HHS Public Access

Author manuscript

Res Theory Nurs Pract. Author manuscript; available in PMC 2015 August 03.

Published in final edited form as:

Res Theory Nurs Pract. 2013 ; 27(1): 53–80.

Physical Activity Interventions Among Older Adults: A Literature Review

Jo-Ana D. Chase

University of Missouri, S343 Sinclair School of Nursing, Columbia, MO 65211

Jo-Ana D. Chase: chasej@missouri.edu

Abstract

Physical activity (PA) is important in the management of chronic illness among older adults worldwide. Researchers have conducted several intervention studies to increase PA behavior in this population. This review of the past 12 years of relevant PA intervention research among adults age 60 and older systematically summarized research findings, identified characteristics of successful interventions, and proposed areas of future research. Twenty studies were reviewed for this paper, most employing a combination cognitive-behavioral intervention design. Cognitive-based only and combination interventions were more successful in changing PA behavior; however, behavioral-based interventions demonstrated more long-term changes in PA behavior. Among theory-based interventions, self-efficacy was the most commonly operationalized construct. Findings from this review may inform future primary research to promote PA behavior among older adults, as well as gerontological clinical practice.

Introduction

Physical activity (PA) is an important component of healthy aging. The population of adults age 60 years and older is growing, as well as the incidence of chronic diseases, such as arthritis, heart disease, and diabetes, within this population (Administration on Aging, 2009; American Hospital Association, 2007). Physical activity has been shown to attenuate symptoms and poor outcomes of these chronic conditions; therefore, it is a useful component of self-management (Chodzko-Zajko, et al., 2009; Taylor, et al., 2004). Nevertheless, despite statements from the American Academy of Sports Medicine, American Heart Association, and Department of Health and Human Services' Physical Activity Guidelines Advisory Committee, only 28% to 34% of adults age 65 and older participate in any leisure time PA (Agency for Healthcare Research and Quality, 2002; Chodzko-Zajko, et al., 2009; U.S. Department of Health and Human Services, 2008).

Prior reviews of interventions to increase PA among older adults support the efficacy of such interventions on PA behavior change in this population (Conn, Valentine, & Cooper, 2002; Cyarto, Moorhead, & Brown, 2005; King 2001; van der Bij, Laurant, & Wensing, 2002). However, gaps in the PA intervention literature remain. Successes gained from interventions to increase PA are short lived, suggesting that we do not yet know what types of interventions contribute to long-term PA behavior change (van der Bij, et al., 2002). Moreover, the characteristics of intervention dose, delivery, and content necessary for successful PA behavior change still remain unclear (King, 2001).

An updated synthesis of the literature is needed to capture the most current information available to address these gaps in research knowledge. Many of the most recent reviews of interventions to increase PA behavior among older adults did not include data from studies covering the past 12 years of PA intervention research (Conn, Minor, Burks, Rantz, & Pomeroy, 2003; Conn, et al., 2002; Cyarto, et al., 2005; van der Bij, et al., 2002). In fact, the latest studies included in the most recent meta-analysis of PA intervention research among aging adults were from 1999 (Conn, et al., 2002). Additionally, other prior reviews examined studies whose samples were younger than 60, without providing disaggregated findings for older participants (Conn, et al., 2002; Conn, Hafdahl, Brown, & Brown, 2008; Foster, Hillsdon, & Thorogood, 2005). A systematic, descriptive synthesis of the past 12 years of PA intervention research among adults age 60 and older will further research knowledge related to intervention effectiveness by identifying current and successful intervention characteristics, to inform and guide future PA intervention studies and clinical practice among the rapidly growing population of older adults. Thus the purpose of this paper is to conduct an up-to-date review of the relevant literature of interventions to increase PA among adults age 60 and older in order to identify and describe successful intervention components, and to address critical areas for further research.

Methods

A literature search was conducted using PubMed, Medline, and CINAHL databases for published papers describing physical activity interventions among older adult. Search terms included “physical activity interventions,” “exercise interventions,” “older adults,” and “elderly.” Furthermore, the author completed author searches and ancestry searches from eligible studies. Study inclusion criteria were papers that 1) were written in English, 2) were published from January 2000 to September 2012, 3) described at least two-group study designs, 4) tested interventions designed to improve PA behavior, 4) that sampled community-dwelling, adult subjects age 60 years or older, 5) regardless of health status, and 5) that measured PA behavior as an outcome. Selecting the past 12 years ensures the most contemporary studies are included in this review. In order to include studies with the most scientifically rigorous designs, studies that did not include randomization or had samples consisting of 30 participants or less were excluded from this review.

Recent synthesis reports have examined PA intervention effectiveness across a variety of populations according to the use of cognitive and/or behavioral strategies (Conn, et al., 2002; Conn, et al., 2008). Therefore, intervention content was categorized as behavioral, cognitive, or combination interventions based on intervention components. Behavioral interventions introduce observable and participatory physical actions to promote behavior change. Examples include supervised exercise sessions, self-monitoring, and prompting. Cognitive strategies aim to alter or enhance thought processes, attitudes, or beliefs related to a specific behavior in order to achieve behavior change. Examples include motivational interviewing, patient education, barriers identification and management, and decisional balance activities. Criteria used assign studies to a category were based on descriptions and examples of each category from prior research syntheses (Conn, et al., 2008; Conn, et al., 2003; Conn, et al., 2002).

Studies meeting the inclusion criteria were reviewed for sample demographics. Additionally, eligible studies were also analyzed for use of theory and operationalization of theoretical constructs given the increase use of theory among PA intervention studies over the past decade (Keller, Fleury, Sidani, & Ainsworth, 2009). Results were reported based on categorization of intervention characteristics, in terms of content, delivery, and dose, and use of theory.

Results

The initial online database search produced 172 studies. The researcher excluded 149 studies based on lack of randomization and small sample sizes. Three studies were separate reports on a single large study. Thus 20 studies met the inclusion criteria of this literature review. Tables 1 through 3 present characteristics of these studies, including intervention content, dose, and delivery, and statistical significance when available from the reports. The review included papers from Australia (Baker, et al., 2007; Bird, Hill, Ball, Hetherington, & Williams, 2011), New Zealand (Kolt, Schofield, Kerse, Garrett, & Oliver, 2007), the Netherlands (de Vreede, et al., 2007), Belgium (Opdenacker, Boen, Coorevits, & Delecluse, 2008), the United Kingdom (Brodie & Inoue, 2005; Kelley & Abraham, 2004; Witham, et al., 2012), and the United States (Allison & Keller, 2004; Barnason, Zimmerman, Schulz, & Tu, 2009; Brawley, Rejeski, & Lutes, 2000; Conn, Burks, Minor, & Mehr, 2003; Greaney, et al., 2008; Morey, et al., 2009; Pinto, Goldstein, Ashba, Sciamanna, & Jette, 2005; Rejeski, et al., 2009; Resnick, Luisi, & Vogel, 2008; Stewart, et al., 2001; Talbot, Gaines, Huynh, & Metter, 2003, VanSwearingen, Perera, Brach, Wert, & Studenski, 2011). Of those studies that documented a theoretical basis, social cognitive theory, specifically the construct of self efficacy, was the most commonly observed framework (Allison & Keller, 2004; Barnason, et al., 2009; Conn, et al., 2003; Morey, et al., 2008; Morey, et al., 2009; Opdenacker, et al., 2008; Resnick, et al., 2008). Intervention designs and results varied. Among behavioral interventions, supervised exercise was the most commonly used intervention, followed by goal-setting and self-monitoring. Self-efficacy enhancement and motivational interviewing were common components of cognitively based interventions. Physical activity was the primary outcome in all but four studies (Baker, et al., 2007; Bird, et al., 2011; Stewart, et al., 2001; Witham, et al., 2012). Instruments used to measure PA included self-report questionnaires, pedometer data, accelerometer data, and activity recall interviews. Most studies used combinations of these instruments for data collection.

Sample characteristics

Sample size ranged from 33 to 966. Studies varied in follow-up time, ranging from two weeks to three years. Some recruitment involved primary care practices (Kolt, et al., 2007; Morey, et al., 2009; Pinto, et al., 2005; Witham, et al., 2012), rehabilitation programs (Allison & Keller, 2004), specific community settings such a retirement village (Baker, et al., 2007), or Veterans' Administration (VA) Hospitals (Morey, et al., 2008; Morey, et al., 2009). Mean ages of study samples ranged from 66.30 to 81.70. Two studies had all women samples (Conn, et al., 2003; de Vreede, et al., 2007). In fact, women were overall well represented in many of the studies. Socio-economic status, education, marital status, and ethnicity were not consistently described across the included studies.

Intervention characteristics

Five studies employed behavioral interventions only (Baker, et al., 2007; Bird, et al., 2011; de Vreede, et al., 2007; Talbot, et al., 2003; VanSwearingen, et al., 2011); while three studies used cognitive interventions only (Barnason, et al., 2009; Brodie & Inoue, 2005; Pinto, et al., 2005). Twelve studies combined cognitive and behavioral interventions (Allison & Keller, 2004; Brawley, et al., 2000; Conn, et al., 2003; Greaney, et al., 2008; Kelley & Abraham, 2004; Kolt, et al., 2007; Morey, et al., 2009; Opdenacker, et al., 2008; Rejeski, et al., 2009; Resnick, et al., 2008; Stewart, et al., 2001; Witham, et al., 2012).

Behavioral-based interventions—Table 1 lists the studies utilizing behavioral-based interventions. Participating in supervised exercise sessions, goal setting, and self-monitoring were common behavioral strategies. All studies using supervised exercise sessions alone demonstrated non-significant findings in differences in PA behavior between treatment and control groups at outcome (Baker, et al., 2007; Bird, et al., 2011; de Vreed, et al., 2007; VanSwearingen, et al., 2011). This was true regardless of the focus of the sessions (e.g., endurance, resistance, or balance training, or functional improvement). For example, a 10-week supervised exercise intervention employed by Baker and colleagues (2007) consisted of progressive resistance training three days a week, moderate intensity aerobic training two days a week, and progressive balance training one day a week. Neither between group or within group comparisons revealed statistically significant improvements in PA behavior.

Incorporating varied forms of training did not increase the success of supervised exercise interventions. For example, Bird and colleagues (2011) randomly assigned participants to received an intervention of flexibility and resistance training versus a non-training control group. However, the researchers found no significant mean difference in PA behavior change between groups either short-term or long-term at 12 months. Additionally, another study demonstrated that increasing progressive intensity of supervised exercise training did not contribute to significant differences in PA behavior between intervention and control groups (VanSwearingen, 2011).

Goal setting and self-monitoring showed some success in increasing PA levels among older adults. A small study from Talbot, Gaines, Huynh, and Metter (2003) described the effects of a home-based pedometer program versus a self-management education program alone on PA behavior in older adult patients with arthritis. Participants randomized to the pedometer program were further instructed on the use of a pedometer, advised to record daily readings and set goals to increase step count by 30%. A 23% increase in daily steps was observed in the pedometer intervention group, while the education only group decreased in daily steps by 15% (Talbot, et al., 2003).

Cognitive-based interventions—Table 2 lists the studies utilizing cognitive-based interventions. Overall, cognitive-based interventions were successful in increasing PA behaviors (Barnason, et al., 2009; Broudie & Inoue, 2005; Pinto, et al., 2005). These interventions primarily involved counseling interventions. One study focused on increasing participant self-efficacy for symptom management to increase PA behavior in post coronary artery bypass patients (Barnason, et al., 2009). Participants were randomized to receive

daily, telephone-delivered counseling sessions over six weeks. Physical activity was measured at baseline by a modified 7-day activity interview, but subsequent PA measurements were obtained by an activity diary and accelerometer at three and six weeks, and three and six months. The intervention group had a significant mean change in PA at 6 months ($p<.001$) and 12 months ($p<.001$), while the control group demonstrated non-significant changes ($p=.211$) (Barnason, et al., 2009).

Two cognitive-based interventions using motivational interviewing strategies demonstrated success in significantly improving PA behavior among participants (Brodie & Inoue, 2005; Pinto, et al., 2005). Brodie and Inoue (2005) compared the results of a motivational interviewing (MI) intervention group, a MI plus standard care group, and a standard care control group (Brodie & Inoue, 2005). For five months, participants randomized to a MI component received a series of home-based sessions discussing concepts such as ambivalence to PA, problem solving, barriers managements. The standard care group only received recommendations to increase PA. Physical activity data were converted from a 3-day PA diary and a leisure-time PA questionnaire into kilocalories per kilogram per day. A significant change from baseline energy expenditure expressed as kilocalories per kilogram per day (M = 6.6, SD 2.6) to five months (M = 9, SD 3.3, $p<.01$) was seen in the MI group (Brodie & Inoue, 2005). Furthermore, MI plus standard control also demonstrated a significant change from baseline energy expenditure in kilocalories per kilogram per day (M = 8.3, SD 2.5) to five months (M = 10.5, SD 4.4, $p<.01$) (Brodie & Inoue, 2005). The standard care control group did not show significant change from baseline. Pinto, Goldstein, Ashba, Sciamanna, and Jette (2005) found similar success when testing the effects of an extended advice intervention involving motivational interviewing-based clinician advice plus telephone counseling versus a clinician advice only control on PA levels in older adults. The extended advice intervention was also tailored to a participant's readiness to increase PA level. Accelerometer and survey data demonstrated significant changes from baseline kilocalorie expenditure in the intervention group compared to controls at three months ($p<.05$) and six months ($p<.05$) (Pinto, et al., 2005). Thus motivational interviewing interventions may contribute to PA intervention success among older adults.

Combination cognitive-behavioral interventions—Most studies in this review (Table 3) used a combination of cognitive and behavioral interventions. Inconsistent success in increasing PA behavior was observed among these studies. Two of these studies conducted follow-up outcome data collection less than six months from the start of the study (Conn, et al., 2003; Kelley & Abraham, 2004). Conn, Burks, Minor, and Mehr (2003) randomly assigned 190 female subjects to four groups, a motivation intervention only group, a motivation plus telephone prompting group, a telephone prompting only group, and a group receiving no motivation or prompting. Physical activity outcome data measured by pedometer and questionnaire data, and an activity log revealed that the combination motivation and telephone prompting intervention was no more effective in increasing overall exercise. Furthermore, there was no significant effect for the motivation intervention compared to control (Conn, et al., 2003). Participants who received the prompts, however, not only engaged in more exercise, but also increased weekly exercise amount by a mean of

37 minutes in comparison to 12 minutes compared to those that did not receive the prompt intervention (Conn, et al., 2003).

A majority of studies testing cognitive and behavioral interventions to increase PA among older adults involved follow-up greater than six months. Greaney et al. (2008) tested a multi-faceted, print and telephone-based intervention to promote eating a healthy diet and participating in regular PA over 12 months. Participants randomized to the intervention arm received educational materials, newsletters, coaching calls, and a computer-generated feedback report of the participant's progress in attaining predetermined goals, while the control did not. The Yale Physical Activity Survey was used to measure PA changes; however, no significant difference was observed between the intervention and control groups with respect to PA behavior from baseline to 12 or 24 months (Greaney, et al., 2008).

Other studies using combination cognitive-behavioral interventions reported more successful long-term findings. For example, Stewart and colleagues (2001) randomized 164 subjects to either a control group or to receive individually tailored, cognitive-based counseling sessions, coupled with behavioral components such as self-monitoring with PA diaries for 12 months. Using the CHAMPS PA Questionnaire for Older Adults to calculate an estimate of caloric expenditure, researchers found that the intervention group significantly increased caloric expenditure in all activities compared to controls at study completion ($F(1,159)=9.06$, $p=.003$) (Stewart, et al., 2001). The intervention group also significantly increased caloric expenditure in moderate intensity activities by 487 calories per week ($F(1,159)=8.84$, $p=.003$), while changes within the control group were non-significant (Stewart, et al., 2001). Another study compared the results of a combination center- and home-based PA program plus group-mediated cognitive behavioral intervention to a combination center- and home-based PA alone program, and a wait-list control group (Brawley, et al., 2000). Follow-up data at nine months revealed that the group-mediated cognitive behavioral intervention group had a higher frequency of moderate PA than the other combination center- and home-based PA group (Brawley, et al., 2000).

One study examined outcomes beyond 12 months (Rejeski, et al., 2009). Rejeski and colleagues (2009) evaluated two year follow-up PA data from a large disability and physical function study, discovering that participants randomized to a PA intervention plus behavioral counseling group continued to engage in more minutes of moderate exercise than those in the control arm, who received only educational counseling for successful aging. Significant findings for increased PA behavior were not evident at the six-month data collection point ($p=.77$) (Rejeski, et al., 2009). However, improved PA behavior from baseline to 12 months ($p<.001$) and 36 months ($p=.042$) were found to be significantly different than control, suggesting a long-term effect on PA behavior from the cognitive-behavioral based intervention (Rejeski, et al., 2009).

Intervention delivery—Although many studies in this review used primarily face-to-face intervention delivery, two studies with telephone-mediated forms of delivery demonstrated success (Morey, et al, 2009; Kolt, et al., 2007). Morey and associates (2009) randomized participants to a usual care control group or to receive telephone counseling focusing on enhancing self-efficacy and barriers management and automated telephone prompting and

periodic tailored progress reports to promote PA behavior. Physical activity behavior was a secondary outcome and was measured using a modified CHAMPS PA questionnaire. At 12 months, researchers observed an increase in the proportion of participants meeting the goal of 150 minutes or more of moderate to vigorous activity per week from 13% at baseline to 32% in the intervention group ($p<.001$) (Morey, et al., 2009). The usual care control group did not demonstrate similar findings. Kolt and colleagues (2007) also utilized a telephone counseling intervention, employing motivational interviewing techniques while promoting goal setting with a counselor and self-monitoring with a walking log. Results nine months after completion of the study exhibited a 42% achievement of the goal of 2.5 hours a week of moderate to vigorous leisure activity in the intervention group, versus 23% in the control group (Kolt, et al., 2007).

Intervention dose—Intervention dose, in terms of the total amount of intervention delivered, was difficult to determine from these studies due to inconsistent and inadequate reporting. Doses varied among studies from as little as one encounter session (Kelley & Abraham, 2004) to multiple sessions involving various intervention components over several months (de Vreede, et al., 2007; Greaney, et al, 2008; Morey, et al., 2009; Opdenacker, et al., 2008; Rejeski et al.; 2009; Stewart, et al., 2001). Intervention dose did not appear to impact effectiveness among the studies reviewed. For example, de Vreede and colleagues (2007) administered one hour superversized exercise sessions three times a week for 12 weeks. These researchers had randomized participants to receive either a supervised exercise program focusing on functional tasks or resistance strength training, or to a non-exercise control group. Data collected at three and nine months using a self-report questionnaire for activities beyond the supervised exercise demonstrated no difference in change of PA scores within or between groups (de Vreede, et al., 2007). Conversely, in a study examining the effects of a healthy living booklet targeting perceived behavioral control and intention, goal setting, and self-assessment feedback, Kelley and Abraham (2004) found that the intervention group reported higher activity levels from baseline to two weeks as measured by the Short Form 12 Health Survey Questionnaire. Effect size of the intervention was .37 (Kelley & Abraham, 2004).

Use of theory

Nine studies specifically mentioned the use of theory in developing PA interventions (Allison & Keller, 2004; Barnason, et al., 2009; Greaney, et al., 2008; Kelley & Abraham, 2004; Kolt, et al., 2007; Morey, et al., 2009; Opdenacker, et al., 2008; Resnick, et al., 2008; Stewart, et al., 2001). The theoretical construct of self-efficacy was the commonly used; furthermore, this construct was the best operationalized among these studies. For example, Allison and Keller (2004) applied the construct of self efficacy to develop their intervention, and measured the construct using a Self-Efficacy Expectation Scale. The intervention protocol incorporated the four sources of self-efficacy to promote PA behavior – performance accomplishment, verbal persuasion, vicarious experience, and physiologic arousal (Bandura, 1977). The self-efficacy intervention did not show direct effect on level of PA self-efficacy, but did positively correlate to self-reported PA and PA performance (Allison & Keller, 2004). However, the study's attention control group, which received only telephone prompting to maintain an exercise program, achieved a 15.56% increase in PA

scores measured by the Physical Activity Scale for the Elderly compared to a 6.49% increase in the self-efficacy intervention group (Allison & Keller, 2004).

The theoretical constructs of self-efficacy and outcome expectations were also used by Resnick, Luisi, and Vogel (2008). Self-efficacy was operationalized by participant engagement in supervised exercise and goal setting (performance accomplishment), positive verbal reinforcement (verbal persuasion), middle-aged lay instructors and older adult participants as role-models (vicarious experiences), and education and coaching regarding physiologic responses to exercise (physiologic arousal). The operationalized constructs were evaluated using separate scales for self-efficacy for exercise and outcome expectations for exercise (Resnick, et al., 2008), and demonstrated that the intervention group spent more time in structured exercise compared to the control group (ES .28, p=.04). However, scores measuring total PA were not significantly different than control (Resnick, et al., 2008).

Other studies mentioning use of theory in intervention development failed to fully operationalize theoretical components. For example, Opdenacker, Boen, Coorvetis, and Delecluse (2008) stated the use of several theories, the theory of self-determination, transtheoretical model, and social cognitive theory, as the basis of their intervention. Yet, specific attribution of theoretical constructs to intervention components, and subsequent measurement and evaluation of operationalized constructs were not quantified.

Methodological Issues

Some common methodological challenges were observed among the studies. Almost half of the studies in this review contained small (n<110) sample sizes. Inadequate sample size for statistical power to detect differences or change may have been a problem in some of these studies. Reported sample demographics did not consistently demonstrate ethnic and socioeconomic characteristics. Lack of inclusion of diverse minorities such as Hispanic, Native American, or Asian ethnicities, and rural or institutionalized elders contributes to further underrepresentation of these populations in current PA intervention research. Furthermore, generalizability of study findings to the community may be hampered by these issues.

Methodological challenges among the reviewed studies' designs contribute to difficulty in interpretation of the results. While several studies included outcome measurements beyond six months, only three of the studies reviewed had outcome measurements beyond 12 months (Greaney, et al., 2008; Opdenacker, et al., 2008; Rejeski, et al., 2009). Thus, long term adherence to changes in PA behavior is difficult to evaluate from studies with shorter follow-up.

Most studies relied on self-report questionnaires such as the Physical Activity Scale for the Elderly, Yale Physical Activity Scale, or a 7-Day Activity Recall Instrument. Only three studies (Talbot, et al., 2003; VanSwearingen, et al., 2011; Witham, et al., 2012) used solely objective measures. Self-report measurements of PA behavior may introduce bias based on participants' subjective interpretation of PA levels or PA definition. Common older adult activities such as volunteerism may be omitted from consideration of quantifiable PA due to lack of mention in the questionnaires or in the definition of PA presented to subjects. Also,

age-related deficits may contribute to poor recall (Charness, 2008; Levy, Holmes, & Smith, 2003). Utilization of more objective measures such as pedometers or accelerometers may support questionnaire reports. However, older adults may experience gait disturbances secondary to co-morbidities such as prior stroke or arthritis, poor understanding of device use, difficulty manipulating small parts within the device, and overall discomfort with technology. As a result, data collected from these devices may be incomplete or incorrect.

Discussion

The findings from this systematic review encompass the past 12 years of relevant literature of intervention studies designed to increase PA behavior among adults age 60 and older. Intervention dose, delivery, and content have been examined, as well as use of theory. Among the studies presented in this paper, interventions containing cognitive-based and cognitive-behavioral based content were more effective at significantly changing PA behavior among older adults subjects than behavioral-only interventions. In fact, studies using only supervised exercise sessions, a behavioral intervention, were the least effective overall. Future intervention studies using this strategy may be enhanced by additional intervention strategies, such as additional behavioral strategies (e.g., goal setting and self-monitoring) or cognitive strategies (e.g., motivational interviewing, self-efficacy enhancement). However, researcher should be cautioned that more complex interventions using multiple and diverse strategies do not necessarily contribute to intervention efficacy. For example, among combined cognitive and behavioral-based interventions, Rejeski and colleagues (2009) were able to encourage long-term success with their participants using two main strategies, while Opdenacker and colleagues (2008) were less successful with eight different strategies. Thus, while broad categories and a few specific intervention strategies appear to be effective in changing PA behavior among older adults, the precise combination of intervention strategies leading to success is not yet clear.

The finding of increased effectiveness of cognitive and cognitive-behavioral based interventions over behavioral based interventions differs from results exhibited in a recent meta-analysis reviewing interventions to increase PA in chronically ill adults (Conn, et al., 2008). The findings of this review may be the result of the nature of cognitive-based strategies used in the included studies. The cognitive-based only interventions were individually tailored based on participants' needs, motivation, and readiness to change. Furthermore, frequency of the interventions may contribute to success. One intervention involved daily sessions over six week (Barnason, et al., 2009), while another involved three in-person counseling sessions and 12 telephone PA counseling sessions over three months (Pinto, et al., 2005).

Of note, one cognitive-behavioral based intervention demonstrated long-term PA behavior change results, with evidence of continued higher levels of PA from baseline up to two years beyond the end of a study (Rejeski, et al., 2009). However, given the small sample of studies collecting longitudinal data, this finding cannot be generalized to all cognitive-behavioral based interventions and should be interpreted with caution. Also of interest is the finding of one study in which the cognitive component of the intervention, motivational counseling, either alone or in combination, failed to produce significant effects on PA behavior, while

the behavioral component, telephone prompting, was successful (Conn, et al., 2003). Allison and Keller (2004) found similar results in their study of the effects of a self-efficacy based intervention on PA behavior. The attention control arm, which only received telephone prompting, had more improvement in PA scores than the self-efficacy intervention group (Allison & Keller, 2004). Therefore, despite the inconsistent success of behavioral strategies as observed in this review, it appears that strategies such as prompting, goal setting, feedback, and self-monitoring, may indeed be useful for enhancing long-term PA behavior change. Further research, such as primary studies or a comprehensive, updated meta-analysis of intervention studies to increase PA in adults age 60 and older, is needed to better delineate aspects of cognitive and behavioral strategies that will promote successful long-term PA behavior change in the older adult population.

The intervention dose needed to significantly increase PA behavior among older adults is yet unclear. The studies reviewed for this paper contained a variety of dose amounts. Furthermore, intervention dosage, in terms of precise times or frequency, was not always adequately reported in these studies. Researchers should be more explicit in describing future interventions to allow for replication and accuracy (Conn, Cooper, Ruppar, & Russell, 2008).

Researchers have a variety of different intervention delivery mechanisms at their disposal. However, prior PA intervention research heavily utilizes face-to-face delivery (Conn, et al., 2002). Nevertheless, findings from this review demonstrate that interventions did not need to be delivered face-to-face to be effective among older adults. Similarly, prior reviews of the literature suggest that telephone-mediated delivery is viable and perhaps cost-effective option (Foster, et al., 2005; King 2001). Future research could also test alternative forms of mediated delivery, such as web, email, or internet-based formats, which could potentially reach larger or geographically diverse populations.

Few studies used theory-based interventions. Operationalization of theoretical concepts is necessary for theory testing. Developing operational definitions allows researchers to translate abstract concepts and constructs into more concrete situations or procedures within the intervention protocol (McEwen & Wills, 2011). Several studies did not fully operationalize concepts, however, often failing to incorporate theoretical constructs into key aspects of intervention design. This issue was common among studies claiming to use more than one theory. Keller and colleagues (2009) reported similar findings in a recent review of fidelity to theory in PA intervention research. In order to effectively test theories of PA behavior change, researchers using theory-based interventions should carefully link theoretical concepts to intervention components and carefully select valid instruments to measure outcome variables consistent with theoretical propositions.

Researchers conducting PA intervention studies among older adults face a number of specific methodological challenges that may affect the generalizability of research findings. Older adult participants pose unique challenges to participating in PA, controlling potential attrition, and employing proper use of study instruments (Chase, 2011). Furthermore, variations in residential location and environments may prohibit researchers from capturing a representative study sample among older adults. Among studies included in this review,

sampling and PA measurement were common methodological issues encountered by researchers.

Samples within these studies were majority female. Ethnicity, socio-economic status, marital status, and educational levels were not consistently reported in all of the studies. Ethnic minorities are steadily growing within the older adult population (He, Sengupta, Velkoff, & DeBarros, 2005). Moreover, ethnicities such as Blacks, Native Americans, Filipinos, and Hispanics have high incidences of chronic diseases such as hypertension and diabetes and may be less likely to engage in regular physical activity (Belza, et al., 2004). Therefore, intervention research including ethnic minorities is essential to promoting PA behavior change in a wider cross-section of society. In addition studies' samples were primarily community-based. There were no reports evaluating interventions to increase PA in institutional settings. Nursing home residents or patients in long-term care facilities may have low levels of PA due to personal and environmental factors (Chen, 2010). Further research would be useful to determine effective interventions to increase PA behavior in this patient population.

Measuring PA is a significant methodological challenge for researchers studying PA behavior in older adults. Many studies in this review utilized a combination of instruments to capture and quantify PA behavior. The most common combination was the use of a questionnaire and an objective form of measurement, such as an accelerometer or pedometer. Future PA intervention research in the older adult population should consider age-related changes and co-morbidities that may affect functional and cognitive competence, as well as subject comfort with technology.

There are some limitations to this review. Single group, pre-test, post-test studies were not included in this review. These studies may contain important information regarding PA intervention characteristics that would be beneficial for future research. By limiting the inclusion criteria to the past 10 years of published studies with larger samples, this review did not include unpublished studies, prior landmark intervention studies, or smaller primary studies, which may have contained further pertinent findings. Studies in this review used community-based samples. Therefore, the results of this review may not be applicable to older adults living in institutional settings such as nursing homes or long term care facilities. Similarly, as inconsistent documentation of subject demographics was observed in this review, findings may be limited in terms of ethnically and socioeconomically diverse populations. Practitioners seeking to promote PA among their older adult clients should interpret the findings of this review with these limitations.

Conclusion

This systematic review includes the past 12 years of PA intervention research among adults age 60 and older. Findings from this review will contribute to the growing knowledge base of PA intervention research among older adults by elucidating effective aspects of intervention dose, delivery, and content and proposing future areas of research. Findings from this systematic review can serve to further inform researchers as well as practitioners. Clinicians and health care practitioners are on the front lines to promote regular PA and to

discourage a sedentary lifestyle among the aging population. Furthermore, increased knowledge regarding interventions to improve PA behavior in this population may contribute to future community-based and policy-driven interventions promoting nationwide adherence to current PA recommendations.

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Table 1

Behavioral Based Interventions

Author/Country	Sample	Use of Theory or Constructs	Intervention Content and Dose	PA Measures and Data Collection Points	Results
Baker, et al., 2007/ Australia	N=38 62% female Age = 76.6 (6.1) Exercise group n=20 Control group n=18	No	Supervised exercise; 10 weeks	Habitual PA using Physical Activity Scale for the Elderly Measured at baseline and end of study period	No significant difference in change scores between exercise group and control over time (p=.81)
Bird, et al., 2011/ Australia	N= 33 % female not given Age = 67.1 (95% CI 65.6–68.7) Exercise group n=22 Control group n=11	No	Supervised exercise group given 16 weeks of flexibility training followed by 16 weeks of resistance training, or vice versa with 4 week washout period in between	Physical Activity Scale for the Elderly questionnaire For exercise group – Measured at baseline, 17 weeks (after first training period), and 39 weeks (end of intervention) For control group – measured at baseline and 16 weeks All groups were also assessed 12 months after start of study.	No significant mean difference between groups at end of intervention (p=.601) or at 12 month follow up (p=.447)
de Vreede, et al., 2007/ Netherlands	N=98 100% female Functional Group n=33 Age = 74.7 (3.5) Resistance Group n=34 Age = 74.8 (4.0) Control Group n=31 Age = 73.0 (3.2)	No	Supervised exercise; 12 weeks Functional Tasks Exercise Program: designed to improve performance of daily tasks Resistance Strength Exercise Program: based on American College of Sports Medicine and Fit For your Life program	Self-reported PA questionnaire Measured at baseline and 6 months	No significant difference in change scores from control at 3, 6 and 9 months
Talbot, et al., 2003/ United States	N=34 Walk+ n=17 Age = 70.8 (4.7) 76.5% female Education group n=17 Age = 69.6(6.7) 76.5% female	No	Both groups received 12 hours of Arthritis Self-Management program; 16 hours Walk+ - pedometer, goal setting, activity logs, educational booklet; 12 weeks with every 4 week assessments	Pedometer and accelerometer Measured at baseline, completion 24 weeks, and 3 month follow-up	23% increase in daily steps occurred in Walk+ group and 15 % decrease in education group; But total vector magnitude maintained; possible more efficient gait No significant changes from posttest to follow up
van-Swearingen, et al., 2011/United States	N=47 65% female Age=77.2 (5.5) Task oriented group n=23 Impairment oriented group n=24	No	Supervised exercise sessions; 12 weeks, twice weekly, progressive intensity, led by physical therapists Task oriented – focused on timing and coordination exercises Impairment oriented – focused on walking, endurance, balance, and strengthening exercises	Actigraph accelerometer work for 7 consecutive days measured at baseline and at completion of intervention	No significant difference in adjusted group difference (p=.097)

Note. Ages expressed as mean (standard deviation) unless otherwise indicated; Age of total number of participants listed unless data only given for groups; PA = physical activity; statistical significance listed when provided by study

Table 2

Cognitive Based Interventions

Author/Country	Sample	Use of Theory or Constructs	Intervention Content and Dose	PA Measures and Data Collection Points	Results
Barnason, et al., 2009/United States	N = 55 16% female Age = 71.6 (5.1) Intervention n= 24 Usual care n = 31	No	Daily self-efficacy and symptom management based counseling sessions; for 6 weeks	Modified 7-day Activity Interview; accelerometer and activity diary Interview at baseline; accelerometer and activity diary at 3 weeks, 6 weeks, 3 months, and 6 months	Intervention group had significant mean change in PA at 6 months (p<.001) and 12 months (p<.001); control group demonstrated non-significant changes (p=.211)
Brodie & Inoue, 2005/United Kingdom	N=60 Age = 79(6.9) Gender percentage not reported Motivational interviewing and Standard Care n=30 Motivational Interviewing n=32 Standard Care group n=30	Yes; Motivational Interviewing	Series of home based motivational interview sessions; for 5 months	Leisure-time PA questionnaire - PA expressed in energy expenditure units kilocalorie per kilogram per day; 3-day PA diary Energy expenditure measured at baseline and 5 months	Significant change in mean energy expenditure in MI (p<.01) and MI plus standard care group (p<.01) from baseline to 5 months
Pinto, et al., 2005/ United States	N=100 63.2% female Age = 68.5 Extended advice group n=52 Brief advice group n= 48	Transtheoretical model; Motivational interviewing	Extended advice: PA prescriptions; face to face PA counseling; 3 sessions, lasting 30–45 minutes; additional 12, 10–15 minute motivational phone counseling sessions weekly x 3 weeks, then every other week for 3 months; 12 PA tip sheets mailed Brief advice: limited to advice given by own clinican	7-Day Physical Activity Recall instrument; accelerometers worn for 3 days Measured at baseline, 3 mo, 6 mo	Significant changes in extended advice group from baseline kilocalorie expenditure at 3 months (F=5.20, p<0.05) and 6 months (F=6.62, p<0.05) and reported minutes of exercise at 3 months (F=5.20, p=0.03) and 6 months (F=6.62, p = 0.01) compared to brief advice group

Note. Ages expressed as mean (standard deviation); Age of total number of participants listed unless data only given for groups; PA = physical activity

Table 3

Combined Cognitive and Behavioral Based Interventions

Author/Country	Sample	Use of Theory or Constructs	Intervention Content and Dose	PA Measures and Data Collection Points	Results
Allison & Keller, 2004/United States	N=83 Age = 71.78 (4.38) 31% female Experimental group n = 28 Attention Control group n = 27 Usual Care group n = 28	Yes; Construct of self-efficacy	Experimental - self-efficacy based intervention via telephone, goal setting, activity log, rehearsal of desired behaviors; every 2 weeks Attention control - received telephone follow up to report progress w PA and cardiac rehab, reminded to continue exercise program; every 2 weeks	Physical Activity Scale for the Elderly Measured at baseline, 6, and 12 weeks post cardiac event	Overall improvement of PA scores from baseline to 12-week data collection point; percent improvement greater for attention control group (15.46%) than experimental group (6.49%) and usual care group (7.99%) Self-efficacy intervention positively correlated with PA measures, but not self-efficacy for PA
Brawley, et al., 2000/United States	N = 60 Wait List Control n = 16 Age = 69.38 (3.29) 62% female Standard PA group n = 20 Age = 70.45 (4.26) 65% female Group mediated cognitive behavioral intervention n = 18 Age = 70.22 (4.26) 61.1% female	No	Standard PA group and Group mediated cognitive behavioral intervention received combined center- and home-based intervention promoting PA, educational lectures; for 6 mo Group mediated cognitive behavioral intervention: group session discussing cognitive/behavioral skills, goal setting, barriers management, relapse prevention; extra 1/2 hour added to sessions	7 day activity recall interview Measured at baseline, 6 months, and 9 months	Group mediated cognitive behavioral intervention had higher frequency of moderate PA than SPA $F(1,30) = 5.72$, $p<.02$ Results of total volume PA favored Group mediated cognitive behavioral intervention, but not statistically significant $F(1,20)=3.29$, $p<.08$ 3 and 6 months differences in PA frequency, duration, and total volume non significant
Conn, et al., 2003/ United States	N = 190 Age = 75.01 (6.72) 100% female Motivation only group Motivation and prompts Prompts only No motivation and no prompts	Yes; Transtheoretical Model, Social Cognitive Theory, Theory of Planned Behavior	Motivational intervention: motivate to exercise and promote self-efficacy through one small group and two individual sessions Prompting intervention: alternating phone calls lasting 3–5 min and mailed materials; weekly for three months	Baecke PA scale; Houston PA scale; pedometer worn for 7 days Measured at 3 months	66% of participants who received prompts performed some endurance exercise, and performed more exercise that those that didn't (p=.04) No significant effect for motivation intervention compared to control; prompt + motivation group not found to be more likely to engage in exercise than other participants
Greaney, et al., 2008/United States	N = 966 Intervention group n = 470 Age = 75 (6.7) 72% female Comparison group n = 496 Age 74.7 (6.6) 70.4% female	Yes; Transtheoretical Model	Educational materials, counselor phone calls to encourage and prompt, expert systems reports for progress feedback, coaching calls, monthly newsletters tailored to stage of change; 12 month of intervention followed by 12 months of observation	Yale Physical Activity Survey Measured at baseline, 12 months and 24 months	No significant difference scores between intervention and comparison group from baseline to 12 or 24 months
Kelley & Abraham, 2004/United Kingdom	N=252 Mean age 81.7 (5.57) 69% female Intervention n = 125 Control = 127	Yes; TPB	Booklet on perceived behavioral control and intention; goal setting; brief diary	Short Form 12-Health Survey Questionnaire - rated on scale of 1–10 Measured pre-intervention and at 2 week follow up	Intervention group reported being more physically active compared to control group at 2 week follow up; ($F(1,188)=5.01$, p=0.02)

Author/Country	Sample	Use of Theory or Constructs	Intervention Content and Dose	PA Measures and Data Collection Points	Results
Kolt, et al., 2007/New Zealand	N=186 Intervention n = 93 Age = 74.1 (6.2) 62.4% female Control= 93 Age = 74.3 (5.9) 69% female	Transtheoretical model; Motivational interviewing	Goal setting, walking log; 8 telephone counseling sessions over 12 week period; weekly x 4 weeks then every 2 weeks for remaining 8	Auckland Heart Study Physical Activity Questionnaire Measured at baseline, 3 months, 6 months, and 12 months	Total amount of time spent in moderate intensity leisure activity higher in intervention group than control group at 12 months (p=.007) 42% of intervention group versus 23% of control group reached health-related goal of 2.5 h/wk of moderate or vigorous leisure PA at 12 mo
Morey, et al., 2009/ United States	N = 398 Age = 77 (5.0) 0% female Intervention group n = 199 Age = 77.7 (5.0) Usual care group n = 199 Age = 77.4 (4.9)	Yes; Social Cognitive Theory	Self-efficacy, barriers management, goal setting, automated provider phone messages, 8 mailed motivational messages; 3 phone calls in first 2 months, monthly for 12 months Tailored progress report every 12 weeks	Modified CHAMPS PA questionnaire Measured at baseline, 3 months, 6 months, and 12 months	Proportion of individuals meeting goal of 150 minutes or more of mod-vigorous activity/week increased from 13% at baseline to 32% at 12 month in intervention group, (p<.001)
Opdenacker, et al., 2008/Belgium	N = 120 Lifestyle intervention group n = 60 Age = 66.30 (3.99) 50% female Structured exercise intervention group n = 60 Age = 66.99 (4.32) 50% female Control group n = 66 Age = 67.86 (5.32) 45.5% female	Yes; Transtheoretical Model, Social Cognitive Theory, Theory of Self-Determination	Structured: Supervised group exercise; 3 weekly 60–90 minute sessions Home-based lifestyle intervention: pedometer use education, collective sessions - goal setting, barriers management, self-efficacy, self-monitoring, social support, motivational interviewing; 5 months Booster phone call initially ever 2 weeks, then monthly	Flemish PA Computerized Questionnaire; pedometer and accelerometer worn for 5 consecutive days Measured at baseline, 11 months, and 23 months	Structured and lifestyle groups significantly increased total PA more than control at 11 months, but not at 23 months. Structured and lifestyle groups did not significantly differ in total PA at 11 or 23 months.
Rejeski, et al., 2009/ United States	N=106 Mean ages not provided PA and counseling intervention n=55 67.3% female Successful aging control group n=51 36% female	No	PA intervention-progressive, individualized exercise training; 3 months Counseling intervention-Weekly group-mediated behavioral counseling sessions; 10 weeks Successful aging: short supervised stretching session, health education in small groups weekly; 26 weeks then monthly	CHAMPS PA questionnaire by interview Measured at baseline, 6 months, 12 months, and 36 months	At 12 (p<.001)and 36 months (p=. 042) participants in PA intervention group continued to engage in more minutes of moderate exercise than those in successful aging group
Resnick, et al., 2008/ United States	N=166 81% women Mean age 73(8.2) Intervention group n =100 Control group n = 66	Yes; Construct of self-efficacy and outcome expectation	PA educational materials, supervised exercise, exercise self-efficacy educational materials, barriers management, overcome barriers, goal setting; sessions 2 times a week for 12 weeks	Yale Physical Activity Survey Measured at baseline and 2 to 4 weeks following completion of intervention	Intervention group spent more time exercising (ES=.28, p=.04); but no significant difference in overall PA from control (p=.63)
Stewart, et al., 2001/ United States	N=164 Age = 74.4 (5.9) 66% female Intervention group n = 81	Yes; Construct of self-efficacy; Transtheoretical model	Face-to-face individual activity planning; barriers management, goal setting, educational PA content, PA diaries, telephone calls form counselor, monthly newsletters,	CHAMPS PA Questionnaire Measured at baseline and 12 months	Intervention group increased estimated caloric expenditure in activities of moderate intensity or greater (F (1,159) = 8.84, p=.003), caloric expenditure in all activities (F

Author/Country	Sample	Use of Theory or Constructs	Intervention Content and Dose	PA Measures and Data Collection Points	Results
	Wait-list control group n = 83 Wait-list control group n = 83		functional fitness assessments, monthly group workshops; 12 months		(1,159)= 9.06, *p*=.003) than control group Intervention group also increased set caloric expenditure in moderate intensity activities by 487 cal/week (p<.001); control changes negligible
Witham, et al., 2012/ United Kingdom	N=107 Gender percentage not reported Exercise n= 53 Age=80.4 (5.8) Control n=54 Age 79.5 (4.9)	No	First phase: Supervised exercise sessions; twice a week for 8 weeks; guided discussions included patient education, written materials, goal setting Second phase: Individually tailored home exercise plan for 16 weeks after supervised sessions; telephone prompting by physiotherapist every 2 weeks for 8 weeks, then monthly for 8 weeks to encourage self-monitoring, problem solving, relapse prevention, and goal setting Usual care given booklet on healthy lifestyle, diet, and exercise	Accelerometer for 7 days at baseline, 8 weeks (at completion of first phase), and 24 weeks (at completion of second phase)	No differences in activity counts at baseline to 8 weeks between exercise and control (*p*=.97), or from baseline to 24 weeks (*p*=.42)

Note. Ages expressed as mean (standard deviation); Age of total number of participants listed unless data only given for groups; PA = physical activity; ES = effect size; CHAMPS = Community healthy activities model program for seniors; statistical significance listed when provided by study