., 2005; Green et al., 2002; Hallam & Petosa, 2004; Hasler et al., 2000; Hooker et al., 2005; Jackson et al., 2007; Jimmy & Martin, 2005; Kelley, & Abraham, 2003; Kim et al., 2004; Kirk et al., 2001; Kirk et al., 2004; Marcus et al., 1998; Marcus et al., 2007; Marshall et al., 2003; Mutrie et al., 2001; Napolitano et al., 2003; Patrick et al., 2001; Pinto et al., 2002; Pinto et al., 2005; Proper et al., 2003; Purath et al., 2004; Reger et al., 2002; Resnick et al., 2008; Vallance et al., 2008; Vandelanotte et al., 2007; Wilcox et al., 2008). Attrition rates were reported in 94.4% of the studies and ranged from 0% to 62.5% with a median of 22.7% (Albright, et al., 2005; Basler et al., 2007; Blissmer & McAuley,

2002; Bock et al., 2001; Calfas et al., 1999; Carmack Taylor, et al., 2006; Chatzisarantis & Hagger, 2005; Cramp & Brawley, 2006; Dallow & Anderson, 2003; Dinger et al., 2007; Dishman et al., 2004; DuVall et al., 2004; Elbel et al., 2003; Faghri et al., 2008; Fahrenwald et al., 2004; Findorff et al., 2007; Frenn et al., 2005; Greaney et al.¸2008; Green et al., 2002; Hallam & Petosa, 2004; Hardeman et al., 2009; Hasler et al., 2000; Hooker et al., 2005; Ishii et al., 2007; Jackson et al., 2007; Jimmy & Martin, 2005; Jones et al., 2004; Kirk et al., 2001; Kirk et al., 2004; Kosma et al., 2005; Marcus, et al., 1998; Marcus et al., 2007; Marshall et al., 2003; Mutrie et al., 2001; Napolitano et al., 2003; Naylor et al.1999; Patrick, et al., 2001; Pinto et al., 2002; Pinto et al., 2005; Proper et al., 2003; Purath et al., 2004; Ransdell et al., 2001; Reger et al., 2002; Resnick et al., 2008; Rovniak et al., 2005; Smith et al., 2000; Stewart et al., 2006; Vallance et al., 2008; Vandelanotte et al., 2007; Wilcox et al., 2008). The highest attrition rates occurred in a 9 month face-to-face intervention among people who were recruited through a general practice (62.5%; Proper et al., 2003). Some of the lowest attrition rates occurred when the participants were not asked for a large commitment to a program. For example, a single contact intervention targeting school kids with a 5 week follow-up assessment was able to retain all participants (Chatzisarantis & Hagger, 2005) and a brief telephone based intervention with breast cancer survivors lost only 4.7% of the participants (Pinto et al., 2005).

Intent-to-treat or imputation procedures were used to account for missing values by 27.8% (n = 15) of the studies (Albright et al., 2005; Basler et al., 2007; Green et al., 2002; Hardeman et al., 2009; Hooker et al., 2005; Jones et al., 2004; Kirk et al., 2004; Marcus et al., 2007; Marshall et al., 2003; Pinto et al., 2002; Pinto et al., 2005; Reger et

al., 2002; Rovniak et al., 2005; Smith et al., 2000; Vallance et al., 2008). Only 24.1% (*n* = 13) of the studies measured changes in quality of life (Blissmer & McAuley, 2002; Bock et al., 2001; Carmack Taylor et al., 2006; Greaney et al., 2008; Goldstein et al., 1999; Hardeman et al., 2009; Kirk et al., 2001; Mutrie et al., 2001; Pinto et al., 2005; Resnick et al., 2008; Vallance et al., 2008; Wilcox et al., 2008) with the SF-36 being the most common measure of quality of life used in 6 of the 13 studies (Carmack Taylor et al., 2006; Greaney et al., 2008; Goldstein et al., 1999; Hardeman et al., 2009; Kirk et al., 2001; Mutrie et al., 2001).

The most ignored part of efficacy was the reporting on any unintended negative consequences of the program with only 2 of the 54 interventions addressing this issue. In addition to reporting on program effectiveness, quality of life, and attrition, Mutrie et al. (2001) reported that their active commuting program had no adverse effects such as increased traffic accidents. Hardeman et al. (2009) reported that 32 of their 321 participants reported having to visit a physician because of exercise related pain, but that none experienced severe complications.

Adoption. Reporting of information necessary to evaluate adoption such as specifying a specific site or recruitment strategy was not included in 14 of the 54 studies included in this review (Bock et al., 2001; Dallow & Anderson, 2003; Dinger et al., 2007; DuVall et al., 2004; Findorff et al., 2007; Greaney et al., 2008; Kosma et al., 2005; Marcus et al., 1998; Marcus et al.¸2007; Marshall et al., 2003; Pinto et al., 2002; Ransdell et al.¸2001; Rovniak et al., 2005; Vallance et al., 2008) and of the remaining 40 studies, 30 (55.6%) included the number of sites participating in recruitment or implementation of the program (Albright et al., 2005; Basler et al., 2007; Blissmer & McAuley, 2002; Calfas et

al., 1999; Chatzisarantis & Hagger, 2005; Cramp & Brawley, 2006; Dishman et al., 2004; Elbel et al., 2003; Frenn et al., 2005; Green et al., 2002; Hallam & Petrosa, 2004; Hardeman et al., 2009; Hasler et al., 2000; Hooker et al., 2005; Ishii et al., 2007; Jackson et al., 2007; Jimmy & Martin, 2005; Jones et al., 2004; Kelley, & Abraham, 2004; Kirk et al., 2004; Naylor et al., 1999; Patrick et al., 2001; Purath et al., 2004; Reger et al., 2002; Resnick et al., 2008; Smith et al., 2000; Stewart et al., 2006; Vandelanotte et al., 2007; Wilcox et al., 2008), but only two studies reported the number of all eligible sites for the study and the percentage of sites participating (Dishman et al., 2004; Smith et al., 2000). Exclusion criteria at the organizational level was reported by 9.3% (n = 5) of the studies (Dishman et al., 2004; Elbel et al., 2003; Hooker et al., 2005; Reger et al., 2002; Resnick et al., 2008), and the percentage of sites excluded and representativeness of the sites participating as compared to those that elected not to participate was reported by only one study (Reger et al., 2002).

Exclusion criteria were reported by one choice-based, telephone-assisted program for older adults offered through 13 diverse agencies. They required that participating sites were experienced in providing wellness-related services to older adults, experienced in recruiting and managing volunteers, had adequate infrastructure, and the ability to provide $10,000 in contribution to the program (Hooker et al, 2005). Although they failed to specifically describe the representativeness of the 13 sites that participated in this study, the researchers did describe each site and the populations served by the site. Another intervention that focused on increasing activity levels on the community level chose the specific city that was targeted because of its adequate and affordable media, co-operation of the local health agencies, and its proximity to the university conducting the

study (Reger et al., 2002). Researchers also briefly described the city's representativeness with certain characteristics of the city, such as annual average income, as compared to the rest of the nation and the state.

Implementation. Implementation was evaluated based on whether the publication reported any data on the faithfulness of intervention delivery. Reporting on implementation and process evaluation varied greatly between the programs. In some cases complete articles were dedicated to implementation while others provided no information. Of the articles reviewed, 29.6% (n = 15) addressed process evaluation on some level (Basler et al., 2007; Calfas et al., 1999; Dishman et al., 2004; Hardeman et al., 2009; Hooker et al., 2005; Jones et al., 2004; Marcus et al., 2007; Marshall et al., 2003; Napolitano et al., 2003; Patrick et al., 2001; Pinto et al., 2002; Pinto et al., 2005; Rovniak et al., 2005; Stewart et al., 2006; Wilcox et al., 2008) and 6 of these studies reported changing the intervention in some way based on the results of a process evaluation or feedback from participants (Calfas et al., 1999; Hardeman et al., 2009; Hooker et al., 2005; Napolitano et al., 2003; Stewart et al., 2006; Wilcox et al., 2008). However, of the 15 studies that reported conducting a process evaluation 6 did not provide information about who conducted the process evaluation (Hardeman et al., 2009; Hooker et al., 2005; Patrick et al., 2001; Pinto et al., 2002; Stewart et al., 2006; Wilcox et al., 2008) and 2 studies reported that the evaluation was completed by the same person conducting the intervention (Basler et al., 2007; Jones et al., 2004). Three interventions based the evaluations on information provided by participants (Marshall et al., 2003; Napolitano et al., 2003; Rovniak et al., 2005). Only 4 of the 15 articles reporting that a process evaluation had been conducted specified that it was conducted by an independent

evaluator or a researcher not delivering the intervention (Calfas et al., 1999; Dishman et al., 2004; Marcus et al., 1998; Pinto et al., 2005).

The actual reporting on process evaluation ranged from a few simple statements to a complete analysis. One study reported that staff received frequent supervision and mailings were sent as planned (Patrick et al., 2001). They also reported the average number of phone calls completed as a part of the intervention (Patrick et al., 2001). In a physical therapy setting, Basler et al. (2007) mentioned that the therapists recorded their actual behavior during the treatment and marked any deviation from the plan. Their recordings were then reviewed by two of the authors and encouragement to adhere to the program was provided to the therapists. A multisite, school-based program evaluated implementation by categorizing each school as high or low implementers based on a comprehensive evaluation of an independent process evaluator's records and the program staff rating of all implementation components and adherence to the physical education class criteria (Dishman et al., 2004).

Maintenance. Individual level maintenance for at least 6 months after the intervention was reported by 25.9% (n = 14) of the studies (Bock et al., 2001; Calfas et al., 1999; Carmack Taylor et al., 2006; Dallow & Anderson, 2003; Greaney et al., 2008; Hallam & Petosa, 2004; Jimmy & Martin, 2005; Marshall et al., 2003; Mutrie et al., 2001; Naylor et al., 1999; Pinto et al., 2005; Ransdell et al., 2001; Rovniak et al., 2005; Vandelanotte et al., 2007). The follow-up period in these studies ranged from 1 to 24 months. Of the programs that did report on individual behavior maintenance, 33.3% (n = 18) reported that significant increases in physical activity levels were maintained (Bock et al., 2001; Calfas et al., 1999; Dallow & Anderson, 2003; Hallam & Petosa, 2004; Marshall et al.,

2003; Mutrie et al., 2001; Pinto et al., 2005; Vandelanotte et al., 2007). Institutional maintenance past the study period was reported by only three interventions (Mutrie et al., 2001; Stewart et al., 2006; Wilcox et al., 2006) and because such maintenance is rare, it can be assumed that most of the programs not reporting on institutional maintenance were not continued.

One study reported on both individual and institutional level maintenance (Mutrie et al., 2001). This worksite program was designed to encourage active commuting and it was effective in maintaining change in active commuting at a 12-month post-intervention assessment. Based on the positive results of this study, the program was improved and printed for national distribution in Scotland free of charge (Mutrie et al., 2001). Another program that was specifically designed for community diffusion targeting diverse older adults at three community centers reported that each site continued to provide physical activity programming at the site after the study conclusion by applying for grants or using volunteer workers (Stewart et al., 2006).

Table 5

Percent and Number of Articles Reporting on the RE-AIM Components

Component	Number Reporting	Percent Reporting
Reach		
Participation rate	11	20.4
Exclusion criteria	45	83.3
Percentage of people excluded	15	27.8
Inclusion criteria	47	87.0
Representativeness of participants	1	1.9
Efficacy		
Behavioral measure	54	100.0
Attrition	51	94.4
Intent-to-treat/Imputation	15	27.8
Quality of life measure	13	24.1
Negative consequences	2	3.7
Adoption		
Number of sites participating	30	56.6
Number of sites eligible	2	3.7
% of eligible sites participating	2	3.8
Exclusion criteria	5	9.3
Exclusion rate	1	1.9
Representativeness of sites	1	1.9
Implementation		
Process evaluation data reported	16	29.6
Changes made to intervention	6	11.1
Maintenance		
Individual level – 6 months post contact	14	25.9
Change in physical activity at follow-up	8	14.8
Institutional level – program continued	3	5.6

Note. Percentages calculated based on a total of 54 interventions.

Evaluation of Psychological Mediators and Intervention Strategies

Although all of the studies included in this review reported being theory-based, only 43 of the 54 physical activity interventions specified which psychological mediators were targeted by the program or how the theory was used in designing the intervention (Albright et al., 2005; Basler et al. 2007; Blissmer & McAuley, 2002; Bock et al.2001; Calfas et al., 1999; Carmack Taylor et al., 2006; Chatzisarantis & Hagger, 2005; Cramp & Brawley, 2006; Dallow & Anderson, 2003; Dinger et al., 2007; Dishman et al., 2004; Elbel et al., 2003; Fahrenwald et al., 2004; Findorff et al., 2007; Frenn et al., 2005; Greaney et al., 2008; Green et al., 2002; Goldstein et al., 1999; Hallam & Petosa, 2004; Hardeman et al., 2009; Hooker et al., 2005; Ishii et al., 2007; Jackson et al., 2007; Jimmy & Martin, 2005; Kelley & Abraham, 2004; Kim et al., 2004; Kirk et al., 2004; Kosma et al., 2005; Marcus et al., 1998; Marcus et al., 2007; Marshall et al., 2003; Napolitano et al., 2003; Naylor et al., 1999; Pinto et al., 2002; Pinto et al., 2005; Proper et al., 2003; Purath et al., 2004; Ransdell et al., 2001; Resnick et al., 2008; Rovniak et al., 2005; Vallance et al., 2008; Vandelanotte et al., 2007; Wilcox et al., 2008). Out of the studies that did target specific mediators, 72.2% (n = 40) reported that they measured change in mediators as a result of the intervention (Blissmer & McAuley, 2002; Bock et al., 2001; Calfas et al., 1999; Carmack Taylor et al., 2006; Chatzisarantis & Hagger, 2005; Cramp & Brawley, 2006; Dallow & Anderson, 2003; Dinger et al., 2007; Dishman et al., 2004; Elbel et al., 2003; Faghri et al., 2008; Fahrenwald et al., 2004; Findorff et al., 2007; Greaney et al., 2008; Goldstein et al., 1999; Hallam & Petosa, 2004; Hardeman et al., 2009; Hooker et al., 2005; Ishii, et al., 2007; Jackson et al., 2007; Kelley, & Abraham, 2004; Kim et al., 2004; Kirk et al., 2001; Kirk et al., 2004; Kosma et al., 2005; Marcus et

al., 1998; Marcus et al., 2007; Marshall et al., 2003; Mutrie et al., 2001; Napolitano et al., 2003; Naylor et al., 1999; Pinto et al., 2002; Pinto et al., 2005; Proper et al., 2003; Purath et al., 2003; Reger et al., 2002; Resnick et al., 2008; Rovniak et al., 2005; Vallance et al., 2008). All but one of these studies found significant changes in at least one mediator after the intervention program (Proper et al., 2003). Physical activity interventions targeting mediators were about equally effective at changing exercise behavior as those not targeting specific mediators with 76.7% and 81.8% success rates, respectively.

A formal analysis of mediators by path or regression analyses was included in only three interventions (Dishman et al., 2004; Pinto et al., 2005; Findorff et al., 2007). The findings of these studies were conflicting in that one of the studies found that none of the TTM variables mediated the effects of the intervention (Pinto et al., 2005) and the other two studies found that self-efficacy mediated the effects of the program and predicted physical activity levels in the long-term (Dishman et al., 2004; Findorff et al., 2007). These two interventions were also found to increase the participants' SOC.

The most commonly targeted mediator across the three theories was the SOC, which was included in 53.7 % (n = 30) of all studies (Albright et al., 2005; Basler et al., 2007; Blissmer & McAuley, 2002; Bock et al., 2001; Calfas et al., 1999; Dallow & Anderson, 2003; Dinger et al., 2007; Findorff et al., 2007; Frenn et al., 2005; Greaney et al., 2008; Green et al., 2002; Goldstein et al., 1999; Hooker et al., 2005; Ishii et al., 2007; Jackson, et al., 2007; Jimmy & Martin, 2005; Kim et al., 2004; Kirk, et al., 2004; Kosma et al., 2005; Marcus et al., 1998; Marcus et al., 2007; Marshall et al., 2003; Napolitano et al., 2003; Naylor et al., 1999; Pinto et al., 2002; Pinto et al., 2005; Proper et al., 2003; Purath et al., 2004; Wilcox et al., 2008), and 21 of the 27 TTM based interventions targeted SOC

or provided stage specific materials to participants (Basler et al., 2007: Blissmer & McAuley, 2002; Dallow & Anderson, 2003; Dinger et al., 2007; Findorff et al., 2007; Frenn et al., 2005; Greaney et al., 2008; Green et al., 2002; Hooker et al., 2005; Ishii et al., 2007; Jackson et al., 2007; Jimmy & Martin, 2005; Kim et al., 2004; Kirk et al., 2004; Kosma et al., 2005; Marcus et al., 1998; Marshall et al, 2003; Naylor et al., 1999; Pinto et al., 2005; Proper et al., 2003; Purath et al., 2004). Fourteen TTM-based interventions or those based on a combination of TTM and another theory also reported targeting processes of change (Blissmer & McAuley, 2002; Bock et al., 2001; Calfas et al., 1999; Carmack Taylor et al., 2006; Dallow & Anderson, 2003; Dinger et al., 2007; Fahrenwald et al., 2004; Greaney et al., 2008; Goldstein et al., 1999; Kim et al., 2004; Marcus et al., 1998; Marcus et al., 2007; Naylor et al., 1999; Pinto et al., 2002), 13 focused on self-efficacy (n = 13; Basler et al., 2007; Bock et al., 2001; Calfas et al., 1999; Carmack Taylor et al., 2006; Dallow & Anderson, 2003; Dinger et al., 2007; Fahrenwald et al., 2004; Greaney et al., 2008; Kim et al., 2004; Marcus et al., 2007; Pinto et al., 2002; Vandelanotte et al., 2007; Wilcox et al., 2008), and 10 targeted decisional balance (Basler et al., 2007; Bock et al., 2001; Carmack Taylor et al., 2006; Dinger et al., 2007; Fahrenwald et al., 2004; Greaney et al., 2008; Kim et al., 2004; Marcus et al., 1998; Marcus et al., 2007; Pinto et al., 2002).

Interventions based on the TPB or a combination of the TPB and another theory most often targeted INT (*n* = 4; Hardeman et al., 2009; Kelley, & Abraham, 2003; Vallance et al., 2008; Vandelanotte et al., 2007) or the underlying beliefs about physical activity (*n* = 4; Hardeman et al, 2009; Chatzisarantis & Hagger, 2005; Vallance et al., 2008; Vandelanotte et al., 2007). Some studies also reported targeting ATT (*n* = 3; Hardeman et

al., 2009; Vallance et al., 2008; Vandelanotte et al., 2007), PBC (*n* = 3; Hardeman et al., 2009; Kelley & Abraham, 2004; Vallance et al., 2008), and SN (*n* = 2; Hardeman et al., 2009; Vallance et al., 2008). Two of the five interventions based on the TPB reportedly targeted all of the TPB constructs and their underlying beliefs (Hardeman et al., 2009; Vallance et al., 2008), and one intervention did not reportedly target any of the TPB constructs (Jones et al., 2004).

Among interventions based on the SCT, the most commonly targeted mediators were self-efficacy and outcome expectations with seven out of the nine SCT-based interventions targeting self-efficacy (Cramp & Brawley, 2006; Dishman et al., 2004; Elbel et al., 2003; Hallam & Petosa, 2004; Ransdell et al., 2001; Resnick et al., 2008; Rovniak et al., 2005) and five interventions targeting outcome expectations (Dishman et al., 2004; Elbel et al., 2003; Hallam & Petosa, 2004; Ransdell et al., 2001; Resnick et al., 2008). Other mediators targeted within SCT-based interventions included physical activity barriers (*n* = 5; Cramp & Brawley, 2006; Dishman et al., 2004; DuVall et al., 2004; Elbel et al., 2003; Ransdell et al., 2001), benefits of physical activity (*n* = 3; DuVall et al., 2004; Elbel et al., 2003; Hallam & Petosa, 2004), social support (*n* = 2; Hallam & Petosa, 2004; Ransdell et al., 2001), and SOC (Elbel et al, 2003). One intervention did not report targeting any mediators (Stewart et al., 2006)

Specific behavioral strategies were reported by 88.9% (*n* = 48) of the studies and seven studies reported assessing the use of strategies before and after the intervention program (Calfas et al., 1999; Chatzisarantis & Hagger, 2005; Dishman et al., 2004; Fahrenwald et al., 2004; Greaney et al., 2008; Hallam & Petosa, 2004; Vallance et al., 2008). Of these studies five found that there was an increase in the use of the measured

strategies among the participants (Dishman et al., 2004; Fahrenwald et al., 2004; Greaney et al., 2008; Hallam & Petosa, 2004; Vallance et al., 2008). The most commonly used strategy in 59.3% (n = 32) of the studies was providing participants with information about overcoming barriers to physical activity (Albright et al., 2005; Blissmer & McAuley, 2002; Bock et al., 2001; Calfas et al., 1999; Carmack Taylor et al., 2006; Cramp & Brawley, 2006; Dallow & Anderson, 2003; Dishman et al., 2004; DuVall et al., 2004; Elbel et al., 2003; Faghri et al., 2008; Fahrenwald et al., 2004; Findorff et al., 2007; Frenn et al., 2005; Green et al., 2002; Goldstein et al., 1999; Hardeman et al., 2009; Hasler et al., 2000; Hooker et al., 2005; Jackson et al., 2007; Kim et al., 2004; Kirk et al., 2001; Kirk et al. 2004; Kosma et al., 2005; Marcus et al., 2005; Napolitano et al., 2003; Patrick et al.,2001; Pinto et al., 2002; Pinto et al., 2005; Ransdell et al., 2001; Vandelanotte et al., 2007; Wilcox et al., 2008).

Other strategies that were frequently used included goal setting (55.6%, n = 30; Albright et al., 2005; Calfas et al., 1999; Carmack Taylor et al., 2006; Cramp & Brawley, 2006; Dinger et al., 2007; Dishman et al., 2004; DuVall et al., 2004; Elbel et al., 2003; Faghri et al., 2008; Fahrenwald et al., 2004; Green et al., 2002; Hallam & Petosa, 2004; Hardeman et al., 2009; Hasler et al., 2000; Hooker et al., 2005; Jackson et al., 2007; Jimmy & Martin, 2005; Kelley & Abraham, 2004; Kim et al., 2004; Kirk et al. 2001; Kirk et al. 2004; Kosma et al., 2005; Napolitano et al., 2003; Patrick et al., 2001; Pinto et al., 2002; Pinto et al., 2005; Purath et al.2004; Ransdell et al., 2001; Rovniak et al., 2005; Wilcox et al., 2008), discussion of the benefits of physical activity (46.3%, n = 25; Blissmer & McAuley, 2002; Bock et al., 2001; Calfas et al., 1999; Dinger et al., 2007; DuVall et al., 2004; Elbel et al., 2003; Fahrenwald et al., 2004; Findorff et al., 2007;

Frenn et al., 2005; Greaney et al., 2008; Goldstein et al., 1999; Hallam et al., 2004; Hardeman et al., 2009; Hasler et al., 2008; Jackson et al., 2007; Jimmy et al., 2005; Kelley & Abraham, 2004; Kim et al., 2004; Kirk et al, 2001; Kirk et al. 2004; Marcus et al., 1998; Napolitano et al., 2003; Pinto et al. 2002; Vandelanotte et al., 2007; Wilcox et al., 2008), social support (37.0%, *n* = 20; Albright et al., 2005; Basler et al., 2007; Blissmer & McAuley, 2002; Calfas et al., 1999; Dinger et al., 2007; Fahrenwald et al., 2004; Goldstein et al., 1999; Hallam & Petosa, 2004; Hardeman et al., 2009; Hasler et al., 2000; Hooker et al., 2005; Ishii et al., 2007; Jackson et al.; Kirk et al, 2004; Kosma et al., 2005; Napolitano et al., 2003; Patrick et al., 2001; Ransdell et al., 2001; Vandelanotte et al., 2007; Wilcox et al., 2006), relapse prevention (29.6%, *n* = 16; Albright et al., 2005; Basler et al., 2007; Blissmer & McAuley, 2002; Calfas et al., 1999; Carmack Taylor et al., 2006; Elbel et al., 2003; Findorff et al., 2007; Hallam & Petosa, 2004; Hardeman et al., 2009; Hasler et al., 2000; Jackson et al., 2007; Kim et al., 2004; Kirk et al, 2001; Kirk et al., 2004; Ransdell et al., 2001; Vandelanotte et al., 2007), self-monitoring (25.9%, *n* = 14; Albright et al., 2005; Calfas et al., 1999; Carmack Taylor et al., 2006; Dinger et al., 2007; Hallam & Petosa, 2004; Hardeman et al., 2009; Ishii et al., 2007; Kelley & Abraham, 2004; Mutrie et al., 2001; Napolitano et al., 2003; Naylor et al., 1999; Pinto et al., 2005; Rovniak et al., 2005; Vallance et al., 2008), using rewards (18.5%, *n* = 10; Blissmer & McAuley, 2002; Bock et al., 2001; Carmack Taylor et al., 2006; Dinger et al., 2007; DuVall et al., 2004; Ishii et al., 2007; Kim et al., 2004; Kosma et al., 2005; Marcus et al., 1998; Napolitano et al., 2003), increasing knowledge (18.5%, *n* = 10; Albright et al., 2005; Blissmer & McAuley, 2002; Calfas et al., 1999; DuVall et al., 2004; Goldstein et al., 1999; Hallam & Petosa, 2004; Kosma et al., 2005; Napolitano et al., 2003;

Ransdell et al., 2001; Vandelanotte et al., 2007), and exercise prescription (13%, *n* = 7; Elbel et al., 2003; Greaney et al., 2008; Green et al., 2002; Goldstein et al., 1999; Hooker et al., 2005; Pinto et al, 2005; Stewart et al.2006).

Discussion

This review focused on examining the extent to which current theory-based physical activity interventions report on the issues that affect external validity by using the RE-AIM framework, as well as analyzing the mediators and behavior change strategies reported in these studies. Similar to a school health promotion RE-AIM evaluation by Estabrooks et al. (2003), most of the studies reviewed focused on internal validity and statistically significant findings rather than on issues of external validity. Few studies included a thorough description of the intervention protocol and materials or how they related to the targeted mediators. Also, theoretical fidelity of many of the interventions is questionable.

When evaluating reach, a major problem in physical activity intervention studies is the small percentage of studies reporting on the target population reached. Compared to the RE-AIM evaluation of school-based health promotion programs, the percentage of theory-based physical activity interventions reporting the total population reached is much lower (59.3% vs. 20.4%, respectively). However, specifying and determining a target population in school-based programs where the total population of a school can easily be documented is simple compared to determining the target population that may utilize various community-based programs. Thus, this difference in reporting is probably most often related to the lack of initially identifying a specific target population or not

realizing that this information is important to report to provide other researchers or practitioners the ability to evaluate the potential reach of an intervention.

Reporting on all other aspects of reach is important for determining the feasibility of translating the intervention to real world settings. For example, inclusion and exclusion criterion and exclusion rate can have an impact on how appropriate an intervention is in a given setting. Several of the reviewed studies excluded anyone with a chronic health condition (Albright et al., 2005; Basler et al., 2007; Jones et al., 2004; Blissmer & McAuley, 2002; Bock et al., 2001; Carmack Taylor et al, 2006; Cramp & Bradley, 2006; Dallow & Anderson, 2003; Green et al., 2007; Hardeman et al., 2009; Kirk et al., 2001; Patrick et al., 2001; Pinto et al, 2005; Purath et al., 2004; Ransdell et al, 2001; Resnick, 2008; Vallance et al., 2008; Vandelanotte et al., 2005) and some studies targeting minorities excluded those participants who did not have adequate control of the English language (Albright et al., 2005). In addition, several studies excluded a large portion of potential participants who would have been interested in the intervention. For example, Pinto et al. (2005) excluded potential participants because of chronic health conditions including high blood pressure and diabetes, medications, and prior history of cancer or for being considered physically active. Being that the target population of this intervention was female breast cancer patients, these exclusion criteria lead to a 71% exclusion rate. On a population level, such exclusion rates would have an unfortunate impact on reach. The importance of reporting exclusion criteria and exclusion rate for translational research is twofold. First, researchers need to know who was excluded to determine if the results can be generalized to a potential population and setting, and second, researchers need to know how many people were excluded based on these

standards to determine the feasibility of the intervention for a given target population. When a large portion of the target population is excluded from an intervention based on strict exclusion criteria the potential public health impact of the program is reduced and provides limited information to practitioners looking to implement the intervention in real world settings where such factors cannot be controlled.

The last facet of reach that is important for determining public health impact and appropriateness of a program for translational research is the representativeness of the study participants to the target population. Unfortunately, only one of the physical activity interventions reviewed reported on the representativeness of the participants to the target population (Hallam & Petosa, 2004). For example, Marshall et al. (2003) recruited a population-based sample of 462 adults based on random dialing, but failed to report if the sample recruited to the mail-based program was representative of the total adult population in Australia. Few studies reported on the ethnic and socioeconomic characteristics of their participants and even those that did report these demographics did not use them in their analysis to determine if demographic differences existed in intervention efficacy (Pinto et al., 2002).

Although all of the reviewed studies reported on the effectiveness of the intervention for changing physical activity behavior, the reporting was often vague. Some studies that first reported that levels of activity changed further stated that no statistical differences in activity levels were found. For example, Jimmy and Martin (2005) reported that nearly half of their participants had become active by 14 months, but the differences found were not statistically significant. In other studies only percentages and raw data were reported with no statistical test to determine if the changes were significant. Other researchers

reported that their program changed behavior in both the intervention and the control group without accounting for the fact that such changes could be caused by testing, seasonal effects, or other programs available to the participants (DuVall et al., 2004). This type of reporting on efficacy may reflect researchers' sense of urgency for finding a way to report intervention effectiveness and significant findings, but the results are meaningless for health promotion professionals and researchers trying to discern the clinical significance of the interventions.

Difficulties in recruiting adequate numbers of participants or having limited resources to include large samples are additional factors that impact the results and efficacy of intervention studies. In the studies reviewed, sample sizes ranged from 20 to 2087 with a median sample size of 126. In addition, 35.2% of the studies had less than 100 participants. Furthermore, several studies divided a relatively small sample into two or more intervention groups. For example, Dinger et al. (2007) compared a pedometer and weekly email reminder program to one that utilized TTM-based strategies. Both programs increased physical activity, but there were no significant differences between the groups. The non-significant results were likely caused by the small sample size of 56 who were split into two intervention groups with no true control group. However, when considering the public health impact of physical activity interventions, the focus should not necessarily be on recruiting massive numbers of people for a single intervention because in real life settings no individual program or organization has the funding to reach thousands of people. Most physical activity programs are run locally through small independently operated community sites and centers; thus, it may be better to focus more on proper reporting of the intervention protocol, results, and effects of interventions

rather than focus only on the efficacy of a single program. This would provide the information needed for future reviews and meta-analyses to determine the actual public health impact of interventions. Shifting focus in this manner would also encourage publication of studies that are well written and described, but that may lack statistically significant findings because of a small sample size.

Based on the articles reviewed and prior reports by other researchers (Estabrooks, et al., 2003), adoption appears to be the most often ignored characteristic of external validity of interventions. The percentage of physical activity interventions that reported the number of eligible sites was lower than in the previous RE-AIM analysis of school-based programs (3.7% vs. 14.7%, respectively). Among the studies included in the review, several investigators relied on a convenience sample from the community while focusing solely on the efficacy of the program. Such studies cannot be translated to real life settings and have limited external validity or value in translational research. However, the studies that did recruit from community centers, physician's offices, schools, or workplaces should have reported the number of sites that were screened or invited to participate in the study, as well as any institutional level exclusion criteria and representativeness or characteristics of the sites choosing to adopt the program.

Only about a third of the interventions reviewed reported any information on process evaluation. Considering the complexity of current behavior change programs this result is not surprising. Fortunately, some authors elected to report on the implementation and process evaluation in a separate article. This is a positive trend considering the space limitations of most journals that have led to brief descriptions of programs and a lack of reporting on process evaluation. Including process evaluation is particularly important

with multisite programs where several individuals are independently responsible for delivering the interventions. If the intervention was not delivered as originally intended, the reader should be made aware of the changes that took place so they can evaluate the effectiveness of the program based on the actual process rather than a description of an ideal scenario. Process evaluation data can also provide practitioners with information about how flexible a given program is to changes while still maintaining efficacy. For example, Steward et al. (2006) examined the CHAMPS physical activity program that was adopted for implementation at three sites and provided a detailed description of the differences in adoption and both organizational and individual level results at each site.

Individual level maintenance levels reported in this review were similar to the review of school based health promotion programs (25.9%). Although, the majority of studies in this review did not report maintenance data, it is promising that more than 50% of the studies that did assess individual level maintenance reported that increases in physical activity levels had been maintained. The three studies that reported on institutional level maintenance were translational in nature (Mutrie et al., 2001; Steward et al., 2006; Wilcox et al., 2008).

There also appears to be a need within intervention research to categorize mediators as theory-based or non-theory-based. According to a definition by Marcus and Forsyth (2009) mediators are factors that help people change their behavior and represent a mechanism by which the intervention is believed to be effective. This definition can be understood to include both theoretical constructs and behavioral strategies. However, among theory-based interventions, mediators typically refer to the theoretical constructs

that have been targeted to effect change through the use of specific strategies. Authors should make a clear distinction between the two types of mediators.

Although the majority of the studies included in this review did identify at least one mediator targeted by the intervention and some of the strategies used to target the mediators, few of the studies provided a rationale or theoretical basis for including some mediators while choosing not to target or measure others. The decision to use specific behavior change strategies as mediators or to assess the use of targeted strategies was more ambiguous. In several interventions, theory-based mediators were targeted, but they were not assessed to provide support that the mediators were affected by the program (Albright et al., 2005; Basler et al., 2007; Frenn et al., 2005; Green et al., 2002; Jimmy & Martin¸ 2005; Ransdell et al., 2001; Vandelanotte et al. 2007) and a few interventions were reportedly based on SOC, but the researchers provided the same materials to people in all SOC making it unclear how the SOC was used in the intervention design (Faghri et al., 2008). Additionally, many of the TTM-based interventions were reportedly only based on SOC with no mention of the other four constructs of the theory. Such programs would be better described as interventions based on the SOC rather than TTM.

The interventions reviewed in this study generally showed poor fidelity to theory. Fidelity to theory is an important component of implementation evaluation and it has been defined as the extent to which a study is consistent and precise with the components of the behavioral theory it was based on (Keller, Fleury, Sidani, & Ainsworth 2009; Rovniak et al., 2005). Theoretical fidelity has an impact on the effectiveness of the intervention and the ability for a reader to compare various programs. Additionally, good

theoretical fidelity is necessary to make conclusions about the effectiveness of a given theory for behavior change because if the interventions are not faithful to the theory, the results cannot be applied to determine the value of the theory. Several studies evaluated in this review reported using a particular theory, yet provided no information on the theoretical mediators targeted by the intervention or a clear rationale for choosing the specific theory. Jones et al. (2004) targeted cancer survivors with a 30 second exercise recommendation by an oncologist that was reportedly based on the TPB, yet the script that the oncologists used to deliver the message was based solely on current exercise recommendations and did not include anything specifically relevant to TPB such as a messages targeting salient beliefs. In some studies, obvious faults can be seen in the way the theory was operationalized. For example, Patrick et al. (2001) based their intervention on the TTM and SCT and stated that they targeted several empirically supported mediators including praise, social support, and problem solving. Their lack of addressing actual constructs from the theories such as SOC, processes of change, decisional balance, self-efficacy, and outcome expectations, or how the chosen strategies would affect these constructs makes one question if the program was actually designed and based on behavioral theory. Elbel et al. (2003) reportedly based their worksite physical activity intervention on the SCT, but chose to measure SOC, a construct of the TTM, as one of the mediators. Another common practice in theory-based research is using only a few of the theory-based mediators in intervention design. Nine of the 27 TTM-based programs targeted and assessed only SOC while ignoring all other components of the theory.

Another issue related to theoretical fidelity is reporting misleading conclusions that the collected data or statistical analyses do not support. Dinger et al. (2007) reported that

they compared a TTM-based pedometer supported activity program to a non-theory-based pedometer program. However, when no statistical differences were found between the groups, they combined both interventions and examined changes pre- to post-intervention. They concluded that their results supported the use of pedometer based interventions for increasing physical activity and changing the TTM-based constructs. Because only half of their participants actually received the theory-based intervention, their conclusion should have been limited to recommending the use of pedometers.

Some researchers have made an effort to specifically examine the effect of theoretical fidelity on intervention effectiveness. Blissmer and McAuley (2002) examined the strength of theory- based interventions by comparing stage-matched materials to non-matched, standard care, and control materials that included general health education. The stage-matched materials outperformed the mismatched and control materials; however, the stage-matched materials were no better than standard materials for increasing physical activity. The authors suggested that this may have resulted from the majority of their participants being in the preparation stage, which closely matches typical materials for physical activity promotion. In light of the lack of theoretical fidelity found in this review and reported in previous studies (Keller et al., 2009), it is clear that prior to concluding that theory-based interventions do not work, future research should focus on designing interventions with high fidelity to theory.

One of the limitations of assessing the external validity of interventions is that the researchers of the reviewed studies may have collected some of the information required to complete a RE-AIM evaluation, but did not report it in the articles and their intention may be to publish this information in the future. Also, while searching for theory-based

interventions, it is possible that not all articles related to the studies reviewed were recovered. This may be the case particularly with articles related to process evaluation and mediators. Also, although each RE-AIM dimension is technically scored from 0-100, specific norms for the RE-AIM components have not been determined. Thus, the meaningfulness of the information provided for each dimension is left to be decided on a case-by-case basis. More studies evaluating various physical activity interventions are needed to determine standards for the RE-AIM dimensions.

Conclusion

The physical activity interventions included in this review were much more likely to report on issues of internal, rather than external validity and on individual, rather than organizational level components of the RE-AIM, making the translation of many of the interventions into practice difficult or impossible. Also, most studies included motivated, healthy participants radically reducing the generalizability of the interventions to real life settings that must provide services to more diverse populations. The current trends of basing interventions on theory, writing separate articles on issues of implementation and process evaluation, and focusing on long-term maintenance of behavior change are encouraged to provide more meaningful information necessary for translational research. Researchers are also encouraged to report the psychological mediators targeted, whether change in mediators was observed, and the specific behavior change strategies used in the intervention to provide information and tools that can be used in practice to increase physical activity on the population level.

To determine if a given intervention is feasible and effective in translational research and not only effective under highly controlled conditions, more information must be

reported about the factors that affect external validity. Although a thorough RE-AIM evaluation is not necessary or always the focus of an efficacy study, it is important for researchers and reviewers to understand that reporting on external validity is important if significant changes in activity levels on the population level are desired.

CHAPTER 3

A THEORY-BASED MOTIVATIONAL INTERVENTION TO INCREASE PHYSICAL ACTIVITY AMONG OLDER ADULTS

Physical activity can help prevent chronic conditions such as cardiovascular disease, stroke, diabetes, hypertension, and some forms of cancer (United States Department of Health and Human Services [USDHHS], 2000). Additionally, within the older adult population physical activity can help maintain or increase strength, control weight gain, reduce the risk of falling, and facilitate independent functioning in activities of daily living (USDHHS, 2000). Thus, physical activity is positively linked to health-related quality of life in older adults.

The current American College of Sports Medicine and American Heart Association physical activity guidelines for older adults over the age of 65 include moderate intensity cardiovascular exercises for 30 minutes, five times a week, or vigorous intensity activity for 20 minutes three times a week (Nelson, Rejeski, Blair, Duncan, Judge, King, et al. (2007). Older adults should also participate in resistance training two to three times a week and stretch on all the days they are physically active (Nelson et al., 2007). Further, balance exercises are recommended for those older adults at risk of falling (Nelson et al., 2007). Unfortunately, one-third of men and two-thirds of women over the age of 75 report participating in no physical activity (USDHHS, 2000). Therefore, there is a need to design and test interventions to assist older adults with the adoption and maintenance of physical activity.

Several studies have shown that among older adults, home-based physical activity programs have high adherence rates and that older adults prefer to be active outside of formal settings such as fitness centers (Ashworth, Chad, Harrison, Reeder, & Marshall, 2005; King, Rejeski, & Buckner, 1998). Home-based, telephone, or mail assisted programs reduce barriers associated with participating such as scheduling conflicts, cost, and availability of time, making it easier to reach larger groups of people, and they have been shown effective for older adults (King et al., 1998). Conn, Valentine, and Cooper (2002) found that interventions for older adults that were delivered by mediated approaches had similar effect sizes as those delivered face-to-face, and in a review of 29 interventions targeting older adults, King et al. (1998) reported that telephone supervision resulted in similar or better adherence rates than face-to-face contact. Among mediated interventions, print-based materials combined with telephone contact have shown promise in both physical activity initiation and long-term maintenance. A narrative review of physical activity interventions among older adults reported that telephone mediated approaches were particularly effective in this population (King et al., 1998) and Marcus, Napolitano, and King (2007) found that printed materials along with telephone contact were superior to telephone contact alone for promoting long-term maintenance of physical activity. Considering the lower cost and convenience of home-based interventions delivered via mediated approaches, further research is warranted to examine their effectiveness for increasing physical activity among older adults.

Unfortunately, to date, physical activity interventions among older adults have rarely included minorities or individuals with low income levels. Only 10 out of 43 intervention studies reviewed by Conn et al. (2002) targeting older adults reported ethnic composition

and in those studies 81% of the participants were White. Conn et al. (2002) also discovered that most studies included only general health education, which was not effective for changing physical activity behavior (Conn et al., 2002). Recommendations based on the findings from narrative reviews suggest that physical activity interventions among older adults should focus on changing only physical activity behavior, prescribe moderate intensity physical activity, include behavioral or cognitive behavioral strategies, focus on supervised home-based programs, and engage diverse older adults (Conn et al. 2002; King et al., 1998).

Despite these recommendations, few studies provided specific information about the intervention design or components, making replication virtually impossible, and few conclusions can be made about the most effective strategies for changing physical activity participation. Of the studies that have provided this information, intervention details included motivational sessions that were most commonly delivered on a weekly basis over a period of 1 to 12 weeks; however, no differences in physical activity behavior have been reported based on intervention length among older adults (Conn, Minor, Burks, Rantz, & Pomeroy, 2003). Therefore, more emphasis should be placed on the reporting of time spent on specific intervention components, quality of intervention delivery, and content validity of interventions (Conn et al., 2003; Conn et al., 2002; King et al., 1998). For example, King et al. (1998) reported that only 13 of the 29 studies they reviewed described or mentioned the specific strategies used to elicit behavior change and that although attendance rates were often reported, few studies reported on the prescribed intensity and duration of physical activity within the intervention.

Another recommendation for designing physical activity interventions is to use behavioral theory as a guiding framework (Biddle & Nigg, 2000; Dishman & Buckworth, 1996). Specifically, interventions should use behavior change strategies to target theory-based constructs and change these mediating variables to affect physical activity behavior. Using a theoretical framework also provides an explanation for why behavior change occurs (Baranowski, Anderson, & Carmack, 1998). Unfortunately, most physical activity interventions among older adults have not been theory-based (Conn et al., 2002) and as a result, little is known about the psychological mediators that precede motivation and ultimately the adoption and maintenance of physical activity in this population. Therefore, more research is warranted to design and evaluate high fidelity, theory-based interventions among older adults.

The theory of planned behavior (TPB; Ajzen, 1991) is a validated framework for predicting physical activity behavior (Biddle & Nigg, 2000; Symons Downs & Hausenblas, 2005). Within the TPB, intention (INT) and perceived behavioral control (PBC) directly affect behavior. The person's INT, in turn, is affected by three separate constructs and their respective underlying beliefs. These three constructs are attitudes (ATT) and their underlying behavioral beliefs, subjective norm (SN) and their underlying normative beliefs, and PBC and their underlying control beliefs. According to a review by Symons Downs and Hausenblas (2005), with the exception of SN, all of the TPB constructs were significant predictors of exercise behavior. Specifically, INT and PBC accounted for 21.0% of the variance in exercise behavior with INT being a significant predictor of physical activity behavior ($\beta = .42$, $P < 0.001$) and in a second model, attitude, PBC, and subjective norm accounted for 30.4% of the variance in INT with

attitude ($\beta = 0.27$, $P = < 0.01$) and PBC ($\beta = 0.27$, $P = < 0.01$) adding unique contributions to the model. Because new knowledge and experiences are hypothesized to change one's beliefs, thus affecting INT and behavior, interventions based on the TPB should include strategies that target the underlying beliefs to promote physical activity adoption and maintenance.

Another validated theoretical framework in the physical activity literature is the transtheoretical model (TTM, Biddle & Nigg, 2000). The most frequently used construct of the TTM is the stages-of-change (SOC) that reflects both intention and behavior. The SOC reflect the person's past behavior and their readiness to change their behavior in the near future. The SOC can be used in intervention programs by targeting individuals based on their stage of readiness for change, and previous studies using the SOC model with other health behaviors have suggested that progressing by just one stage can double the chance of successfully changing behavior in the future (DiClemente et al., 1991). Results of narrative and statistical reviews have shown that the TTM is an effective framework for physical activity intervention design (Adams & White, 2003; Spencer, Adams, Malone, Roy, & Yost, 2006). Specifically, Adams and White (2003) found that 73% of TTM interventions lasting less than 6 months and 29% of TTM interventions lasting 6 months or longer were effective at increasing physical activity levels. Spencer et al. (2006) found that 17 of 32 stage-matched interventions were effective at increasing physical activity and that most of the interventions that were not effective were single-contact, single-strategy interventions.

In a review of physical activity interventions targeting older adults, Conn et al. (2003) recommended combining theoretical frameworks as a useful strategy for creating

effective interventions, and recent research has shown that integrating the TPB with the TTM by replacing the INT construct from the TPB with the SOC construct from the TTM may be more effective in promoting physical activity than using INT because the SOC accounts for both INT and current behavior (See figure 1.1; Kosma, Ellis, Cardinal, Bauer, & McCubbin, 2007). This integrative framework has been tested in previous research among adults with physical disabilities and it better predicted future physical activity compared to the original TPB (Kosma et al., 2007). The integrative framework also strongly predicted future physical activity and health-related quality of life (Kosma, Ellis, Cardinal, Bauer, McCubbin 2009). Although the TPB and TTM have both been used in intervention programs designed for older adults, to date no published studies have utilized the integrated framework among community-dwelling older adults to promote self-chosen, at-home physical activities via low-cost, mail-based, stage-targeted materials (Conn et al. 2003; Kelley & Abraham, 2003).

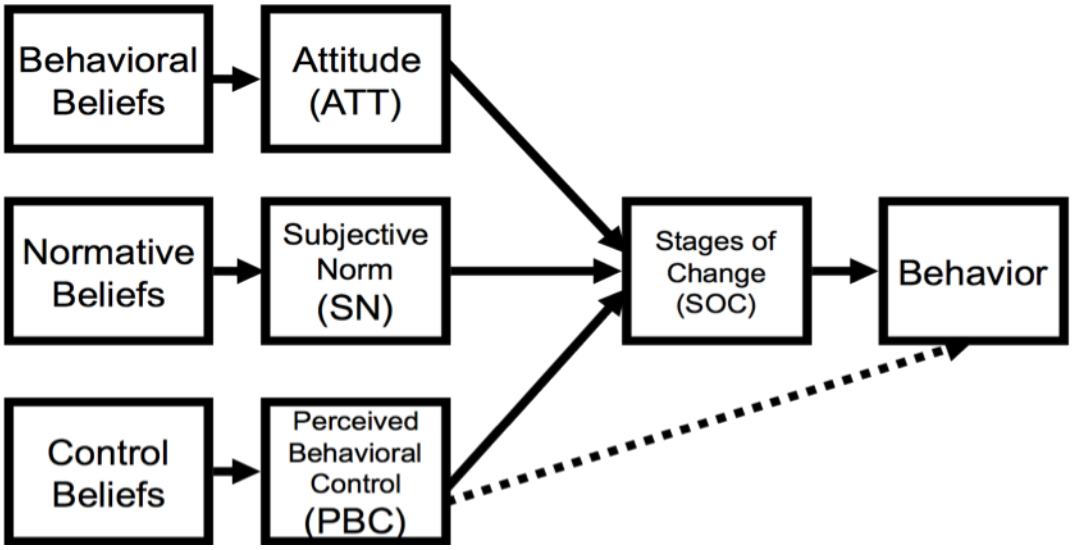


Figure 1 The Integrative Theoretical Framework

Therefore, the purpose of this study was to examine the efficacy of a 4-week mail-based physical activity intervention based upon an integrative theoretical framework that replaces the INT construct from the TPB with the SOC construct from the TTM. The intervention duration was chosen specifically because the information to be tested to promote change in population specific physical activity beliefs could comfortably be covered in four weekly packages. In addition, previous research has shown that behavior change and positive changes in theoretical constructs can occur in 4 weeks (Cardinal & Sachs, 1995; Kosma, Cardinal, & McCubbin; 2005), and given the paucity of TPB-based interventions, this study was designed to encourage future efforts in examining TPB-based interventions. Specifically, the efficacy of the motivational physical activity intervention was determined by investigating changes in the psychological mediators and physical activity among older adults. Using an experimental design, the following hypotheses were tested: (a) ATT, SN, and PBC would significantly increase from baseline to follow-up among participants in the treatment group compared to the control group; (b) physical activity participation would significantly increase from baseline to follow-up among participants in the treatment group compared to the control group; (c) a significantly greater percentage of participants in the treatment group would progress through the SOC from baseline to follow-up compared to the participants in the control group; and (d) the changes in the psychological mediators (ATT, SN, PBC, SOC) would be significantly related to the changes in physical activity participation.

Method

Participants

Older adults over the age of 50 were recruited from a larger study that assessed falls risk factors among older adults. Initial contact with potential participants was made at falls risk screenings that took place at 12 community centers and retirement communities around the metro Atlanta area during a 1-year period. Volunteers at the intervention sites were asked to participate in a mail-based motivational physical activity intervention. Exclusion criteria included being younger than 50 years of age, lack of access to a phone or inability to hear on the phone, severe mobility limitations, and/or cognitive impairment as demonstrated by their inability to comprehend instructions.

Procedures

Each participant completed a 20-minute screening to assess their home safety, medical and medication history, mobility and balance, and vision (Fabre et al., 2010). At the end of the screening, each participant received brief educational materials about their falls risk and how to reduce their falls risk. Using an experimental design, each center was randomly assigned to be an intervention site or a wait-list control site. Randomization was conducted by site and not by participants to prevent carry-over effects of the intervention to the control participants (Goldstein et al., 1999). Baseline measures of physical activity and SOC were assessed at the falls risk screenings. In the following week, participants received a TPB questionnaire via mail. Once this questionnaire was returned, the participants were enrolled in the 4-week program.

The intervention included four weekly stage-matched packages that targeted population specific physical activity beliefs based on previous research (Antikainen et al., 2009) and weekly phone calls to reassess SOC and answer any questions about the

materials. If the participant could not be reached on the first phone call attempt, two additional phone calls were placed to attempt to reach them. If the person could not be contacted, materials matching their last assessed SOC were mailed to them the following week. During the phone calls, the participant was also asked if they received the materials from the previous week and whether they read the materials to assess program compliance.

At the completion of the 4-week intervention, physical activity, SOC, and TPB constructs were reassessed. In the final packet, the participants was asked to rate the program effectiveness using a five-point Likert style scale that ranged in scores from 1 to 5 (1 = lowest score and 5 = highest score). The program was evaluated on its ease of use, ease to understand, helpfulness, ability to attract attention, ability to change physical activity, and ability to maintain physical activity. The participants were also asked to provide specific comments about the program. The participants in the wait-list control condition answered all the same questionnaires at baseline and at the end of the 4-week intervention period, and they received weekly phone calls to assess SOC and physical activity participation. Wait-list control participants had the option to participate in the physical activity intervention after completion of the study.

Intervention Materials

The interactive intervention materials were stage-matched and designed to target population specific beliefs based on previous research (Antikainen, et al., 2009). Each booklet, the size of an 8 by 11 page, included three to four pages. Based on the Flesch-Kincaid grade level readability test the materials were ranked as 7th grade level. In the first package, all participants received an exercise log designed to promote self-

monitoring of physical activity and the motivational materials appropriate for their SOC with materials for stages 1 and 2 focusing mainly on cognitive processes of change and materials for stages 3 and 4 focusing more on behavioral processes of change. Specifically, week 1 materials for the individuals in stage one addressed benefits and barriers of physical activity prevalent in the target population. In addition to benefits and barriers, materials for those in stage two asked the participant to set a physical activity related goal varying from talking to their physician or an active friend about physical activity to gardening or washing a car. Week one materials for stage three also included the benefits and barriers of physical activity and participants were encouraged to make a more specific physical activity goal based on the recommended levels of activity for older adults. Finally, week one materials for individuals in stage four included benefits and barriers for physical activity and reflective questions about the meaning and benefits of physical activity for them and their families or others around them.

Week two materials included a time management inventory for individuals in stages one through three with different physical activity related goals depending on the SOC level (i.e., the goals in stage one were more health related while goals for stage three were specific to physical activity). The week two materials for stage four included information and suggestions for social support, rewards, and reminders to reduce changes of relapse.

Week three materials for stage one included a list of health behaviors and asked the individual to make one health related goal for the following week. For stages two and three, week three materials included a reminder of the recommended level of activity and they were asked to select ways to increase physical activity. They were also be asked to

set a specific activity related goal and a reward for achieving their goal. Additionally, stage three individuals were given tips to recruit more social support. Week three materials for stage four gave various alternative physical activity options and encouraged these individuals to try something new to improve maintenance of physical activity. They were also encouraged to celebrate their achievements and were given examples of various ways to reward themselves.

Week four materials for stages one through three included a list of lifestyle activities and hobbies that may help them increase physical activity and they were encouraged to join an organization that their friends may be a part of or to ask friends to go out for a short walk. Additionally, week four materials for stage three included ideas for preventing relapse during times when being active is not easy such as vacations and illness and ideas for staying motivated to be active. Stage four materials included relapse prevention techniques and ideas for staying motivated.

In addition to being stage-specific and targeting beliefs, the materials were designed to encourage the use of more cognitive processes in stages one and two and behavioral processes in stages three and four. The weekly materials included examples of older adults in different life circumstances outlining how they stay physically active and each week participants in all stages of change received a pamphlet with at home strength and balance exercises that require no equipment and little space.

Measures

Demographic Information. A questionnaire developed for the falls risk screenings was used to gather demographic information including age, race, sex, marital status, educational attainment, and household income. For the analyses, demographic

information was dichotomized such that participants were grouped by race as White or Black, and by marital status as married or not married. Education and income were categorized as high or low with high levels representing those with more than high school education and greater than $1571 per month, respectively, and low as those who had high school education or less and income less than or equal to $1571 per month, respectively.

Physical Activity Scale for the Elderly (PASE). The PASE (Washburn, Smith, Jette, & Janney, (1993) is a self-report measure of physical activity that accounts for frequency (days/week) and duration (hours) of various activities of daily living, strength and endurance activities, sports involvement, occupational activity, family care, and yard work. The unitless score on the PASE can be 0 to 400 or more, with higher scores reflecting higher levels of physical activity (Washburn et al. 1993). Validity and reliability of the PASE has been demonstrated among community-dwelling older adults (Moore et al., 2008; Washburn, McAuley, Katula, Mihalko, & Boileau, 1999, Washburn et al., 1993).

SOC Modified Four Stage Algorithm. The participants' SOC was assessed with a modified four stage algorithm (Kosma & Ellis, 2010). This four item self-report instrument categorizes a person in either precontemplation (stage 1), contemplation (stage 2), preparation (stage 3), or action/maintenance stage (stage 4). Evidence of construct validity has been demonstrated because it accurately differentiated physical activity levels across the stages among adults with physical disabilities (Kosma & Ellis, 2010).

Digi-walker SW-200 Pedometer. A random subsample of intervention and control participants was asked to wear a Digi-walker SW-200 pedometer for one week at the

beginning of the study and during the final week of the intervention to validate the self-reported physical activity. The participants were asked to record the number of steps they take each day and return their step log in a prepaid envelope. Pedometers are objective and valid measures of physical activity in research and practice (Tudor-Locke, Williams, Reis, & Pluto, 2002), and they are accurate measures of physical activity with relatively healthy community-dwelling older adults (Cyarto, Myers, & Tudor-Locke, 2004).

Theory of Planned Behavior Questionnaire. TPB constructs were measured with 35 items using 7 point Likert-type scales developed according to the recommendations by Ajzen (2002). To measure global ATT, seven adjective pairs (e.g., 1= very boring and 7 = very interesting, 1 = harmful and 7 = beneficial, 1 = unpleasant and 7 = pleasant) were used to rate the following statement: "To me, participating in regular physical activity is". Global SN was measured using four statements such as, "Most people who are important to me, participate in regular physical activity" (strongly agree = 1 and strongly disagree = 7) and, "Most people who are important to me, think that I should participate in regular physical activity" (1 = strongly agree and 7 = strongly disagree). Global PBC was assessed with four questions, such as, "If you are really motivated, how confident are you that you can participate in regular physical activity?" (1 = very much and 7 = not at all) and "If you are really motivated, participating in physical activity is" (1 = easy and 7 = difficult). When applicable, answers were reverse-coded so that higher scores for each construct represented more positive ATT, stronger SN, and stronger PBC. Scores were then averaged for each global TPB construct to obtain a final score.

To measure belief-based TPB constructs, previously elicited population specific beliefs (Antikainen et al., 2009) were adapted for the questionnaire. For example, two of

the eleven questions used to assess belief-based ATT were: “My participation in physical activity is going to be beneficial to my overall health” (1 = totally disagree and 7 = totally agree) and “Participating in regular physical activity makes me feel better emotionally or puts me in a better mood” (1 = strongly disagree” and 7 = strongly agree). Examples of the three questions to assess belief-based SN included, “My family members think that I should participate in regular physical activity” and “My friends think that I should participate in regular physical activity” (1 = totally disagree and 7 = totally agree). Belief-based PBC was assessed with six questions such as, “For me, having a lot of other responsibilities makes it difficult to be physically active” (1 = totally disagree and 7 = totally disagree) and “My current health makes it more difficult for me to be physically activity” (1 = strongly agree and 7 = strongly disagree). Similar to the global constructs, scores were reverse coded when necessary for higher scores to represent more positive ATT, stronger SN, and stronger PBC and averaged to obtain a final score.

Statistical Analysis

Demographic variables were summarized using frequencies, means, and standard deviations. Scale reliabilities (i.e., Cronbach’s alpha; α) were calculated for the TPB constructs. Alphas greater than or equal to .70 were considered at least adequate, between .60-.69 were questionable, .50-.59 were poor, and below .50 were unacceptable (George & Mallery, 2003). Pearson correlations were performed to examine the associations among the TPB constructs and physical activity, both self-reported (i.e., PASE) and objectively measured (i.e., pedometer). Correlations between .10-.29 were classified as small, correlations between .30-.49 were classified as moderate, and correlations .50 and greater were considered large (Cohen, 1988). Analyses of variance (ANOVA) was used

to check for baseline differences in physical activity, TPB constructs, and demographic variables (age, race, education, marital status) between the treatment and control groups.

To test hypotheses a and b, group differences on TPB constructs and physical activity levels were assessed with separate repeated measures mixed ANOVAs with group assignment (treatment and control) as the between-groups variable and time (baseline and follow-up) as the within-groups variable. The proportion of variance in the dependent variable explained by the independent variable (i.e., η^2) was determined by using thresholds of .01 = small, .06 = moderate, and .14 = large variance (Cohen, 1988). To test hypothesis c, SOC progression was examined with chi-square analysis using three stage movement groups (progress, regress, stable). Stage progression was defined as an increase of one or more stages from baseline, stage regression as a decrease of one or more stages from baseline, and stable as maintaining baseline stage. Any participant who was stable in stage 4 was removed from this analysis because of ceiling effect. To test hypothesis d, measured variable path analysis was used to determine associations between the TPB constructs, SOC, and physical activity participation (see Figure 3.1). Level I in the model was physical activity and consistent with the integrated framework, SOC was proposed as the most proximal determinant of physical activity (Level II) with ATT, SN, and PBC as the antecedents of SOC (Level III). The TPB constructs were freed to correlate with each other. Statistical calculations were considered significant at alpha level of $p < .05$. Path analysis was performed using LISREL 8.80 and all other analyses were conducted using SPSS version 19.0.

Results

Ninety-nine older adults from 11 sites volunteered for the motivational physical activity intervention and of these, 61 returned the baseline questionnaire and were subsequently enrolled in the study. Of the 61 participants enrolled, one withdrew from the study because of illness, one participant exhibited cognitive impairment, one had incomplete baseline data, and two participants withdrew consent. In addition, one participant was identified as a multivariate outlier and was excluded from the sample. The final sample included 55 older adults between the ages of 54 and 96 (*M* age = 72.3 yrs, *SD* = 8.0) from 11 senior centers and senior living facilities. Most of the participants were female (72.7%), Black (89.1%), and reported low levels of education (70.4% $\leq$ high school degree) and income (85.5% $\leq$ $1571 monthly; see Table 3.1).

Table 6

Participant Characteristics

Characteristics		*All Participants*		*Treatment*		*Control*	
		N	*%*	*n*	*%*	*n*	*%*
Age	50 – 64 years	6	10.9	4	11.4	2	10.0
	65 years +	49	89.1	31	88.6	18	90.0
Gender	Male	15	27.3	12	34.3	3	15.0
	Female	40	72.7	23	65.7	17	85.0
Race	Caucasian	6	10.9	5	14.3	1	5.0
	African American	49	89.1	30	85.7	19	95.0
Marital Status	Married	6	10.9	5	14.3	1	5.0
	Not Married	49	89.1	30	85.7	19	95.0
Education	≤ High School	38	70.4	27	77.1	11	55.0
	> High School	16	29.1	7	20.0	9	45.0
	Did not answer	1	1.8	1	2.9	0	0
Income	< 18,852 annually	47	85.5	31	88.6	16	80.0
	> 18,852 annually	6	10.9	3	8.6	3	15.0
	Did not answer	2	3.6	1	2.9	1	5.0

Most of the global TPB scales had adequate internal consistency with scores between .72 and .80; however, SN at baseline (α = .61) and at follow-up (α =.67) and PBC at follow-up (α = .65) were considered questionable. The belief-based TPB scales were acceptable only for attitude at baseline (α = .76) and at follow-up (α =.78). Belief-based

PBC had poor consistency both at baseline (α = 51) and follow-up (α = .55) and belief-based SN had unacceptable internal consistency at baseline (α = .19) and follow-up (α =.33). Because most of the global TPB scales had better internal consistency than the belief-based questions, they were the only TPB constructs used for the remaining analyses.

The TPB constructs exhibited small to moderate positive associations with self-reported physical activity (see Table 3.2). At baseline, the pedometer data (n = 6) had a large association with self-reported physical activity (r = .90) and exhibited expected moderate to large positive relationships with the TPB constructs (r = .32 - .79). Pedometer data were not available at time 2 because of difficulties in collecting these data. The ANOVA revealed that there were no significant group differences in demographic variables, baseline physical activity levels, or baseline TPB constructs between the treatment and control groups.

Table 7

Correlations between TPB Constructs and Physical Activity

	TPB Constructs		
	Baseline ATT	Baseline SN	Baseline PBC
Baseline Physical Activity (PASE)	.41**	.29*	.41**
Baseline Pedometer	.79**	.32	.43*
	Follow-up ATT	Follow-up SN	Follow-up PBC
Follow-up Physical Activity (PASE)	.35**	.11	.44**

* = $p < .05$; ** $p < .01$.

The repeated measures mixed ANOVAs (hypothesis a) revealed only a significant main effect for ATT, F (1, 53) = 7.66, $p < .01$, $\eta_p^2 = .13$, observed power = .78. Specifically both groups reported more positive ATT toward physical activity at follow-up. There were no significant main effects or interactions for SN or PBC.

The repeated measures mixed ANOVA for physical activity (hypothesis b) revealed no significant main effects for physical activity; however, there was a significant interaction effect for the PASE score for time and group, F (1, 53) = 14.08, $p < .001$, $\eta_p^2 = .07$, observed power = .48. Specifically, the treatment group increased physical activity participation from baseline to follow-up (M = 97.1 vs. M =110.1) while physical activity participation in the control group declined (M = 129.2 vs. M = 88.4; see Figure 3.1).

Table 8

Physical Activity Levels and TPB Constructs by Group Assignment

	Treatment Group Baseline	Treatment Group Follow-up	Control Group Baseline	Control Group Follow-up
Physical Activity				
Mean	97.1	110.1	129.2	88.4
SD	63.3	72.5	82.7	75.3
ATT				
Mean	5.6	5.8§	5.9	6.1§
SD	1.0	.9	.7	.8
SN				
Mean	4.6	4.6	4.8	4.8
SD	1.0	1.1	1.1	1.0
PBC				
Mean	4.8	5.0	5.3	5.2
SD	1.2	1.1	1.1	1.1

Note: § = Groups significantly different at follow-up.

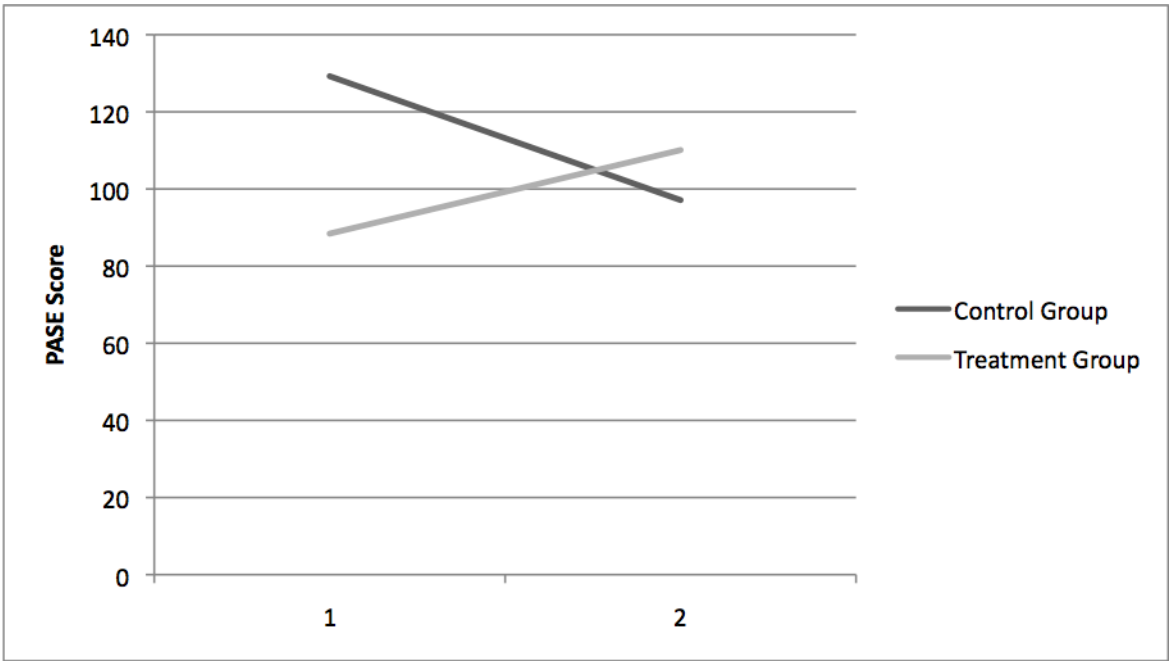


Figure 2 Interaction Effect for Group and Time for Physical Activity

Ten participants in the treatment group and 8 participants in the control group reported stage 4 SOC (action/maintenance) at baseline and follow-up and they were removed from the analysis because they were not expected to progress. Based on the Chi-Square analysis (hypothesis c), the intervention did not have a statistically significant effect on SOC, $\chi^2 = 5.124$, $p = .077$. However, there was a trend towards greater SOC progression in the treatment group with 14 participants (56%) progressing in SOC, while only 2 participants (16.7%) in the control group progressed (see Table 3.4 for additional details). Approximately equal numbers of participants remained stable or regressed within the treatment and control groups.

Table 9

Stages of Change Movement by Group

Group	Stage of Change						Total
	Progress		*Stable*		*Regress*		
	n	*%*	*n*	*%*	*n*	*%*	
Treatment	14	56.7	9	36.0	2	8.0	25
Control	2	16.7	8	66.0	2	16.0	12

The integrated TPB model at baseline with global measures for the TPB constructs had an inconclusive fit to these data ($\chi^2 = 3.33$, $p > 0.05$, RMSEA = .111, CI = .00; .31, NFI = .94, CFI = .97, SRMR = .05; see Figure 3.2). The integrated model at follow-up showed good model fit ($\chi^2 = 0.55$, $p > 0.05$, RMSEA = .00, CI = 0.00; 0.18, NFI = .99, CFI = 1.00, SRMR = .02; see Figure 3.3). Based on the follow-up data, none of the TPB constructs had a significant effect on SOC, but PBC had a statistically significant direct effect on self-reported physical activity behavior (standardized regression coefficient of 25.81, $p < 0.01$).

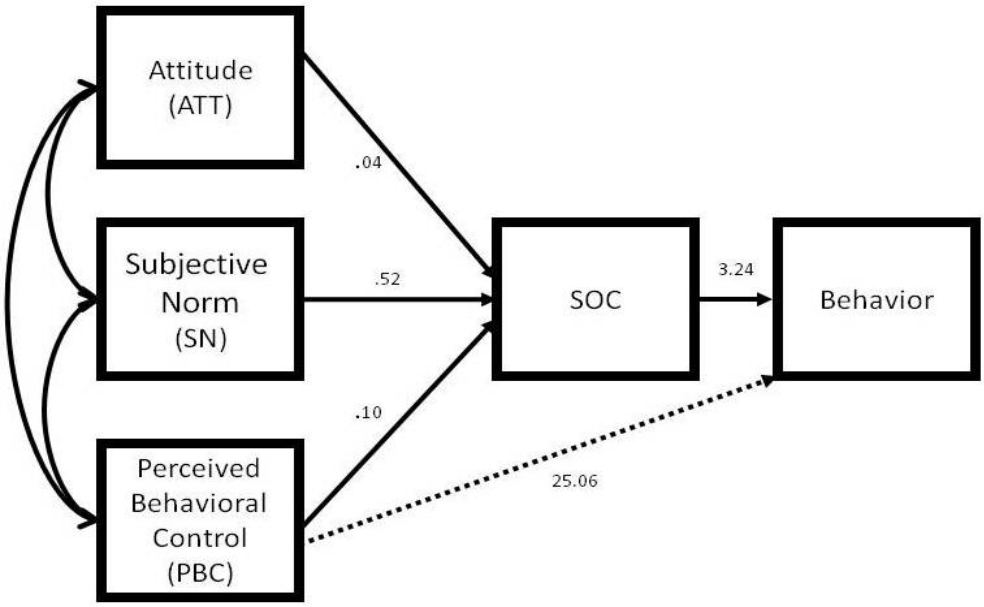
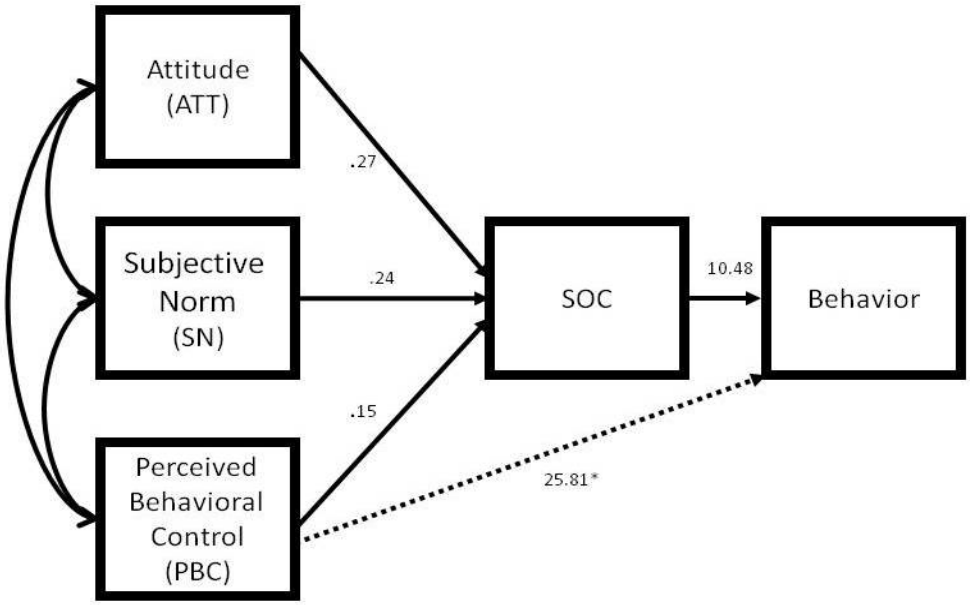


Figure 3 Integrated Framework Model Path Coefficients at Baseline



* = $p < 0.01$

Figure 4 Integrated Framework Model Path Coefficients at Follow-up

Discussion

Lack of physical activity is a major risk factor for chronic illness among older adults and it contributes to falls and the inability to perform activities of daily living (USDHHS, 2000). Yet, little is known about how to motivate older adults to be more physically active. Thus, the purpose of this study was to examine the efficacy of a 4-week mail-based physical activity intervention among older adults by examining change in psychological mediators of physical activity and physical activity behavior, and to examine the relationships between the mediators and physical activity. The results of this study indicated that the intervention was effective at increasing PA levels in the treatment group. Also, the treatment group exhibited a trend towards higher SOC than the control group and based on the measured variable path analysis, PBC emerged as a significant predictor of physical activity.

Similar to other physical activity intervention studies among older adults, the study sample included more females than males (Greaney, Riebe, Garber, et al., 2008; Hooker, Seavey, Weidmer, et al., 2005; Kelley and Abraham, 2004; Resnick, Louisi, and Vogel, 2008; Stewart, Gillis, Grossman, et al., 2006). This is also consistent with health promotion literature because it has been found that generally more women participate in health screenings than men (Evans, Brotherstone, Miles, & Wardle, 2005). However, unlike previous physical activity intervention studies, these participants were mostly Black and reported low levels of education and income, and previous researchers have specifically called for more research with underserved populations (Conn et al., 2002; Conn et al., 2003; Dishman and Buchworth, 1996; King et al. 1998). The characteristics of the participants enrolled in this study are a strength because low socioeconomic status, minority, older adults are an under-represented population in motivational physical

activity literature, and in health promotion literature in general (Conn et al., 2002; Hendrickson, 2005). However, these results cannot be generalized to all older adult populations and future research is needed to examine how other subgroups of older adults would respond to this intervention.

It was hypothesized that ATT, SN, and PBC would significantly increase from baseline to follow-up among participants in the treatment group as compared to the control group (hypothesis a), but this hypothesis was not supported. Instead, both the treatment and the control groups reported more positive ATT towards physical activity at the end of the intervention and thus, this change cannot be attributed to the intervention. A possible explanation for why both groups reported more favorable ATT at the end of the intervention could be because of exposure to competing health promotion programs, such as seminars, classes, or pamphlets about the benefits of physical activity offered at all of the study recruitment sites and likewise all study participants. Most physical activity interventions focus on knowledge and the benefits of physical activity (Conn et al., 2002), and interventions that targeted attitude through positive messages have effectively changed ATT (Chatzisarantis & Hagger, 2005). Exposure to other classes, seminars, or brown bag luncheons offered at the study recruitment sites could have emphasized the positive effects of physical activity, and therefore, improved ATT (the participant's positive or negative feelings towards physical activity) for all participants. This explanation is further supported by the fact that SN and PBC did not change in either group because knowledge-based programs are not designed to change people's perceptions about what others think they should do (i.e., SN) and their perceptions of physical activity barriers and opportunities (i.e., PBC). Future researchers are encouraged

to interview program managers about other programs available at the sites used to recruit participants to determine what effect competing physical activity and health promotion programs have on physical activity beliefs.

In addition to both groups unexpectedly reporting increased ATT, the treatment group also failed to report increased SN and PBC from baseline to follow-up as hypothesized. Because change in any of the TBP constructs cannot be attributed to the interventions, it may be that the sample size was too small to have enough power to detect any possible influence that the intervention had on the psychological constructs. Additionally, it is possible that the intervention materials were not strong enough to elicit change in these constructs and that the change in physical activity was related to the sample exercises included in the packages.

Physical activity participation was also hypothesized to significantly increase from baseline to follow-up among participants in the treatment group compared to the control group and the results confirmed this hypothesis (hypothesis b). These results are similar to other 4-week physical activity interventions that found that 4 weeks is long enough for an intervention to produce a change in physical activity (Cardinal & Sachs, 1995; Kosma et al., 2005). However, more research is needed to determine if a 4-week intervention is potent enough to produce a change in physical activity that can be maintained over a long period time. Therefore, future researchers are encouraged to conduct multiple follow-ups to assess the maintenance of physical activity behavior change following a 4-week intervention. A benefit of this 4-week intervention is that its short duration and mediated approach make it feasible for translation into community settings and can be administered with little manpower and low attrition rates. These factors, along with positive feedback

from the study participants, provide evidence of the strong external validity of the intervention. Finally, these results also support the effectiveness of stage-matched physical activity interventions based on an integrative theory that combined SOC with TPB constructs (Kosma et al., 2007) for promoting behavior change. Previous studies with this population have included community and church-based exercise classes, but programs designed specifically for minority older adults have rarely included a motivational component, and most physical activity interventions among older adults have not been theory-based (Conn et al., 2002). This was the first study to use stage-matched materials based on population specific physical activity beliefs using an integrative theory that targeted all of the TPB constructs. Although this study provides preliminary support for the use of the integrative framework and belief-based motivational materials with this population, more studies are necessary to continue to validate the integrative theory for intervention design.

A significantly greater percentage of participants in the treatment group were hypothesized to progress through the SOC from baseline to follow-up compared to the participants in the control group (hypothesis c). Although there was no statistical group difference between the treatment group and control group SOC progression, there was a positive trend in SOC progression after the intervention with 56% of the treatment group progressing in SOC as compared to only 16.7% of the control group. One reason there may not have been significant differences between the two groups is limited power due to a small sample size. These results may have practical significance because previous research has shown that progressing by just one stage may double the chance of successfully changing behavior in the future (DiClemente et al., 1991). In addition to the

change in physical activity participation, these findings provide preliminary support for the use of stage-matched materials based on population specific beliefs to change people's attitudes and physical activity behavior. However, more research is needed to determine if change in SOC is maintained after the study period.

Finally, it was hypothesized that the changes in the psychological mediators (ATT, SN, PBC, SOC) would be significantly related to the changes in physical activity participation (hypothesis d) and the follow-up data partially supported this hypothesis. Specifically, PBC was found to have a direct relationship with self-reported physical activity behavior after the intervention. The relationship between PBC and physical activity behavior is consistent with a meta-analytic review of over 100 TPB exercise studies that found PBC was a strong predictor of physical activity behavior (ES = .51; Symons Downs & Hausenblas, 2005). Practically speaking, the results indicated that a one standard deviation increase in PBC would lead to a 25.8 standard deviation increase in physical activity. PBC may be a particularly strong predictor of physical activity among low-income older adults who often depend on other people for transportation, live in areas with limited sidewalks and lighting, or may otherwise not have adequate resources to be able to be active; indicating that actual control over the behavior may be limited. This supports the TPB's original hypothesis about the direct relationship between PBC and behavior (Ajzen, 1991). Future research with low-income participants should focus on determining whether the reported barriers are real or perceived and then within interventions test differences in physical activity behavior change based on changing real control issues versus changing perceptions of barriers. It is unclear why the model fit improved from baseline to follow-up. It may be possible that having read the questions

previously, the participants rated their answers more accurately the second time, thus improving the sensitivity of the questionnaire.

In addition to the small sample size, a few other limitations of this research should be discussed. With many senior living facilities and senior centers now offering computer access and classes, mail-based programs may no longer be the most feasible medium to reach this population. This is important because when addressing issues of translatability, the cost of mailing is a possible barrier to program adoption. Furthermore, program efficacy may also be affected because of the likelihood that mailed documents may not be opened or read. Although the attrition rate was low for this physical activity intervention, there is no way to confirm that participants actually opened and read the mailed materials. Thus, we cannot with complete certainty confirm that the significant changes in physical activity were the result of the intervention. Future researchers examining mediated programs with older adult samples should consider the use of internet or email-based physical activity interventions because of lower cost and the ability to verify that participants opened the email and completed interactive portions of the program. Moreover, the accuracy of previous comparisons of face-to-face or group programs to mediated programs must be questioned (Conn et al., 2002; King et al. 1998). When participation in direct programs was verified by attendance, but participation in mediated programs was self-reported or tracked by pedometers, then social desirability bias, recall bias, and a Hawthorne effect may be responsible for the significant changes in physical activity behavior and not the intervention itself. Finally, in addition to the difficulty of reaching participants over the phone, losing materials in the mail, and the difficulties of getting participants to return the questionnaires, it was difficult to collect pedometer data.

Initially, most participants declined the request to wear a pedometer and if they agreed, explaining the use of a pedometer multiple times was rarely enough to get the participants to record their number of steps correctly. Furthermore, several participants did not return their pedometers, and most of the people who did return their pedometer data, were missing several days from their logs. Because of the problems encountered collecting these data at baseline, pedometer data collection was discontinued at follow-up; however, the data that were collected provided validity evidence of the self-report physical activity measure with this sample.

Overall, results also indicate that this physical activity intervention has good external validity, which has positive implications for the translation of this intervention for use at other community organizations. The reach of the intervention was good with 40.7% of the targeted population enrolling in the program. During the enrollment period for the intervention study, 150 older adults participated in the falls risk screenings, 99 volunteered for the intervention, and 61 (40.7%) were enrolled. The attrition rate was similar to other intervention programs using mediated approaches with 95.1% of the enrolled participants completing the intervention. The reach of this intervention was much higher than the median reach of the 54 theory-based interventions reviewed (18.7%). This intervention was able to reach participants in all SOC and using a mediated approach that targeted specific SOC, it may be a particularly attractive program for those at lower SOC as compared to interventions that attempt to enroll people into activity classes, which targets participants who are in higher SOC and generally participate in physical activity interventions. However, the adoption rate was lower at 20.8% with 11 of the possible 53 sites enrolled participants in the physical activity intervention. A total of

67 senior centers and residences were identified as potential screening sites and they were contacted via mail, networking, and direct phone calls. In one county, the Department of Health and Wellness denied access to 13 sites, leaving 54 possible venues. During the recruitment period, 19 sites were contacted and 15 sites scheduled falls risk screenings. Three screenings were eventually cancelled and at one site none of the falls risk screening participants volunteered for the intervention study. Future intervention studies should define a target population and target sites and determine exclusion criteria for participants and venues from the perspective of external, rather than internal validity and then report reach and adoption so that comparisons can be made about the external validity of interventions.

In terms of efficacy, the intervention was found to be effective in changing physical activity rates and no negative consequences were reported. Therefore, this intervention can be confidently considered for safe use at other community organizations. Future researchers should report effectiveness of interventions clearly, for instance by including effect sizes for future meta-analysis. A few changes did occur in the implementation of the intervention. First, pedometer data were not collected at follow-up. Also, because some participants were difficult to reach by phone, the intervention packets were not mailed out at exact 1 week intervals, but rather as soon as the participant was reached or 3 phone call attempts were made. These changes need to be documented before this intervention is implemented for future use. With regards to maintenance, on the individual level, follow-up data were not collected, but on the institutional level the physical activity intervention will be continued with some changes, such as reducing the intervention period to cut cost and time requirements to administer the intervention. If

resources are available, future researchers are encouraged to evaluate individual level maintenance past the study period and design interventions that can be continued in the community with minimal cost to the participating centers.

In summary, this study examined the efficacy of a theory-based motivational physical activity intervention. The results of this study indicated that stage-matched, home-based programs delivered via mail, can be effective for increasing the physical activity participation of underserved older adults. Unfortunately, there were no statistically significant changes in the TPB constructs in order to explain what caused the change in behavior, but the positive trend seen with SOC suggests that with a larger sample size and more power, future researchers might help reveal the mechanism for how TPB-based programs change physical activity behavior. Additionally, PBC was shown to be a predictor of physical activity at follow-up. This research provides preliminary evidence that stage-matched motivational programs based on the integrative framework and delivered using a mediated approach are effective at increasing physical activity among diverse older adults.

CHAPTER 4

GENERAL DISCUSSION

The overall purpose of this dissertation was to examine the external validity of theory-based physical activity interventions and to design and test a theory-based, motivational physical activity intervention for older adults who were recruited from community-based settings. The specific objectives were:

- to review the published literature on theory-based physical activity interventions by evaluating the external validity of the existing intervention studies based on the RE-AIM framework and
- to test the effectiveness of a motivational physical activity intervention for older adults.

Therefore, the purpose of the final chapter is to (a) summarize the main findings of the studies, (b) identify the strengths of the dissertation studies, (c) outline the limitations of the dissertation studies, (d) identify areas for future research, and (e) convey the general implications of this research.

Summary of the Dissertation Studies

Study 1: RE-AIM Evaluation of Theory-Based Physical Activity Interventions: A Review of the Research Literature

The purpose of the literature review (Chapter 2) was to use the RE-AIM framework to determine how well the extant literature on theory-based physical activity interventions reported on issues of external validity, and to analyze the mediators targeted and assessed

by the interventions. Based on the inclusion criteria, 54 intervention studies were included in the analysis and of these 54 studies, 27 were based on the TTM, 5 were based on the TPB, 9 were based on the SCT, and 13 used a combination of 2 or more of these theories. The following paragraphs are brief summaries of the main findings of the literature review.

RE-AIM Analysis. As the main component of reach, participation rate was reported in 20.4% of the studies. Efficacy, in terms of a behavioral measure to assess physical activity levels, was reported in 100% of the studies (this was an inclusion criteria of the literature review). The main component of adoption, the number of participating sites, was reported in 56.6% of the studies. Implementation or some form of process evaluation was reported by 29.6% of the studies. Individual level maintenance was reported in 25.9% of the studies, while institutional level maintenance was reported by 5.6%.

Mediator Analysis. Although reportedly all of the studies were based on theory, only 43 of the 54 physical activity interventions specified which psychological mediators were targeted by the intervention or how the theory was used in designing the intervention. Of the studies that specified mediators, 72.2% reported that they measured change in mediators after the intervention. Physical activity interventions, that targeted mediators, were about equally effective at changing exercise behavior as those that did not targeted specific mediators with 76.7% and 81.8% success rates, respectively. The most commonly targeted mediator, included in 53.7% of the studies, was the SOC. Other mediators, commonly targeted, included processes of change, decisional balance, intention, physical activity beliefs, self-efficacy, and outcome expectations. Specific

behavioral strategies were reported by 88.9% of the studies and seven studies reported assessing the use of strategies before and after the intervention program. Five of these seven studies found that there was an increase in the use of the measured behavioral strategies after the intervention. The most commonly targeted strategy in 59.3% of the studies was providing participants with information about overcoming barriers to physical activity. Other commonly targeted strategies included goal setting, discussing benefits of physical activity, social support, relapse prevention, self-monitoring, using rewards, increasing knowledge and exercise prescription.

Overall, most of the studies focused on internal validity and evaluating the efficacy of the intervention, rather than on issues of external validity. Few studies included a thorough description of the intervention protocol and materials or how the materials related to the targeted mediators. Also, theoretical fidelity of many of the interventions was found to be questionable.

Study 2: A Theory-Based Motivational Intervention to Increase Physical Activity among Older Adults

The purpose of the experimental study (Chapter 3) was to design and test the efficacy of a 4-week mail-based physical activity intervention that was designed according to an integrative theoretical framework that incorporates variables from the TPB and TTM (Kosma, Ellis, Cardinal, Bauer, & McCubbin, 2007). The final sample included 55 older adults between the ages of 54 and 96 (*M* age = 72.3 yrs, *SD* = 8.0) from 11 senior centers and senior living facilities. Most of the participants were female (72.7%), Black (89.1%), and reported low levels of education (70.4% $\leq$ high school degree) and income (85.5% $\leq$ $1571 monthly).

The results of this study indicated that both the treatment group and control group reported more positive ATT towards physical activity at follow-up, and while the treatment group reported higher levels of physical activity at follow-up, physical activity decreased in the control group. This was a statistically significant difference in physical activity between the two groups from baseline to follow-up. The treatment group also reported higher SOC after the intervention with 56.0% reporting higher SOC than at baseline compared to only 16.7% in the control group; however, this difference was not found to be statistically significant. The measured variable path analysis for the integrated model at baseline was found to have poor fit, but at follow-up the model exhibited good fit with PBC emerging as a statistically significant predictor of physical activity.

Strengths of the Dissertation Studies

The main purposes of these studies was to examine the external validity of theory-based physical activity interventions to emphasize the need to focus on the translation of interventions to real world settings, and to design and test a physical activity intervention with strong theoretical fidelity and external validity. The intent of these studies was to help shift the focus within the physical activity literature away from a medical model of research towards translatable interventions with high external validity so that population level changes in physical activity can be realized. The literature review (Chapter2) was the first review that used the RE-AIM framework to evaluate the factors related to the reporting of external validity of theory-based physical activity interventions. The shortcomings of previous research that were identified in the RE-AIM evaluation should

assist with the design of future interventions for the purpose of achieving meaningful physical activity behavior change.

The experimental study provided support for the effectiveness of using the integrated theoretical framework (Kosma et al., 2007) with belief-based, stage-matched materials for promoting physical activity behavior change among underserved (e.g., low income, low education, and Black) older adults during a 4-week intervention. The intervention targeted and tested all constructs of the model, which indicates high theoretical fidelity, and the intervention materials were described in detail to assist with translation. Additionally, the intervention was implemented in community settings that provided services to low-income, minority older adults and therefore, the focus was on making the intervention financially feasible and simple to administer. The locations where this intervention was implemented attracted an underserved population and the path analysis revealed that PBC was the only statistically significant predictor of physical activity in this population. Recognizing the physical activity barriers of underserved populations may prove useful in future intervention design.

Limitations of the Dissertation Studies

The main limitation of the literature review (Chapter 2) was that the researchers of the reviewed studies may have collected some of the information required to complete a RE-AIM evaluation, but did not report it in the articles. Their intention may have been to publish this information in the future, which means that all available information about these studies may not have been discovered. Also, although each RE-AIM dimension is recommended to be scored from 0-100, specific norms for the RE-AIM components have

not yet been determined. Therefore, the meaning of these findings is open to interpretation.

The major limitation of the experimental study (Chapter 3) was the small sample size that may have limited the ability to examine SOC progression and the mechanisms for physical activity behavior change. Also, all measures were self-report introducing possible social desirability and recall bias, which may have affected the accuracy of the results. However, one of the major goals of this research was to test a home-based intervention with high external validity, and using self-report measures was the only cost-efficient way to measure physical activity. Another limitation is the delivery method of the interventions. It cannot be verified if the participants opened and read the mailed materials. Finally, because the participants in this study represent an underserved population, these results cannot be generalized to all populations of older adults.

Suggestions for Future Research

Although previous researchers have recommended evaluating the public health impact and external validity of physical activity interventions (Estabrooks, Dzewaltowski, Russell, Glaskow, & Klesges, 2003), this literature review (Chapter 2) was the first study to use the RE-AIM framework to examine the external validity of theory-based physical activity interventions. Hopefully, the results of this study will encourage other researchers to report the information necessary to evaluate the external validity of their interventions or publish studies examining the impact their interventions had in the community. Future research is also needed to determine standards for the RE-AIM dimensions within physical activity intervention research. Additionally, theory-based interventions should be designed with good theoretical fidelity, outlining which

mediators were targeted and what specific strategies were used. Clear distinctions between theory-based mediators (i.e theoretical constructs) and behavioral strategies (i.e. the practical steps taken to change behavior) are also warranted to assure theoretical fidelity.

Previous researchers have suggested that integrating various behavioral theories could lead to more effective intervention programs (Conn, Minor, Burks, Rantz, & Pomeroy, 2003; Marcus & Forsyth, 2009) and previous studies on the integrated framework have shown that it may be more effective in promoting physical activity than the original TPB model (Kosma et al., 2007). This study showed that by targeting TPB beliefs, it may be possible to change SOC, and it is possible to change physical activity behavior. More studies using this framework are needed to verify the underlying mechanisms that lead to increases in physical activity and to determine if change in physical activity behavior is maintained long-term after a 4 week intervention. Ultimately, the goal of physical activity interventions and other health promotion programs is to improve the health of the participants and objective markers of health including blood pressure, cholesterol, blood sugar, and body composition. Currently, a great deal of effort is placed on teasing out the effects of each individual component for physical activity, nutrition, and other health behaviors, yet ultimately all of the components should be addressed together to examine what, if any, effect such efforts have on the health of the participants. These programs may also have better translation to real life settings where funding may not be available to run separate programs for each health behavior. Especially, in the midst of the current health crisis, it may be important to shift the focus to the effects that various programs have on the markers of health and away from internally valid, highly specialized studies

that measure theoretical constructs. Specifically within physical activity research, such a shift may also help researchers overcome the difficulty of measuring physical activity participation with self-report instruments because they can be validated against objective measures of health indicators.

General implications of this research

The general implication of this research is that the current use of the medical model to examine the efficacy of physical activity interventions is slowing down the progress of designing truly effective health promotion programs that can be translated into real world settings where physical activity programs do not exist in a vacuum. While examining the effects of each theoretical construct and controlling for various other factors that may change behavior is important for designing and understanding the mechanism of interventions, if these studies are conducted without regard to how the results can be used in the community, the results have little practical implication. Additionally, such research utilizes resources that are needed to combat the serious health problems that inactivity causes creating a negative consequence when examining external validity. With the current levels of sedentary behavior and overweight, we cannot lose focus of what is truly needed in the communities and waste time and resources on examining interventions that are not feasible or practical outside of research settings.

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