SYSTEMATIC REVIEW AND META-ANALYSIS OF PRIMARY CARE-BASED
PHYSICAL ACTIVITY INTERVENTIONS AMONG OLDER ADULTS

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**SYSTEMATIC REVIEW AND META-ANALYSIS OF PRIMARY CARE-BASED
PHYSICAL ACTIVITY INTERVENTIONS AMONG OLDER ADULTS**

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and hereby certify that, in their opinion, it is worthy of acceptance.

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DEDICATION

This dissertation is dedicated to my family. My husband Ken has done everything he possible could to help me succeed, from helping me with Excel to doing more than his share of chores. He is the most generous person I know. My daughters, Caitlin, Emily, Rachel, and Becca have all helped in big and small ways from proof reading papers to keeping me hydrated. Mostly, they all believed in me so much that even when I wanted to, quitting was never an option.

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SYSTEMATIC REVIEW AND META-ANALYSIS OF PRIMARY CARE-BASED PHYSICAL ACTIVITY INTERVENTIONS AMONG OLDER ADULTS

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ABSTRACT

Background. Most healthcare providers agree that increasing physical activity (PA) in older adults is beneficial but providing effective interventions can be difficult. The purpose of this research is to determine the effectiveness of primary care interventions to increase PA levels in older adults and to analyze which interventions are most effective.

Methods. A comprehensive search was conducted to find studies that tested interventions delivered in primary care to improve levels of physical activity in adults ≥ 65 or with a mean age of ≥ 70 . Standardized mean difference effect size was calculated related to changes in physical activity levels. Moderator analysis was performed to explore the relationship between participant characteristics, interventions, and interventionists, and effect size.

Results. Overall mean effect size 0.27 (95% CI 0.15-0.39, $p = 0.000$) was calculated for 25 two-group comparisons involving 4,685 total participants. Mean age of participants was 75.08. Most involved counseling by the primary provider or different healthcare providers. Counseling was provided in person or via the phone. The use of physical or occupational therapists, number of counseling sessions and an exercise referral were significant moderators. There was little evidence to support counseling over exercise referrals. The use of theory and use of a pedometer did not modify the effect size.

Conclusion. PA interventions delivered in primary care are effective. PA interventions can be effectively delivered by other healthcare providers working with the primary provider. Many different behavior change strategies may be used to promote PA. More research is needed to explore interventions to promote long term changes in PA levels as well as interventions for adults >80 years old and older adults that are members of minority groups.

CHAPTER 1

INTRODUCTION

We have within our tool kits, an effective and economical prevention and treatment modality that can prevent cancers and chronic diseases, modify the trajectory of chronic diseases, and preserve cognition and mobility in older adults. Physical activity (PA) offers these benefits and more for the older adult patient. Unfortunately, few older adults consider PA a vital part of their healthcare regimen and others have the mistaken belief that they are already engaging in sufficient activity (Justin et al., 2013; Biedenweg, et al., 2017). Only 16.3% of adults 65-75 meet the recommended guidelines for PA and an even smaller number, only 9.9% of adults 75 and older meet the guidelines (CDC, 2018). The American College of Sports Medicine (ACSM) along with the American Medical Association launched the Exercise is Medicine® (EIM) campaign in 2007 to promote the inclusion of physical activity promotion and assessment in health care (ACSM, 2018). This dissertation is a systematic review and meta-analysis to examine the effects of interventions to increase physical activity in older adults delivered in primary care. Moderator analysis examined the specific types of interventions, their delivery method, and their relationship to levels of physical activity to guide providers in the delivery of physical activity recommendations.

Physical activity is defined as any skeletal movement that produces increased energy expenditure and can include planned exercise as well as movement throughout the day (World Health Organization, 2018). Activity should be at a moderate or greater intensity level and utilize all major muscle groups. Guidelines per the Center for Disease Control are 150 minutes of moderate intensity activity or 75 minutes of vigorous intensity activity per week (U.S. Department of Health and Human Services, 2018). Physical activity that is performed for the

purpose of physical fitness (exercise) is considered in physical activity levels as well as physical activity that is attained through daily activities (Dasso, 2018).

PA research has demonstrated that even small amounts of PA can have positive effects on the health of older adults (Marques et al., 2019). Low to moderate intensity PA is associated with reduced risk of chronic disease including cancer, Parkinson's disease, hip or femoral fracture and Alzheimer's disease in men and hypertension, diabetes, chronic lung disease, stomach or duodenal ulcer, Parkinson's disease and hip or femoral fracture in women (Marques et al., 2019). These positive disease prevention benefits were seen even in those who participated in only one session of PA per week (Marques et al., 2019). Other benefits of PA include a lower risk of falls (Batcir and Melzer, 2018; Harvey et al., 2018), lower mortality and fewer hospitalizations (Ramos et al., 2019). A meta-analysis involving 46,602 participants found decreased cancer mortality in breast cancer regardless of whether the PA was pre or post diagnosis (Zhong et al., 2014). Older adults who participate in PA regardless of the intensity are better able to preserve their cognitive function (Reis et al., 2019).

While healthcare providers are generally aware of the recommendations, they may find themselves at a loss as to how to motivate patient to increase activity. Healthcare providers face many barriers to providing PA interventions including time constraints, feelings that they do not have enough knowledge to recommend PA and the belief that attempts at intervening are futile (Malan et al., 2015; Mathew et al., 2017). Yet, older adults do respond positively to their provider's advice to increase their PA (Balde et al., 2003; Blair et al., 2012; Navarro et al., 2007). Additionally, the primary care provider has the advantage of seeing their patients an average of 5.5 times per year providing opportunities to reinforce their recommendations (CDC, 2018).

This dissertation explores the role of the primary care provider in providing PA interventions to older adults. Chapter 2 is a published manuscript entitled *Practical Implications for Providing Physical Activity Counseling for the Older Adult: An Integrative Review* exploring the topic of PA counseling in primary care. Chapter 3 describes the methodology of the systematic review and meta-analysis conducted for this dissertation research. Chapter 4 is the manuscript-style report of study findings. Chapter 5 summarizes the implications for physical activity interventions in primary care based on the systematic review and meta-analysis findings.

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CHAPTER 2

PRACTICAL IMPLICATION FOR PROVIDING PHYSICAL ACTIVITY COUNSELING

FOR THE OLDER ADULT Otmanowski, Jennifer A. RN, MSN, CNE (Doctoral Candidate)¹; Chase, Jo-Ana D. PhD, APRN-BC (Assistant Professor).¹ Practical implications for providing physical activity counseling for the older adult, *Journal of the American Association of Nurse Practitioners*: July 2020 - Volume 32 - Issue 7 - p 511-519 doi: 10.1097/JXX.0000000000000483

Research by the American College of Sports Medicine demonstrated that 60% of patients stated that they would be more likely to begin exercising if advised to exercise by their healthcare provider (Blair, Sallus, Huber & Archer, 2012). While most clinicians recognize the importance of recommending physical activity (PA) to their older adult patients, they struggle with barriers such as time constraints, lack of training and lack of confidence in the effectiveness of their interventions (Hébert, Caughy, & Shuvall, 2012; Walsh, Swangard, Davis, McPhee, 1999). Nurse Practitioners (NPs) have the potential to become key providers of PA counseling. NPs see a high volume of patients, an estimated 1.02 billion patients a year and so can have a wide impact (Knowles, 2017). Nurses are members of a trusted profession and so their interventions may be more likely to be accepted by patients (Brenen, 2018). The purpose of this review is to examine PA counseling intervention research among adults age 65 and older and to identify best practices for clinical practice.

The population of adults age 65 and older is rapidly growing in the United States and is the least active of any age group (Watson et al., 2016). The next decade will see the generation termed the Baby Boomers reach their late 70s and 80s. PA declines as people age, with the annual decline accelerating with increasing age (Bachman et al., 2014; Thompson et al., 2014).

Globally, 5.3 million deaths per year are associated with physical inactivity (Li et al., 2012).

Physical inactivity in the older adult leads to loss of muscle mass, declines in strength and endurance and problems with maintaining balance which can contribute to functional decline, loss of independence, and subsequent nursing home placement (Rist, Nguyen, Whitmer & Glymour, 2016).

PA is associated with a reduced risk of stroke, cardiovascular disease, breast and colon cancers, hypertension, type 2 diabetes, Parkinson's disease and dementia and has positive effects on lipid levels and glycemic control (Guure, Ibrahim, Adam & Said, 2017; Mosen et al., 2017; Ou, Chen, Shih, & Tarng; Kyu et al., 2016). Additionally, PA can reduce the rate of falls and improve cognition in the older adult (Aoyama, Suzuki, Kuzuya, 2015; Langlois, 2012). Some of the complaints for which patients visit their providers can be moderated by PA. For example, increased PA is associated with almost immediate positive changes in sleep quality (Kredlow et al., 2015). Additionally, PA is associated with lower rates of depression, improved cognition, and higher quality of life (Paulo et al., 2016; Langlois et al., 2012). Consequently, PA is gaining ground as a global priority for the development of public health policies (World Health Organization, 2013).

To reap the benefits of PA, individuals can participate in any movement generated by skeletal muscles that utilizes energy (World Health Organization, 2018). The 2018 PA recommendations for older adults from the United States Department of Health and Human Services (USDHHS, 2018) are 150 minutes to 300 minutes of moderate aerobic activity a week or 75 to 100 minutes of vigorous aerobic activity with at least two days that include a muscle-strengthening activity. Aerobic activities consist of activities where participants move their large muscles in rhythmic method for an extended amount of time (World Health Organization, 2010).

Examples of aerobic activities include walking, running, biking, swimming, dancing, or aerobic exercise classes. Additional recommendations for the older adults include balance training as well as aerobic and muscle training activities. The level of effort should be determined by the older adult's fitness level and participants can improve physical fitness by gradually increasing PA intensity and duration (Dasso, 2018). Older adults who cannot attain the 150 minutes per week guidelines due to chronic conditions should strive to be as active as possible (USDHHS, 2018). Unfortunately, despite the health benefits of PA, the proportion of adults over age 75 sufficiently active per the guidelines is only 35-44% (USDHHS, 2017).

Many studies have attempted to increase PA in older adults with PA counseling interventions. PA counseling is defined as offering advice or guidance in a verbal or written form to encourage someone to increase PA. PA counseling can be in-person or by phone, which may help overcome the issue of time constraints, the primary barrier for physicians in initiating a PA prescription program (Patel, Schofield, Kolt & Keog, 2011). PA counseling can be based on a variety of theories such as Bandura's social cognitive theory (Bandura, 1997) and the transtheoretical model (Prochaska, Redding, & Viswanath, 2015).

Exercise prescriptions are sometimes incorporated in PA counseling interventions. These prescriptions are dispensed after evaluating the patient's goals along with their physical condition and comorbidities. A prescription represents a familiar method of communication between a provider and a patient and has been successful in improving PA levels over verbal advice alone (Swinburn, Walter, Arroll, Tilyard & Russel, 1998). The American Medical Association and the American College of Sports Medicine (ACSM) are leading advocates of the exercise prescription. Their Exercise is Medicine® (EIM) program promotes exercise referrals

to increase PA levels and promote health. ACSM has published the *Health Care Providers' Action Guide* (2019) which includes an exercise prescription sample.

Behavior change theories often provide a framework for counseling interventions and have been demonstrated to improve the success of interventions (Chase, 2015). Social cognitive theory (SCT) is one that is used widely to guide PA interventions. One of the major constructs of SCT is self-efficacy. Self-efficacy with regards to PA refers to a person's belief in their ability to perform exercises or walk outdoors. Self-efficacy can be increased through vicarious reinforcement or modeling, verbal persuasion, managing physiological arousal and enactive mastery (experiencing success; Bandura, 1997). Another behavior change theory is self-regulation theory which involves the process of regulating behavior by moving toward, or occasionally away from goals. Individuals use feedback and self-evaluation to self-correct as they move toward their goal (Kanfer & Kanfer, 1991). Like SCT, the transtheoretical model of change has also been used extensively in PA research. In this model, the healthcare provider identifies the patient's stage of change before initiating appropriate interventions (Prochaska, Redding & Viswanath, 2015).

Recent reviews and meta-analyses have found that interventions to increase PA in older adult are effective. These studies did not focus on PA counseling interventions specific to the oldest old population (Chase, 2015; Olanrewaju, Kelly, Cowan, Brayne, & Lafortune, 2016). A recent systematic review on health coaching captured studies with participants ≥ 60 years old resulting in a mean age of 60-79 (Oliveira et al., 2017). Additionally, the last 10 years have seen an explosion in research related to PA interventions with the number of articles written about PA in primary care doubling between 2012 and 2004, necessitating this synthesis of the PA counseling research generated in the past ten years (Lion et al., 2018). This present review aims

to summarize the recent body of PA counseling and exercise prescription literature among adults ≥ 65 years old (Center for Medicare and Medicaid Services, 2020). This review proposes to answer the following questions: 1) which types and combinations of PA counseling interventions are efficacious in increasing time spent in PA in the older adult? 2) which behavioral theories support counseling interventions that result in increased time spent in PA?

Method

This review utilized the Preferred Reporting Items for Systematic and Meta-Analysis (PRISMA) guidelines and the search procedure as outlined in the PRISMA diagram (Moher, Liberati, Tetzlaff, & Altman, 2009) in Figure 1. Databases utilized for this search include CINAHL, PsycINFO, PubMed, Scopus and SPORTDiscus along with a review of bibliographies of retrieved articles. The search was completed in January of 2020. The following is an example of the search utilized in PubMed: exercise OR physical activity AND counselling OR counseling OR counsel AND older adult. To capture an older population, the search was restricted to adults ≥ 65 years old (Center for Medicare and Medicaid Services, 2020). Counseling was defined as a process where a patient learns how to increase their PA and is assisted in addressing barriers to PA by a professional competent in relevant psychological skills. This process may also include goal setting and assessments of readiness to change. Counseling interventions can be delivered in many different modalities and by different interventionists. Eligible studies described PA counseling interventions, which may include exercise prescriptions, in-person counseling, counseling by trained peer leaders, and counseling conducted by phone calls in the generally healthy population. to focus on the average older adult, articles that included participants diagnosed with a specific disease process were excluded. Only peer-reviewed, full-text articles were included, and dates were restricted to the past 10 years to

capture the recent growth in PA literature. Articles that were written in languages other than English were excluded as this author does not read any other languages.

A total of 465 articles were screened for eligibility by reviewing the title and abstract (Figure 1). Twelve articles were included with an outcome measure of PA participation. Two articles meeting the inclusion criteria were obtained from CINAHL, three articles from PsycINFO, one article from Scopus, three articles from PubMed, and none from SportDiscus. An ancestry search resulted in three additional studies. Information extracted from eligible studies included study design, sample size, age of participants, outcome measures, type of interventions, frequency of interventions, provider of intervention, length of follow up, outcome measures, and theoretical frameworks. Study details can be found in Table 1.

Study quality was assessed using the Physiotherapy Evidence Database (PEDro) scale (Refer to Table 2; Verhagen et al., 1998). The PEDro scale evaluates methodological quality of trials. Criteria related to external and internal validity and the presence of sufficient statistical reporting for inferences are used to assess the methodological quality. The PEDro scale has been found to be a valid instrument for determining the quality of clinical trials (de Morton, 2009, Maher, Sherrington, Herbert, Moseley & Elkins, 2003).

Findings

Study Characteristics

In keeping with the global nature of the problem of physical inactivity, the 12 studies reviewed for this paper were representative of several different countries. The Netherlands, France, New Zealand, Sweden, Romania, Scotland, United Kingdom and Finland each contributed one study and four studies were from the United States. All the studies reviewed for

this paper are randomized controlled trials with two of the studies using cluster or stratified randomization (Kerr et al., 2018; Bickmore et al., 2013). All studies reported an outcome measure of time spent in PA although in some of the studies, PA was not the primary outcome. In two of the studies the primary outcome was reducing frailty (Barreto, 2018; de Vries, 2013), in one study the primary outcome was fall prevention (Arkkukangas, Söderlund, Eriksson, & Johansson, 2019) and one of the studies had multiple health outcomes (Robare, 2011). The participants represented in our synthesis are significantly older than previous syntheses, with mean ages range from 71.6 to 85.3.

The PEDro scores ranged from six to eight (Refer to Table 2.2). Intention to treat was carried out in eight out of the 12 studies. Random allocation was included in each of the twelve studies. In all but two of the studies, the treatment and control group had similar characteristics at baseline such as PA levels, age, and education. For all groups of participants represented, at least one between-group statistic was reported. Six of the studies utilized objective measures of PA outcomes, such as accelerometer and pedometer (Barreto et al., 2018, Kerr et al., 2018, Kolt et al., 2012, McMurdo et al., 2010, Mutrie et al., 2012 & Thompson et al., 2014).

Theories

Four different behavioral theories were utilized including transtheoretical model of change, social cognitive theory, social learning theory, and self-regulation theory. Social cognitive theory (SCT) with a specific focus on self-efficacy was used most and has historically been a prevalent framework for PA research. Four studies in this review used SCT to inform their counseling interventions (Kerr et al., 2018; Mutrie et al., 2012; Rasinaho et al., 2011). The studies differ in their adherence to theory constructs. In their use of peer counselors, Kerr et al. (2018) were able to provide vicarious experience or self-modeling, important constructs in SCT.

Additionally, they utilized verbal persuasion and performance outcomes or feedback. Rasinaho et al. (2011) focused their counseling strategies on reducing and overcoming barriers to increasing time spent in PA, techniques that are not specific to SCT.

In addition to SCT, Rasinaho et al. (2011) used the transtheoretical model of change. Rasinaho et al. (2011) and Arkkukangas et al. (2019) identified their participant's state of change through a brief questionnaire and used the information to guide their counseling approach. Conversely, Herghelegui et al. (2017) assessed for readiness to change, but did not describe how those delivering the counseling incorporated the identified stage of change.

In McMurdo et al. (2010), researchers used self-regulation theory along with pedometers to increase PA in sedentary older women. A walking target was set for the first month that was 20% above the participant's baseline. Action plans were created along with plans to address barriers to PA. A brief education session focused on motivation for walking along with goal setting, self-monitoring, and feedback. Four other studies in this review did not identify a theoretical framework (Barreto et al., 2018; Bickmore, et al., 2013; Kolt et al., 2012; Thompson et al., 2014).

Interventions

In all the studies, an intervention was considered successful if time spent in PA increased from baseline or if time spent in PA differed from the control group. In all but one study, the counseling was provided verbally, and the initial counseling was in person. The one study that did not rely on verbal in-person advice used an automated health coach accessed via a tablet (Bickmore et al., 2013). A variety of other interventions were utilized to supplement the counseling, including pedometers, phone calls, and motivational interviewing, a counseling style

focused on resolving the ambivalence that keeps individuals from achieving their goals.

Pedometers provide feedback to the participant, as well as an objective measure of PA. Phone calls were used after the initial in-person counseling to provide continued support.

Short Term vs Long Term Results. Short term PA increases were observed in several studies (Baretto et al., 2018; Bickmore et al., 2013; de Vries, 2012; Herhelegiu et al., 2017; McMurdo, 2010; Mutrie et al., 2012). Successful long-term interventions were more elusive. While some studies showed positive results at the end of the intervention, participants' activity levels reverted to baseline at follow up (Barreto et al., 2018; Bickmore et al., 2013; McMurdo et al., 2010). Two studies demonstrated continued positive results at post intervention follow up at twelve or more months (Rashinaho et al., 2011; Kerr et al., 2018). Both studies utilized social cognitive theory and multiple contacts with the interventionist during the maintenance phase. The Kerr et al. (2018) study involved interventions on an individual level (goal setting, pedometers, and phone counseling) as well as interventions at a community level (group education and peer leaders). The Rashinaho et al. (2011) study involved follow up phone calls every 4 months for 2 years. The most successful interventions for attaining long term results had a structured maintenance phase and relied on behavioral change strategies and theories.

Step Counting. A step counting device was utilized in four of the studies to provide motivation as a supplement to counseling strategies, as well as to record outcomes (Bickmore et al., 2013; Kolt et al., 2012; McMurdo et al., 2010; Thompson et al., 2014). However, in two of the studies, participants did not sustain or maintain step increases with a pedometer without the accompanying counseling support (McMurdo et al., 2010 and Bickmore et al., 2013). These results imply that pedometer alone cannot enact long term behavior change.

Phone calls. Phone calls are a popular method for continuing counseling interventions after initial in person counseling (Kerr et al., 2018; Kolt et al., 2012; McMurdo et al., 2010; Rasinaho et al., 2011). Phone calls can provide motivation and encouragement or help participants overcome barriers. Follow up phone calls can enhance compliance with the PA interventions (Lilienthal, Pignol, Holm, & Vogeltanz-Holm, 2014). A recorded call from the nurse in the office, NP, or the physician can also be a money- and time-saving strategy (Mutrie et al., 2012).

Interventionists. Studies were heterogeneous regarding the interventionist. Only one study examined an exercise prescription provided by a physician (Kolt et al., 2012). Other interventionists included nurses, physiotherapist, geriatricians, peer leaders, physical therapists, PA instructors, health counselors, and an automated exercise coach. Kerr et al. (2018) is unique among the studies as the only one that uses trained peer leaders to provide the primary intervention.

Counseling Strategies. Older participants can be strongly motivated by the desire to help manage chronic conditions and maintain an active lifestyle, yet at the same time chronic conditions can limit participation (Newson & Kemps, 2007). Since older adults do have many barriers to participating in PA, two studies included strategies for reducing barriers in the counseling sessions (Herghelegiu et al., 2017; Mutie et al., 2012). Herghelegui et al. (2017) used a health risk assessment tool to identify the participant's barriers to PA prior to initiating interventions. The ability of the counselor to alleviate concerns and provide reassurance and encouragement is a vital role when working with the older adult. Bardach and Schoenberg (2018) were able to demonstrate improvements in PA levels by providing information to the participants about improvements in their health status. The researchers emphasized

improvements in lab values and progress towards weight loss goals to motivate the participants. Goal setting was a strategy used in several studies (de Vries et al., 2016; Kolt et al., 2012; Robare et al., 2011)

Implications

The research supporting the positive effects of increasing PA in the older adult population is extensive. While the most intense interventions generally have greater success, NPs should not be discouraged from beginning to incorporate PA interventions into their practices (Conn, Valentine, & Cooper, 2002). Our findings suggest that PA counseling is an important strategy for increasing PA behavior in this vulnerable population. This review expands upon previous work by examining studies aimed at maximizing the effect of PA counseling interventions in the oldest old population.

The Health Provider's Action Guide (2019) from The American College of Sports Medicine provides practical advice for the NP wishing to incorporate PA counseling into office visits. The guide provides educational brochures for the office, a tool for assessing and recording PA levels, and sample exercise prescriptions. The guide also makes recommendations for patients with special needs and chronic conditions, as well as how to refer to exercise professionals (Refer to Table 3). Healthcare providers should prescribe a low intensity level and short duration of PA at the onset for older adults that are highly deconditioned (Lee et al., 2017). Before progressing to aerobic training, older adults with frailty indicators, such as low energy, poor grip strength, slow walking speed, or unintentional weight loss (Xue, 2011), should participate in exercises that build muscle strength and balance. The first step for the NP is to assess the patient's current health and activity level. The American College of Sports Professionals offers a preparticipation screening tool (Refer to Table 3). The National Institute

on Aging (2018) and the American College of Sports Medicine (2019) recommend the use of exercise prescriptions as a practical and economical intervention to providers to use in combination with counseling to promote PA. While older adults are responsive to verbal encouragement to increase PA, they prefer the addition of written instructions or a prescription (Pfeiffer, Clay & Conaster, 2001). Writing an exercise prescription in an economic and effective way to incorporate PA interventions into practice. Exercise prescriptions should specify exercise frequency, intensity, duration, modality, and progression (Lee, Jackson & Richardson, 2017). Helping the patient to set a goal and including it on the prescription can promote success. Sample exercise prescriptions can be found in the article by Lee, Jackson, and Richardson (2017) (Refer to Table 3). Using a behavior change theory or technique is a good strategy for tailoring counseling interventions. For example, counseling based on social cognitive theory has been shown to be an effective strategy, at least in the short term (Herghelegiu et al., 2017; Kerr et al., 2018, Mutrie et al., 2012). To tailor PA interventions, NPs may consider assessing patients' self-efficacy, or perceived confidence to engage in PA behaviors. PA counseling strategies could target various contributors to self-efficacy, such as identifying ways to improve performance mastery and providing verbal encouragement (Bandura, 1997). Additionally, utilizing the transtheoretical theory of change to assess a patient's readiness for change can help the NP deliver the support the patient needs at each stage of behavior transformation (Herhelegiu et al., 2017). A patient in the precontemplation stage may benefit from discussion of the health benefits of exercise, while a patient in the contemplation stage may benefit from a discussion of the pros and cons of exercise (American College of Sports Medicine, 2019). A brochure about PA for older adult can be downloaded from National Institute on Aging (Refer to Table 3). Older adults may have low self-efficacy for exercise, so starting with something familiar such as

walking may help increase their success. Additionally, verbal encouragement from the provider can help build the patient's self-efficacy. Follow up phone calls can be made by the NP or the office staff to provide support and encouragement. Successful interventions contain multiple opportunities for reinforcement of the older adult's efforts at increasing PA (Herhelegui et al., 2017).

Incorporating other disciplines as PA counselors reduces the burden on physicians, NPs, and physician assistants who may have time constraints during office visits. For example, physical therapists or kinesiologists are specially trained in PA counseling (Shirley, Van der Ploeg, & Bauman, 2010). Barreto et al. (2018) and Kerr et al. (2018) demonstrated that it is possible to train other personnel or peer leaders to provide PA counseling. A multidisciplinary approach could be utilized where the primary provider leverages their credibility with the patient to make referrals to other providers of PA counseling. If the patient is very deconditioned, functionally limited, or has chronic conditions, they may need more guidance. The American College of Sports Medicine suggests enlisting the help of office staff to generate a list of qualified exercise professionals and offers tips on how to identify qualified individuals (Refer to Table 3). Community senior centers may have supervised exercise classes to which older adults may be referred.

While the risk of injury from participation in PA by the older adult may be a concern for the provider, the benefits of participation in PA outweighs the small risk of injury to the older adult (Stathokostas, Theou, Little, Vandervoort & Raina, 2013). The older adult can experience fears related to falling, over exerting, or sustaining injury. In addition to emphasizing the health benefits of PA, counseling should also address patient's fears surrounding increasing their activity level (Baert et al., 2011). NPs may allay patient concerns about the risk of injury from

participation in PA by discussing safety strategies. An older adult who is experiencing falls may need a referral to physical therapy for balance training prior to starting a new exercise regimen (Lee, 2017). NPs may also share CDC brochures on fall prevention strategies and educate the older client that PA may reduce fall risk (CDC, 2019; Cowper et al., 2017).

Several methodological limitations were noted among studies included in this review. For example, racial/ethnic diversity and certain age groups were not well-represented. Individuals from racial/ethnic minority groups are less likely to participate in healthy exercise and dietary behaviors than Caucasians (August & Sorkin, 2011). Yet increasing PA in these individuals is essential. Obesity rates in African American women, for example, are increasing. Obesity combined with low levels of PA contributes to high rates of heart disease and diabetes (Bland & Sharma, 2017). Additionally, the old-old (85-94 years) and the oldest old (95+) are not well represented in PA research. Yet, frailty, a condition modifiable by PA, has been shown to be a predictor for nursing home placement (Kojima, 2018). The need for further research regarding how to encourage older adults from diverse backgrounds and of advanced age cannot be underestimated. Additionally, research is needed to demonstrate long term compliance with PA, thus further supporting the benefits of providing PA interventions.

Consistent use of objective measures to determine levels of PA, as well as larger sample sizes,, are needed to better establish counseling effectiveness. The collection of accurate PA outcomes is vital for reporting and analyzing data across studies. Social desirability bias can cause participants to choose responses that they believe are more socially acceptable and can influence results (Sallis & Saelens, 2000). Poor recall due to memory impairments in some older adult can further impact the use of self-report in PA research (Sallis & Saelens, 2000).

Further research regarding the healthcare cost savings related to chronic disease prevention due to greater PA could support incentives for providing PA interventions in primary care. PA counseling interventions have been associated with not only an increase in PA behavior, but also a decrease in falls with a cost that is only a small fraction of an individual's health care costs, about 6% (Cowper et al., 2017). Participants who received the Coach2Move intervention reached their outcomes for physical therapy and were discharged after significantly fewer visits than the control group, a significant savings in health care dollars (de Vries et al., 2016).

Limitations

Limitations of this review include a lack of adequate studies utilizing a variety of disciplines, including physicians, nurses, physical therapists and health counselors, as well as studies to determine the minimal amount of counseling encounters needed to improve and maintain PA levels. This current review was limited to only five data bases; CINAHL, PsycINFO, PubMed, SPORTDiscus, and Scopus. Inclusion of more studies involving racially/ethnically diverse participants and the older old adult would be beneficial for identifying interventions for these special populations. The use of objective measures in PA research is important since most adults overestimate their activity levels (Sallis & Saelens, 2000). The concern that participants may overestimate their activity on questionnaires at baseline may impact the ability to demonstrate significant increases in PA. Subsequent reviews should include a more extensive data search along with meta-analysis to determine the most effective interventions in primary care to promote PA in adults ≥ 65 .

Conclusion

PA counseling can be an effective way to improve PA levels in older adults. NPs can employ diverse PA counseling strategies in varied clinical settings to improve the PA levels of older patients. The theoretical frameworks that proved efficacious in the reviewed studies were the SCT and transtheoretical theory of change. NPs can incorporate these theories by promoting exercise self-efficacy in their patients and by assessing for stages of change. Resources are available for writing exercise prescriptions. While following up with the patient by phone or in person is recommended. During counseling sessions, it is important to address the patient's fears related to increasing PA, emphasize the benefits of PA, and help the patient set PA goals. Using an interdisciplinary approach, as well as employing alternative techniques to in-person counseling, may improve efficiency. Further research is needed to determine the ideal amount and duration of counseling, and any differences in the older adult's response to counseling based on diverse demographic characteristics.

Table 2.1
Included Articles

Author, Year, Location	Design	Theory	Sample Characteristics	Intervention	Results
Arkkukangas et al., (2019) Sweden	Randomized controlled trial	Transtheoretical Model	Mean age of all groups: 83 Exercise Program n=61 Exercise Program + Motivational Interviewing (MI) n=58 CON n=56	Intervention Duration (Months): 3 Interventionist: Physical Therapists Intervention: Otago Exercise Program (OEP)/OEP with MI	Outcome Measure: Frändin/Grimby Activity Scale No difference between groups in the Frändin/Grimby Activity Scale Within groups, the OEP + MI group significantly improved ($P = .02$) physical performance, fall self- efficacy, activity levels, handgrip strength, adherence to the exercises and decline in fall frequency Differences in the OEP and control groups in the Frändin/Grimby Activity Scale not significant
Barreto et al., (2018) France	Randomized controlled trial	None Noted	Multi domain + Omega 3: mean age: 76, n=417 Omega3: mean age: 76.1, n=422 Multidomain: Mean age, 75.5 n=420 Placebo + usual care: Mean age: 75.6, n=420	Intervention Duration (Months): 36 Interventionist: PA instructor Intervention: Cognitive training, Nutritional and PA counseling, Omega 3 supplements	Outcome Measure: MET- min/week Nutritional and PA counseling increased MET-min/week at 6 months ($p \leq 0.002$) and had limited decline at 2 and 3 year follow up. Omega-3 supplementation did not affect PA levels

Bickmore, et al., (2013) United States	Randomized controlled trial	None Noted	Mean age of all participants: 71.3 Treatment n=132 CON: n=131	Intervention Duration (Months): 12 Interventionist: Embodied Conversational Agent Intervention: Coaching daily for 2 months then intermittently for 10 month maintenance phase	Outcome measure: Steps via pedometer Statistically significant increase at 2 months ($p=.01$) No longer significant at 12 months ($p=.09$)
De Vries, et al., (2015)	Randomized controlled trial	None Noted	Intervention: mean age: 78.4, n=64 CON: mean age: 78.6, n=65	Intervention Duration (Months): 6 Interventionist: Physical Therapists Intervention: Coach2Move. Goal oriented treatment plan fitting barriers of the patient and his or her environment.	Outcome Measure: LASA Physical Activity Questionnaire (LAPAQ). Between group mean differences for PA: 17.9 min per day at 6 months
Herhelegiu et al., (2017) Romania	Randomized controlled trial	Transtheoretical Model	Mean age: Intervention: 74.8, n=100 CON: Mean age: 75, n=100	Intervention Duration (Months): 6 Interventionist: Geriatrician Intervention: Monthly 15-30-minute counseling sessions	Outcome Measures: Mets collected via the International Physical Activity Questionnaire (IPAQ) Intervention: PA increased by a median of 180.0 MET minutes/week (95% confidence interval (CI) 43.4 ± 316.6 , $p = 0.01$) Control group: PA decreased by a median of 346.5 MET minutes/week (95% CI

178.4±514.6, $p < 0.001$) due to seasonal effect

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Kerr et al.,
(2018)
United States

Cluster
randomized
controlled
trial

Social Cognitive
Theory

Intervention:
Mean age:
85.3, n=151
CON: Mean age
81.9, n=156

**Intervention Duration
(Months):** 12
Interventionist: Health
Educators and Peer
Leaders

Intervention:
Individual-goal setting,
Interpersonal- group
walks, and community
level-pedestrian
advocated
improvements
in walkability

Outcome Measure:
Accelerometer reading
Intervention; Significant
increase in PA (about 56 min
of moderate-vigorous PA per
week or 119 min of light PA)
Control group: no change
overall

Kolt et al.,
(2012)
New Zealand

Cluster
randomized
controlled
trial

None Noted

Intervention:
Mean age: 73.9,
n=165
CON: Mean age:
74.3, n=165

**Intervention Duration
(Months):** 3
Interventionist:
Primary Care Physician
Intervention:
Group 1: Green
prescription with
pedometer and
in person prescription
followed by 3 telephone
counseling sessions
provided by activity
counselor
Group 2: Green with
in person prescription
followed by 3 telephone

Group 1 (pedometer-based)
increased leisure
walking by 63.0 min/wk on
average, more than double the
increase in Group 2 (no
pedometer) of 30.9 min/wk at
3-4 months

counseling sessions
provided by activity
counselor- No
pedometer-focus on
setting time goals rather
than step counting

McMurdo,et al., (2010) Scotland	Randomized controlled trial	Self-regulation Theory	Mean age of all groups: 77.3 BCI n=68 BCI + pedometer n=68 CON n= 68	Intervention Duration (Months): 6 Interventionist: Trained study coordinators Intervention: Group1: Behavioral Change Intervention (BCI) Group 2: Behavioral Change Intervention (BCI) plus pedometer Group 3: Usual Care Participants were contacted 1x/week for the first month, then every 2 weeks for 2 months, and then monthly	Outcome Measure: Accelerometer reading Secondary outcome- lower extremity function Results: PA at 3 months was higher in the BCI group than in the control group ($p=.002$) and the pedometer plus group ($p=.04$). No significant difference between BCI group and BCI + pedometer
Mutrie et al., (2012) United Kingdom	Randomized controlled trial	Social Cognitive Theory	Intervention mean age of 71.6 Control mean age of 70.0 n=20 CON n=21	Intervention Duration (Months): 3 Interventionist: Nurse Intervention: Two 30-minute nurse led counseling sessions, use of pedometer	Outcome Measures: Sealed pedometers and an <i>activPAL</i>^{tm} monitor. Results: 12 Weeks: Intervention increased step counts by 2119 steps/day ($p = .001$)

Rasinaho et al., (2011) Finland	Randomized controlled trial	Social Cognitive Theory Transtheoretical Model	Mean age of both groups: 77.6 Intervention: n=318 CON: n=314	Control group: received intervention 12 weeks later Intervention Duration (Months): 24 Interventionist: Physiotherapist Intervention: 1 hour of face to face counseling followed by phone counseling sessions 3 times per year	Outcome Measures: Number of physical activities attended Results: Effect was significant for water aerobics (odds ratio (OR) 2.49, 95% confidence interval CI 1.16– 5.36), and for walking for fitness (OR 1.58, 95% CI 1.05–2.40) Participants followed for 3.5 years
Robare et al., (2011) United States	Randomized controlled trial	Social Learning Theory	Mean age of both groups: 73.9 Lifestyle Plus n = 188 Education and Counseling n = 201	Intervention Duration (Months): 24 Interventionist: Health Counselors Intervention: BECI: Brief education and counseling interventions BECI-plus: Received brief education and counseling intervention plus a physical activity intervention (the Key to Life Exercise Intervention) and, for those with a history of hypertension, a dietary sodium nutritional intervention	Outcome Measures: Modified Activity Questionnaire Results: Levels of PA Declined 1.6 hours per week in the BECI-plus group

Thompson et al., (2014) United States	Randomized controlled trial	None Noted	Mean age: 79.5 Intervention: n=25 CON: n=24	Intervention Duration (Months): 12 Interventionist: Counselor Intervention: Face to face counseling every 2 months, phone counseling weekly and FitBit. Utilized READY, get SET, and GO from the Go4Life materials Control group: FitBit only	Outcome Measures: Activity units (using accelerometer), B/P, Cholesterol, weight, %body fat, glucose, Hgb a1c% Results: No significant differences between intervention group and control group

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Table 2.2

Pedro Scale

PEDro Criteria	Eligibilit y criteria specified	Subjects randomly allocated to groups	Allocation concealed	Groups similar at baseline regarding most important prognostic indicators	Blinding of all subjects	Blinding of all interventio nists	Blinding of all assessors	Measures of at least one key outcome obtained from >85% of subjects allocated to groups	All subjects for whom outcomes were available received assigned condition, or intention- to-treat analysis was performed on at least one key outcome	Results of between- group statistical compariso n reported for at least one key outcome	Reported point measures and measures of variability for at least one key outcome
Arkku- kangas et al. (2019)	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Bickmore et al., (2013)	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Barreto et al., 2018.	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
de Vries et al., 2016	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
Kerr et al., (2008)	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	Yes

Kolt et al., (2012)	Yes	Yes	No	Yes	No	No	Yes	No	No	Yes	Yes
Herhelegi u et al., (2017)	Yes	Yes	No	No	No	Yes	Yes	Yes	No	Yes	Yes
McMurdo, et al., (2010)	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Mutrie et al., 2012)	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Rasinaho et al., 2011	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Robare et al. (2011)	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Thompson et al., (2014)	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Purat et al., (2013)	Yes			Yes					No		

Table 2.3*Resources for Recommending Physical Activity*

American College of Sports Medicine (2019). Health care providers' action guide. Retrieved from https://www.exerciseismedicine.org/assets/page_documents/EIM%20Health%20Care%20Providers%20Action%20Guide%20clickable%20links.pdf
Lee, P.G., Jackson, E.A., Richardson, C.R. (2017). Exercise prescription in older adults. <i>American Academy of Family Physicians</i> , 97(7), 425-432
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Figure 2.1
PRISMA 2009 Flow Diagram

Reference

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CHAPTER 3

RESEARCH PROPOSAL

Specific Aims

Older adults are living longer and with more chronic diseases that threaten their independence and quality of life (United Nations: Department of Economic and Social Affairs, 2019). The impact of physical inactivity can have serious implications for the older adult, leading to loss of muscle mass, decline in strength, endurance and function, increased fall risk, and the inability to live independently (Aoyama, Suzuki, Kuzuya, 2015). According to the World Health Organization, physical inactivity is associated with 3.2 million deaths per year (2008). Negative health outcomes associated with physical inactivity strain the United States healthcare system, with 90% of healthcare dollars going to the management of chronic diseases that can be prevented or treated by physical activity (PA). Participating in recommended levels of PA can prevent four of the costliest diseases: cardiac disease, diabetes, cancer, and Alzheimer's disease (Center for Disease Control (CDC), 2017).

Recently, organizations such as the National Institute on Aging (NIH) (2018) and the American College of Sports Medicine (2019) have focused on the role of primary care in promoting PA. This is consistent with the goals of the National Institute of Aging (NIA) and the goal of the (NIH) to improve the well-being of the older adult, (2018). Primary care providers also recognize the importance of recommending PA to their older adult patients, but struggle with barriers such as time constraints, lack of training, and lack of confidence in the effectiveness of their interventions (Hébert, Caughy, & Shuval, 2012; Walsh, Swangard, Davis, McPhee, 1999). Diverse interventions have been shown to improve PA behavior in the older adult population (Arkkukangas, Söderlund, Eriksson, & Johansson, 2019; Bickmore, et al.,

2013). Interventions include exercise prescriptions, counseling, patient education, exercise classes, and motivational interviewing. There is an urgent need to identify effective interventions for promoting PA in older adults in primary care. However, determining the best approach to promoting PA in older adults in the primary care setting is difficult due to the diversity of interventions and the inconsistency of intervention effects in the PA literature.

This systematic review and meta-analysis synthesizes the existing body of literature related to primary care-based PA interventions among older adults age ≥ 65 . An extensive literature search was conducted to identify studies that determine a PA outcome, are focused on primary care interventions among community dwelling adults ≥ 65 , are written in English, and include data to calculate an effect as well as sample size data. In addition to database searching, ancestry searches of pertinent articles and a thorough search for grey literature was completed. Data was extracted from each article using a detailed codebook. A random-effects model was used to synthesize effects and calculate the standardized mean difference effect size (Cohen's d) between treatment and control groups. Heterogeneity was explored using the Q statistic and I^2 . Moderator analyses, using subgroup analysis and meta-regression, were conducted to determine variations in effects by theoretically relevant variables. The proposed study aims were to:

Specific Aim 1 Determine the overall effect size of primary care-based PA interventions on physical activity in older adults.

Research Question 1: What is the overall effect size for primary care interventions on PA behavior in older adults?

Specific Aim 2 Determine factors that moderate primary care-based PA intervention effects in older adults.

Research question 2: How do intervention effects vary based on study design characteristics (e. g., randomization technique, blinding)?

Research Question 3: How do intervention effects vary based on participant characteristics (e. g., demographics)?

Research Question 4: How do intervention effects vary based on interventions characteristics (e. g., use of theory, intervention duration, and interventionist)?

Findings from this meta-analysis provides information for primary providers in planning PA interventions for their patients. Additionally, meta-analysis findings will inform future primary research in PA interventions in the older adult population.

Significance

Effects of Inactivity on the Older Adult

The population of adults age 65 and older is expected to double globally, reaching two billion by 2050 and is the least active of any age group (Bauman et al., 2016; Watson et al., 2016). Older adults are a vulnerable population with 85% living with at least one chronic condition and at least 60% living with two or more chronic conditions (USDHHS, 2017). Additionally, 7. 7 million older adults live below the poverty line which increases their susceptibility to chronic conditions (US Census Bureau, 2018). Levels of PA decline as people age with less than 60% of older adults engaging in PA (USDHHS, 2020). The current recommendations from the United States Department of Health and Human Services are 150 minutes to 300 minutes of moderate aerobic activity a week or 75 to 100 minutes of vigorous aerobic activity with at least two days that include a muscle strengthening activity (USDHHS,

2018). Only 16.3% of adults 65-75 meet the recommended guidelines for PA and an even smaller number, only 9.9% of adults 75 and older meet the guidelines (CDC, 2018).

Increasing PA levels is vitally important for the older adult, as declines in strength, balance, endurance and an increase in falls are profoundly linked to the older adult's ability to live independently (Aoyama et al., 2015). Physical activity can lower an individual's risk of cardiovascular disease, diabetes and several cancers including breast and colon cancers (Bauman, 2016; Olanrewaju, 2016). Additionally, older adults who are physically active have higher levels of cognition and quality of life than those who are inactive (Langlois, 2012). The economic benefits of increasing levels of PA in older adults were demonstrated with findings from Cowper et al., (2017), who found a medical cost savings of \$1,634 per year for participants who reached their target exercise levels. Ninety percent of healthcare dollars are used for the management of chronic diseases, many of which can be prevented or modified by PA (Center for Disease Control, 2017).

Role of Primary Care Providers in Promoting PA among Older Adults

Many clinicians recognize the importance of recommending PA to their older adult patients and 60% of patients state that they would be more likely to begin exercising if it was recommended by their physician (Blair et al., 2012). However, providers encounter many barriers to providing PA counseling including time constraints and lack of knowledge regarding efficacious interventions. Adults over 75 visit their physician an average of 5.5 times per year, advantageously positioning physicians and other primary care providers to recommend and promote PA to older adults (CDC, 2018).

Diversity of Interventions for Increasing PA among Older Adults

Several primary care-based PA interventions such as motivational interviewing, follow up phone calls, and exercise prescriptions have been demonstrated to be effective in the short term (Arkkukangas et al., 2019, Kolt et al., 2012; Herghelegiu, 2012). Armit et al. (2009) compared brief physician counseling to more extensive interventions including pedometer and follow up calls and found no significant difference between the groups. Märki et al. (2006) were able to improve time spent in PA with only a brief physician counseling session. Two studies using nurses as interventionists have demonstrated increases in PA behavior (Mutrie et al., 2012; Dubbert, et al., 2008). Other intervention studies have demonstrated no significant changes in the treatment group and even declines in PA behavior (Robare et al., 2011; Thompson et al., 2014). In other studies, women benefited from the intervention more than men (Petrella et al., 2010). These studies demonstrate the inconsistency in research results that make it difficult to determine the type and delivery of effective PA interventions.

Meta-analysis Research and Primary Care-Based PA Interventions among Older Adults

Recent meta-analyses have found PA interventions for older adults to be effective, but these prior meta-analyses were not focused on interventions delivered in primary care or those delivered to the oldest older adults (Olanrewaju et al., 2016; Chase, 2015). Another recent meta-analysis on PA intervention for older adults focused on long term interventions and their effect of fall rates and physical functioning, but did not analyze a PA outcome or perform moderator analysis of PA interventions (García-Hermoso et al., 2020). A 2014 systematic review of primary care-based interventions included only six studies and found significant results ($p \leq 0.007$) in only one study, leaving practitioners wondering about the value of adding PA interventions into their practice (Stevens et al., 2014). An integrative review by Neidrick, Fick, and Loeb (2012)

examined eleven studies of primary care-based interventions and found the interventions to be efficacious at least in the short term, but the authors did not complete a meta-analysis.

While most reviews on PA interventions have included community-based interventions, this systematic review and meta-analysis is unique in that it focuses on primary care-based PA interventions and seeks to support an underutilized resource for increasing PA in older adults, primary care. Additionally, the last 10 years have seen an explosion in research related to PA interventions with the number of articles written about primary care-based PA interventions doubling between 2012 and 2014 (Lion et al., 2018). Furthermore, interventionists in primary care represent a wide range of disciplines. The proposed study would add to the body of knowledge of how providers can incorporate PA interventions efficiently into their practices utilizing an interdisciplinary team.

Evaluating the effectiveness of primary care interventions to increase PA among older adults directly addresses the Healthy 2020 mission to “measure the impact of health interventions,” and “improve practices that are driven by the best available evidence,” as well as the goal of improving health at all stages of life (USDHHS, 2020). This meta-analysis summarizes the body of primary care-based PA interventions among adults ≥ 65 years old to determine efficacious interventions to be utilized in primary care. Quantitatively synthesizing data across many studies produced an overall effect size of primary care-based interventions to increase PA. Using moderator analyses to determine factors that impact primary care-based PA intervention effects identified evidence-based PA behavior strategies that primary care providers can employ to make efficient use of their time. For example, increasing PA in the oldest old adults may require different interventions than the interventions that increase PA in younger adults. The oldest old face different barriers to PA including fear of falling and fear of over doing

(Baert et al., 2011). Additionally, older adults belonging to minorities are less likely to participate in PA (August & Sorkin, 2011; Bland & Sharma, 2017). Finding effective interventions are essential in this group since low levels of PA contribute significantly to chronic conditions in this population (González et al., 2017).

Innovation

A recent article exploring factors that influence PA counseling by physicians note that effective strategies for encouraging PA among different populations and medical conditions is essential (Goldberg et al., 2019). The study also found low rates of PA counseling among primary care providers. Overall, PA counseling rates are declining, and when rates are compared with age groups of patients, rates of counseling declines with advancing age (Goldberg et al., 2019). While research has been done to determine the effectiveness of PA interventions for older adults, these interventions are not being utilized in primary care. Using meta-analysis to combine studies of various sample sizes and patient populations can increase generalizability to a larger population and settle disputes from studies with inconsistent results making the choice of which interventions to use easier for primary care providers (Lee, 2019). This meta-analysis builds on previous work by Chase (2015) to determine effective interventions to increased PA and work by Conn et al. (2008) to determine effective educational interventions to increase PA among chronically ill adults. This meta-analysis focuses on interventions to increase PA in primary care and includes healthy older adults as well as those with chronic diseases. Findings from this work will inform future researchers in PA interventions regarding potentially efficacious interventions for different patient populations. Moderate analysis allows for more specific inferences about intervention type, dose, and duration. Practitioners can use the research to determine how to implement PA interventions into their practices. This meta-analysis is also relevant to physical

therapists, nurses, health coaches, exercise specialists, and anyone who desires to impact PA behavior in their older patients.

Approach

The study aimed to: 1) determine the overall effect size of primary care-based PA interventions on physical activity in older adults; and 2) determine factors that moderate primary care-based PA intervention effects in older adults. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) provided the guideline for this meta-analysis. The PRISMA statement is a 27-item checklist that helps researchers follow a systematic process in meta-analysis research (Moher et al., 2009).

Sampling

Eligible published and unpublished reports : 1) tested an intervention to increase PA; 2) included an outcome measure of PA or exercise behavior (e. g. pedometer, accelerometer readings, survey or questionnaire); 3) used a one-group pre- post-test design or a two-group post-intervention comparison experimental design; 4) included adequate data to calculate and effect size, including outcome and sample size (e. g. mean with measure of variability, t-statistic, p value from t-statistic or success rate; 5) were written in English; 6) included community-dwelling participants age ≥ 65 , with a mean age of participants of ≥ 70); and 7) were based in primary care. Primary care referred to an initial or first point of contact for outpatient, non-specialized care. There were no restrictions on date of publication.

Literature Search

A health science research librarian was consulted to aid in a comprehensive search of library databases. Databases utilized for this search included CINAHL, PsycINFO, PubMed,

Scopus, SPORTDiscus, and Dissertation Abstracts International/Proquest. Google Scholar was also included per suggestion of the librarian. The following is an example of a search utilized in PubMed: “Clinical trial” OR “clinical study” OR “randomized controlled trial” OR “comparative study” OR “meta-analysis” OR synthesis OR review AND exercise OR “physical activity” OR “physical inactivity” OR “physically inactive” OR exercise AND “primary care” AND “older adult” OR geriatric* OR “senior citizens” AND “green prescription” OR “exercise prescription” OR intervention OR interventions. The “view related works” feature in Web of Science was utilized to find additional articles. Additional search avenues included: 1) contact with authors who publish PA literature for unpublished research; 2) bibliography search of applicable studies and review articles; 3) search of content page of relevant journals, including *American Journal of Health Behavior*, *International Journal of Behavioral Nutrition and Physical Activity*, *Journal of Aging and Health*, and *Journal of Aging and Physical Activity*; 4) locating and review unpublished manuscripts by searching the DAI data base for unpublished studies; and 5) reviewing conference programs, including *The Gerontological Society*, *American Society of Aging*, and *International Conference on Active Aging*, for applicable presentation and poster abstracts.

Codebook Development

A codebook was developed based on the primary investigator’s knowledge of the literature and after reviewing a random selection of 15 articles for common outcomes and variables. Types of variables included were related to study design, study quality, participant characteristics, interventions, and outcomes. A comprehensive list of variables was included in the codebook and it was pilot tested on 15 studies and missing characteristics were added. Detailed coding is required to analyze patterns of interventions characteristics that are associated

with increases in PA, as well as characteristics of participants that respond best to specific interventions.

Procedure

Citations from the database search were loaded into Zotero. Other unpublished articles and dissertations were also added to Zotero. Duplicate articles were removed using the duplicate article function in Zotero. Citations were reviewed for inclusion by the principle investigator (PI) by reading the title and abstract. Existing synthesis and meta-analysis works were reviewed by the PI for an ancestry search of bibliography entries. Eligible studies were assigned a study number along with any corresponding articles and coding of the studies was complete. Once the PI had coded all the articles, an experienced and doctorally-prepared second coder coded 20% of the studies, as well as 100% of the outcome data. Outcome data were entered into Comprehensive Meta-analysis Software (CMA) for analysis. Moderator analyses were completed on available variables to determine effect size related to study design, sample, and intervention characteristics.

Data Collection

Each variable was operationally and theoretically defined for the development of the code book to guide the coding procedure. This detailed code book helped ensure intracoder and intercoder reliability. All outcome data was coded by the principal investigator and 20% of the studies and all the outcomes was double-coded by the experienced coder. Any discrepancies in how a variable should be coded was discussed until an agreement had been reached. Examples of characteristics included in the codebook are shown in Table 3.1.

Data Management

As the PI reviewed each study, notes were made using the note function of Zotero. Coding was completed on eligible studies on paper and then duplicate-entered in Excel. Data was then compared and cleaned to ensure accuracy of data entry prior to entering data into CMA (Borenstein, 2005). When questionable data were found, the original studies were reviewed by the PI to resolve the questionable data.

Data Analysis

Analyses were conducted using CMA software developed especially for meta-analysis (Borenstein, 2005). Due to the heterogeneity of the primary care-based PA interventions, a random-effects model was used to account for the sampling error within studies and the true variation of effect sizes between studies (Borenstein et al., 2009). Homogeneity of effects was assessed using heterogeneity statistics, Q and I^2 . The Q statistic tests the null hypothesis that all the studies share a mutual effect size. The I^2 represents the percentage of between study heterogeneity that is not related to chance (Borenstein et al., 2009).

- **Aim 1: Determine the overall effect size of primary care-based PA interventions physical activity in older adults.** The summary effect size of interventions is represented by the standard mean difference (SMD) or Cohen's d . The SMD is the mean difference between the treatment and control group divided by the pooled standard deviation of the participant outcomes. Cohen's d is used to combine a variety of designs and outcome measures when they address the same central question (Cooper, 2017). Study effect sizes will be synthesized using a random-effects model which considers the within-study variance, as well as the between-study variance or the true effect size across studies. Study

weights are allocated to reduce the effect of the two sources of variance (Borenstein et al., 2009). It was not possible to convert the effect size to an original metric, such as minutes of PA per week due to the heterogeneity of outcome measures (Lipsey & Wilson, 2000). Data from pre- post-test designs and two-group designs were analyzed separately.

- **Aim 2: Determine the factors that moderate the effect size of primary care-based PA intervention in older adults.** Moderator analysis was used to determine which interventions are more effective for improving PA levels. The data was analyzed using meta-regression to test the impact of the continuous variables on PA levels and subgroup analysis was used to test the impact of the dichotomous variables (Borenstein et al., 2009).

Anticipated Difficulties

Sampling

Most of the time designated for this project was devoted to the search for eligible studies. It is essential that tremendous effort be committed to the endeavor of finding all possible eligible studies. While attempts were made to locate unpublished studies, some studies may have been missed. Publication bias may have occurred as the result of specific within-study issues that result in outcome bias or issues with the entire study that results in dissemination bias. There is evidence that effect size can influence the likelihood of a study getting published with studies with smaller effect size less likely to be published (Thornton & Peter, 1999). Three methods were utilized to detect and adjust for publication bias. The first method was evaluation of the symmetry of the funnel plot. If there was publication bias, we would expect the funnel plot to have a gap in one corner of the funnel indicating that smaller, less favorable studies are missing (Borenstein, 2019). Another method was the Classic Fail-safe N. This test determines the number of studies with a mean risk ratio of 1.0 which would need to be included in the analysis for the

results to be considered insignificant (Borenstein, 2019). The last method was Egger's regression test which regresses the standard normal deviations by their standard errors on precision. This resulted in a regression intercept that determined the amount and direction of asymmetry of the funnel plot (Borenstein, 2019).

Missing data

Missing data could be the result of missing studies due to publication bias, as discussed above. Missing data may also occur when outcomes are incompletely reported. Authors may selectively report outcomes that are favorable (Hutton, & Williamson, 2000). Studies may also be missing predictors that could be used for moderator analysis (Cooper, 2017). Pigott (2019) notes that predictor variables may be missing because of the way variables are defined in the different disciplines. Patterns were explored as to how missing data impacted the results (Pigott, 2019). Authors were contacted when data for calculating an effect size were missing. If data were not received, the study was removed from the meta-analysis.

Coding

The process of coding multiple studies can introduce the potential problem of coding mistakes. To minimize coding errors, the code book included specific instructions and descriptions of each coded item. To ensure that all necessary variables were included in the code book, the code book was pilot tested on 15 studies and revised throughout the coding process. If a coding issue was identified after studies had been coded, steps were taken to retroactively implement the change in the coding of the previous studies. Additionally, two coders coded the outcome variables. Disagreements between the coders was discussed until a consensus was reached. Another potential coding issue was that authors are not always consistent about how

they report different items. For example, some studies reported mean body weight while others reported mean body mass. When data were missing, attempts were made to reach the researcher to obtain results.

Study Quality

Internal and external validity of eligible studies was assessed using the PEDro scale developed by Physiotherapy Evidence Database (Verhagen et al., 1998). The PEDro scale has been found to be a valid instrument for establishing the methodological quality of clinical trials (de Morton, 2009, Maher et al., 2003). Some of the studies included in the meta-analysis contained methodological issues, such as small sample size and imprecise measures. Other studies have conceptual problems related to operational definitions. Two studies were removed due to methodological issues. While it is necessary to evaluate study quality, it is also important to try not to eliminate studies unnecessarily and to include as much data as possible (Conn & Rantz, 2003). The relationship between study quality indicators and effect sizes was statistically tested using a moderator analysis.

Limitations Related to Primary Study Reporting

Although the PI had the assistance of a health science librarian, the selected search criteria may have inadvertently missed relevant studies due to the variability in terms used in PA literature (Glanville, 2019). Additionally, studies involving non-white older adults, as well as the oldest old adults, were limited. Some descriptions of interventions were not detailed enough to allow for accurate moderator analysis. Another limitation of primary studies was related to the lack of inclusion of studies written in languages other than English.

Inclusion of Women and Minorities

Women were well represented. Attempts were made to include studies that included participants of underrepresented racial/ethnic groups. However, studies inconsistently reported racial/ethnic demographics and less physical activity research has been conducted among underrepresented racial/ethnic groups, limiting generalizability of study findings to more diverse groups.

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CHAPTER 4

FINDINGS

SYSTEMATIC REVIEW AND META-ANALYSIS OF PRIMARY CARE-BASED PHYSICAL ACTIVITY INTERVENTIONS AMONG OLDER ADULTS

Manuscript in preparation for Journal of Aging and Physical Activity

Physical inactivity impacts many aspects of the lives of older adults. Lack of physical activity is associated with many diseases such as cancer, diabetes, and hypertension (Center for Disease Control (CDC), 2017). Older adults who are inactive have higher rates of hospitalizations and nursing home placements (Aoyama et al., 2015). Overall, older adults who exercise regularly are more resilient and experience less depression (Avila et al., 2016; Overdof et al., 2016). While most healthcare providers agree that increasing physical activity (PA) in older adults is beneficial, providers face many barriers to delivering interventions including time constraints and the complex medical issues of their patients (Fowles et al., 2018). Additionally, some health care providers believe that efforts to motivate their patient to increase physical activity do not result in any real changes in their patient's behavior (Mathews et al., 2017). Unfortunately, a lack of discussion around PA by the health provider can be misinterpreted by the patient as a lack of the need to make any changes in their lifestyle (Bardach & Schoenberg, 2018).

Despite the challenges associated with motivating older adults to increase their PA, interventions to increase PA can be effective and even a small increase in PA can be beneficial (Marques et al., 2019; CDC, 2018). A meta-analysis by Chase (2015) found that PA interventions for the older adult had an overall mean effect size of 0.18 for two-group post-test comparisons which represents an increase of 73 minutes of PA per week. Compared with younger adults, the average older adult values and respects their health provider's advice,

(Schutzer & Graves, 2004). Older adults visit their physician's office an average of 5.5 times per year, giving primary care providers opportunities to deliver PA interventions (CDC, 2018).

Meta-analysis research offers the opportunity to explore variations in intervention types, doses, and delivery methods (Deeks, Higgins, Altman, 2019). Recent meta-analyses have found PA interventions for older adults to be effective, but these prior meta-analyses were not focused on interventions delivered in primary care (Olanrewaju et al., 2016; Chase, 2015). Meta-analyses of primary care PA interventions by Orrow et al. (2012) and Pavey et al. (2011) were not restricted by age of participant, so did not capture the effects of interventions on the older adult. Another recent meta-analysis on PA intervention for older adults was not restricted to primary care interventions and focused on long term interventions and their effect of fall rates and physical functioning, rather than a PA outcome (García-Hermoso et al., 2020). Orrow et al. (2012) found small-to-medium effects of primary interventions, while a 2014 systematic review of primary care-based interventions found significant results ($p \leq 0.007$) in only one out of six studies, leaving practitioners wondering about the value of adding PA interventions into their practice (Stevens et al., 2014). The present systematic review and meta-analysis integrated primary care-based studies designed to increase PA in the older adult to determine the overall effect of PA interventions, and aimed to identify and resolve divergences within the literature of primary care interventions for increasing PA, as well as highlight areas for further research. This research is guided by the following research questions:

1. What is the overall effect size for primary care interventions on PA behavior in older adults?
2. How do intervention effects vary based on study design characteristics (e. g., randomization technique, blinding)?

3. How do intervention effects vary based on participant characteristics (e. g., demographics)?
4. How do intervention effects vary based on interventions characteristics (e. g., use of theory, intervention duration, and interventionist)?

Methods

This systematic review meta-analysis adheres to reporting guidelines for the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) (Moher et al., 2009).

Inclusion Criteria

Eligible study designs were two-group pre- post-test designs in which control groups received usual care and single group pre-posttest. Two-group designs where one group was compared to another group receiving a different PA intervention, rather than compared to a control group receiving usual care, were treated as pre/post study design analysis. Eligible studies were conducted in a primary care setting. Primary care was defined as a patient's main source of healthcare, providing holistic care, rather than care focused on a specific disease process (World Health Organization, 2019). Only studies written in English were included, but studies were not restricted based on geography. There was no restriction on date of publication. Primary care-based interventions were defined as activities utilized in primary care aimed at increasing the time older adults spend in PA. PA was defined as any skeletal movement that produces increased energy expenditure and can include planned exercise, as well as movement throughout the day (World Health Organization, 2018). Participants were community dwelling older adults ages ≥ 65 or with a mean age of ≥ 70 . Included studies had a PA outcome measured either subjectively or objectively, and studies were not restricted by the length of follow up. Studies were not limited to the number of participants, as long as the study included data to

calculate an effect size (e.g. mean with measure of variability, t-statistic, and p value from t-statistic or success rate).

Search Strategies

A research librarian experienced in meta-analysis procedures assisted with the search strategy for this study. The search strategy included a search of databases including Pubmed, CINAHL, PsycINFO, Scopus, SportDiscus, Dissertation Abstracts International (DAI)/Proquest, and Google Scholar. The “view related works” feature in Web of Science, which, lists the number of shared references from high to low, was utilized to find additional articles (Cooper, 2017). An ancestry searching was completed for relevant articles. Bibliographies of relevant previous systematic reviews were reviewed after locating systematic reviews via Prospero. Researchers who have published work in physical activity and older adults were contacted to inquire about unpublished works. The DAI data base was searched for unpublished studies. Research by Chan and Altman (2005) reviewed 519 trials and found that unreported outcomes were a common occurrence and present in over one third of trials. Relevant journals were hand searched for applicable articles with dates varying due to availability. Conference programs from *The Gerontological Society*, *American Society of Aging*, and the *International Conference of Active Aging* were reviewed for podium or poster presentation fitting the inclusion criteria. Because studies with positive effect sizes are more likely to be published, attempts were made to find unpublished, as well as published literature, to avoid over exaggeration of the effectiveness of interventions (McAuley et al., 2000). Search strategy for Medline consisted of the following, “Clinical trial” OR “clinical study” OR “randomized controlled trial” OR “comparative study” OR “meta-analysis” OR synthesis OR review AND exercise OR “physical activity” OR “physical inactivity” OR “physically inactive” OR exercise AND “primary care” AND “older

adult” OR geriatric* OR “senior citizens” AND “green prescription” OR “exercise prescription”
OR intervention OR interventions.

Coding and Data Extraction

Data were extracted from the eligible studies using a codebook developed by reviewing the literature related to PA interventions. The codebook was tested using 15 eligible articles and necessary adjustments were made. All studies were coded by the principal investigator. To reduce coding errors (Buscemi et al., 2007), a second, experienced, doctorally-prepared coder coded 100% of PA outcome data and 20% of entire studies. The studies included in the 20% were chosen using a random number generator. Both coders met and coding discrepancies were resolved once coding was completed. Adjustments were made to the codebook throughout the coding process and studies coded previously were recoded. Study quality variables such as randomization and intention to treat were collected, as well as participant characteristics and interventions used. Authors were contacted for missing data. After coding on paper, codes were added to excel by the primary investigator and another person, after which the excel sheets were compared using a comparison application. Codes were checked for accuracy prior to data entry.

Risk of Bias

Publication bias was examined using three methods. A funnel plot was used as a visual representation to check for publications bias. Studies with high precision should fall near the edges and those with less precision should spread evenly on both sides of the funnel shape (Borenstein et al., 2009). Additionally, Egger’s regression test which regresses the standard normal deviations by their standard errors on precision and quantifies the amount and direction of symmetry was used (Vevea et al., 2019). Finally, the Classic fail-safe N was used to examine

the number of studies which would need to be included in the analysis for the results to be considered inconsequential (Borenstein et al., 2009).

The PEDro scale, developed by Physiotherapy Evidence Database, was used to assess the internal and external validity of the included studies (Verhagen et al., 1998). The PEDro scale has been found to be a valid instrument for determining the methodological quality of clinical trials (de Morton, 2009; Maher, Sherrington, Herbert, Moseley & Elkins, 2003). Table 4.8 is the results for the PEDro scale for the two-group design studies.

Data Analysis

Data analysis was conducted using Comprehensive Meta-Analysis software (CMA) (Borenstein et al., 2005). A random-effects model was used to synthesize study effects due to the expected heterogeneity of physical activity studies. The random-effects model takes into account the differences of effects within studies, as well as between-study variance. PA interventions studies include participants with a wide mix of characteristics, as well as interventions with a variety of features, making the random effects model particularly useful (Borenstein et al., 2010). The overall effect size (ES) was calculated by calculating the mean of the treatment group minus the mean of the control group and dividing by the pooled standard deviation. To adjust for bias, studies were weighted by the inverse of the variance. The effect sizes for two-group design studies and pre/post design studies were calculated separately using a statistical significance level of $\alpha \leq 0.5\%$. None of the pre/post design studies included the correlational data needed to associate a pre- and post- score, so a moderate correlation of 0.6 was used. Because a correlation is required to use the standard deviation difference to determine the standard deviation within groups, this correlation was estimated (Cooper et al., 2019). For studies that collected data at multiple time points, the most distal collection point was used to calculate effect

sizes to better capture a longer term effect of interventions. When multiple outcomes were given, moderate PA was used for analysis. When more than one outcome measure was collected, the objective measure was used followed by the subjective tool that was most specific for the older adult population. According to Cohen (1988), ES may be described as small (≤ 0.20), medium ($= 0.50$), or large (≥ 0.80). Analysis of potential moderators of the effect size is particularly important in PA intervention research where the interventions often vary between the studies (Conn & Rantz, 2003). Descriptions of the moderators used in this analysis are in Table 4.5.

Heterogeneity of effects were examined using Cochran's Q and I^2 statistics. The Q statistic tests the null hypothesis that all the studies share a mutual effect size and is determined by taking the sum of the weighted squared deviation of each study. I^2 represents the percentage of between-study heterogeneity that is not related to chance and is a measure of inconsistencies across the true effects (Borenstein et al., 2009). Subgroup analysis of potential moderators were completed to determine what study characteristics associated with better outcomes. To maintain rigor, moderator analysis was completed on only the two-group study designs. Meta-regression was used to evaluate the impact of the continuous variables. Analysis of variance (ANOVA) was used to evaluate the impact of the dichotomous variables.

Results

The comprehensive data base search identified 4,123 potential studies. Hand searching of journals, bibliography search, and the "view related works" feature in Web of Science yielded 13 more potential studies. After removal of duplicates, 3,022 studies were screened for inclusion. The flow of study selection is shown in Figure 4.1. The 28 studies selected for inclusion in this meta-analysis are described in Table 4.2. Four of the studies had two comparison groups. A total

of 5,685 participants were included in the effect size calculations, 4,685 in the two-group analysis ($k=25$) and 940 in the pre/post group analysis ($k=11$).

Overall Intervention Effects

The overall mean effect size for the two-group comparison was 0.27 (95% CI 0.15-0.39, $p=0.00$) which represents a small-to-medium effect size of primary care PA interventions on PA behavior. Figure 4.2 shows the forest plot for this analysis. For the two-group comparison, results demonstrated significant heterogeneity: $Q=117.56$ ($P=0.00$) and $I^2 = 80.435$. One study (Tarazone-Santabalbina, 2016) with a large effect size $d=2.83$ (95% CI 2.22-3.44, $p=0.00$) focused on all frail patients and involved a nurse and a physiotherapist who led five sessions per week of 65 minutes of strengthening, endurance, and balance activities that increased patients' overall levels of PA. When this study is removed from the analysis, the effect size is somewhat smaller: $d=0.10$ (95% CI 0.012-0.27, $p=0.00$).

The funnel plot in Figure 4.3 may be indicative of publication bias with individual studies asymmetrically placed about the mean effect size (Borenstein et al., 2009). Egger's regression was not statistically significant ($t=1.6$, $p=0.12$). Classic Fail-safe N suggests 451 studies would be needed to yield an insignificant p value.

Study Design Characteristics

Studies ranged in date of publication from 1999 to 2019. Studies included 25 randomized controlled trials and 3 pre- post-test, single-group studies. In four of the randomized controlled trials, the control group received an alternative intervention, so these studies were analyzed as pre- post-test studies. Five of the studies had a primary outcome of fall prevention (Tarazona-Santabalbina, 2016; Mackenzie & Clemson, 2014; Perula et al., 2012; Campbell et al., 1999).

Studies represented seven different countries: Australia (n=3), Canada (n=3), New Zealand (n=2), Romania (n=1), Spain (n=2), Switzerland (n=1), United Kingdom (7), and the United States of America (n=9). All 28 studies identified a funding source.

Overall, the two-group design studies met most of the PEDro scale criteria (Table 4.8). Intention-to-treat analysis was used in 14 of the comparisons. There was no significant difference in effect size between the studies that used intention-to-treat analysis ($d=0.32$) and those that did not ($d=0.2$) ($p=0.32$). Assessors were blinded in 11 of the comparisons. There was no significant difference in effect size between comparisons with blinded assessors ($d=0.17$) and those without ($d=0.33$) ($p=0.23$). Seven of the comparisons used objective measures of PA. There was no significant difference in effect size between those studies with objective measures ($d=0.17$) and those with subjective measures ($d=0.29$) ($p=0.45$). These results are for two group studies and can be found in Table 4.6.

Participant Characteristics

The mean age of all participants was 75.08 years. Both men and women were well represented with 55.8% of participants female. Many studies did not document race or ethnicity and non-Caucasian groups were not well represented. One study enrolled only participants with heart failure (Witham, et al., 2011); one study enrolled participants with chronic obstructive pulmonary disease (Coultas et al., 2018); and one study enrolled only frail participants (Tarazona-Santabalbina, 2016). Overall, participant's health characteristics were not well documented. Study and participant characteristics for single-group studies are included in Table 4.2. Study and participant characteristics for two-group studies are included in Table 4.3. The

age of the participants and the number of women included were not significant moderators. Continuous moderator analyses are displayed in Table 4.7.

Intervention Characteristics

Intervention characteristics were explored to determine if effects varied based on strategies, duration and interventionist. Intervention characteristics include strategies used by the interventionists as well as the extent of the intervention, such as the length of interventions and the number of sessions. A variety of interventionists were used to deliver the interventions.

Strategies

Results from the moderator analysis for the dichotomous variables are listed in Table 4.6. Barrier management ($k=14$) and problem-solving ($k=10$) were the most common interventions in the 25 comparisons of randomized controlled trials. There was no significant difference in effect between studies that used barrier management ($d=0.36$) and those studies that did not use barrier management ($d=0.23$) ($p=0.35$). Similarly, studies that used problem solving ($d=0.33$) versus studies that did not use problem-solving ($d=0.25$) did not have significantly different effects ($p=0.6$). Other interventions strategies such as goal-setting, feedback, action-planning, decisional balance, education and risk assessment, pedometer, and diary use, did not significantly impact the effect size. Studies using counseling ($d= 0.17$) were less effective, compared with studies that used counseling ($d=0.60$) ($p=0.00$). Studies employing exercise referral initiated in primary care ($d=0.70$) had significantly greater effects compare to those studies that did not use exercise referral ($d=0.18$) ($p=0.00$). Transtheoretical model of change (TTM) was the most used theory ($k=8$), followed by social cognitive theory ($k=5$). TTM had a

positive effect on overall effect size ($d=0.36$); however, there was no significant difference in effects over studies that did not use TTM (0.24) ($p=0.41$).

Intervention Dose

While counseling was not shown to have a positive effect on PA activity, in those studies that did utilize counseling, more counseling sessions were associated with an increased effect size ($B=0.02$, $p=0.01$). Other continuous moderators including the length of the intervention, number of phone calls, and the number of face-to-face interactions were not significant. The mean length of the intervention in days was 329.

Interventionists

PA interventions were provided by a variety of interventionists including physical and occupational therapists, physicians, nurses, exercise trainers, health counselors, volunteers, and peers. Studies that included physical or occupational therapists as interventionists demonstrated greater effects (0.53) than studies without these disciplines' involvement ($d=0.21$) ($p=0.05$). Multiple studies utilizing physician involvement in PA interventions yielded positive effect sizes ($n=16$) ($d=0.21$, $p=0.00$). Studies with positive effect sizes not involving the physician in the primary care office often involved the nurse ($k=9$) and, in some studies, both were involved ($k=6$). Studies utilizing nurse interventionists ($d=0.40$) were not significantly more effective than studies not using nurse interventionists ($d=0.2$) ($p=0.12$).

Discussion

The overall effect size of 0.27 ($p=0.00$) represents a small-to-moderate positive effect for interventions used in primary care to facilitate PA. This effect size is consistent with a previous primary care intervention meta-analysis that found a 0.25 effect size in interventions provide for

adults ages 17-92 (Orrow et al., 2012). Though the effect size was small-to-moderate, small changes in PA can positively impact the health of older adults. The single group pre/post studies had an effect size of 0.14 ($p=0.00$). Marques et al. (2019) found that older adults who participated in even low-to-moderate levels of PA at least one time per week reduced their risk of chronic diseases including diabetes and hypertension. Exercising three times per week for only 15 minutes at time is associated with a lower risk of depression in the older adults (Chang, 2017). Results from this meta-analysis are similar, but slightly larger than effect sizes for intervention to facilitate PA in older adults found by Chase ($d=0.18$) and found by Conn et al. ($d=0.19$) (Chase, 2015; Conn et al., 2011). The slightly larger effect size found in this current meta-analysis may represent a positive effect of the primary care setting for delivering PA interventions.

A variety of delivery methods may be used ranging from in-person sessions to automated phone calls (Dubbert et al., 2008; Morey et al., 2009; Coultas et al., 2018). More counseling sessions are more effective, but these can be provided in person or by phone. Older adults may experience many barriers to participation in PA, so it is not surprising that barrier management can be an effective strategy for increasing PA and was used in 14 out of 25 studies. The positive effects of barrier management and problem-solving techniques did not reach statistical significance in this meta-analysis, which is inconsistent with prior research (Chase, 2015). A systematic review of studies addressing older adult's barriers to PA identified poor health as the most common barrier (Baert et al., 2011). Perhaps more counseling sessions give more opportunities to address and resolve barriers as they arise. Interventions do not need to require an extensive amount of time. Kerse et al. (2005) increased PA in participants ($d=0.245$) by using an exercise prescription which took an average of 7 minutes to deliver.

The use of theory-based interventions did not positively modify PA effect size. Chase (2015) found that the use of theory-based interventions is positively associated with effect sizes, while Conn (2002) found no association. The use of theory was not consistently described in all included articles; thus, it is difficult to say how closely the constructs of each theory were applied. Theories that are more consistently applied may lead to more effective interventions (Mitchie et al., 2013). Future research utilizing theory-based interventions should strive to closely apply the theoretical constructs, as well as describe how the constructs were used in their reports.

Only seven of the included studies used objective measures of PA. While objective measures can be more accurate than subjective measures, pedometers and accelerometer sometimes do not record the variety of functional activities older adults participate in. Additionally, they can be worn incorrectly or not worn consistently. When studies rely on only self-report, accuracy can be decreased due to misinterpretation of the questions, memory impairments of the participant, as well as the effect of the older adult choosing responses that are viewed to be more socially desirable (Banda et al., 2010; Sallis & Saelens, 2000). Future research should include studies with objective measures of PA outcomes.

The use of technology in providing interventions is a growing area of research. The search for this meta-analysis found only two studies utilizing technology to promote PA (Bickmore et al., 2013; Weinstock et al., 2011) meeting the inclusion criteria. There is limited research in the use of technology in older adults to promote PA, especially in adults ≥ 65 . Parker and Ellis (2016) found that text messages were effective in increasing levels of PA in older adults age ≥ 50 over a four-week period. Currently, 53% of adults ≥ 65 in the United States own a smart phone and 73% use the internet (Livingston, 2019). As older adults are using cell phones

and the internet more often, more research will be needed to identify effective interventions utilizing technology. Using technology-based interventions can be efficient and economical. More research is needed analyzing the cost of providing PA interventions to older adults versus the savings in healthcare expenditures when older adults are active.

Primary care-based interventions can be provided by an interdisciplinary team without putting the entire burden on the primary care provider. In a quantitative study of barriers and facilitators for exercise, older adults listed their physician support and encouragement as motivating factors (Costello et al., 2011). Although involvement of the physician did not positively moderate the overall effect size in this meta-analysis, all of the PA interventions delivered in primary care may be viewed by patients as being backed by the provider and thus confounding the effect of the moderator of the physician as the interventionist.

The nurse alone or in conjunction with the physician was the interventionist in many of the studies. Unfortunately, none of the studies reported the educational level of the nurse interventionist. Other interventionists included health counselors, exercise specialists, and volunteers, supporting the finding by Chase (2015) that a variety of personnel can be utilized to deliver interventions. Utilizing ancillary personnel to deliver PA interventions can free up time for the primary care provider.

Physical and occupational therapists, as well as exercise specialists or trainers as interventionists, have the advantage of being able to demonstrate exercise to the older adult and provide recommendations on the different types of exercise, strengthening, balance, and aerobic training that are recommended for the adult population (CDC, 2018). This can help alleviate another barrier that older adults face, lack of knowledge about types of exercise (Baert et al., 2011). In quantitative research by Huffman and Amireault (2020), the authors found that the

older adults value help from trainers and other fitness experts because they gave them confidence that they were doing the exercises correctly. While physical and occupational therapist interventionists in this meta-analysis were more effective, general supervised exercise provided by a variety of interventionists was not associated with an increase in effect size. This fits the assumption that older adults prefer exercise experts to lead them in PA. Older adults with chronic conditions face greater challenges to increasing PA. Studies involving those with chronic conditions had negative or small effect sizes (Coultais et al., 2018; Witham et al., 2011), and results are consistent with prior meta-analysis work (Chase, 2015). More research on the role of physical or occupational therapists in promoting PA in primary care is needed. Furthermore, studies incorporating exercise specialists, exercise trainers, and health coaches are needed to demonstrate the effectiveness of these ancillary personnel for providing PA interventions.

Limitations

Moderator analyses are intended to be exploratory in nature and are useful for generating hypotheses to guide further research (Borenstein et al., 2009). The limitations of this meta-analysis are related to the limited ability to complete moderator analysis due to the number of studies, as well as missing data within studies. Many studies collected very minimal participant data. Some potential moderators, such as objective outcome measurements, peer support, types of exercise recommended, and exercise prescription, were present in numbers too small to use moderator analysis. The primary studies contained limited information about interventions so information about the interventions should be interpreted with caution. Although some studies enrolled participants with diabetes, heart disease, and other conditions, many only reported aggregate data across these groups, limiting the ability to identify effect size within specific

populations. Sufficient information about specific chronic illnesses would have been valuable information for moderator analysis.

Despite attempts to locate all applicable studies published and published, some studies may have been missed. Several studies were located that did not contain the outcome data needed to perform meta-analysis. PA research is needed that explores the unique needs of ethnic and racial minority groups. Further research is also needed to explore the unique needs of ethnic and racial minorities groups. Researchers should strive to enroll more people of color and document characteristics of racial/ethnic diversity, as these groups participate less frequently in health-promoting behaviors compared to non-Hispanic White counterparts (August & Sorkin, 2011). By setting a mean age of ≥ 70 , it was hoped to capture a greater percentage of the oldest old population. This represents a significantly older population than other PA intervention meta-analyses in primary care (Orrow et al., 2012; Pavey et al., 2011). Yet, the mean age of participants was only 75.0. Few of the studies included participants older than 85. There were not enough participants in this older age to detect any differences in response to intervention based on an oldest old population. This study only included studies of community-dwelling participants; thus, results cannot be generalized to vulnerable older adults in facilities. Finally, all meta-analyses should be interpreted based on the quality of the studies that go into the analysis (da Costa & Juni, 2014). Study quality was addressed through adherence to inclusion criteria and analyzing single-group studies separately from two-group studies. Meta-analyses are observational studies and are useful for synthesizing research and providing directions for future research. However, meta-analysis and moderator analysis findings do not establish cause-and-effect relationships between and among variables.

Conclusion

Primary care providers are often a respected information resources for patients and a valuable source of motivation to improve their health. Primary care providers can provide interventions that increase PA levels in their older adult patients, significantly impacting their overall health. Taking a team approach to these interventions can help to manage the extra time required to facilitate effective interventions. While this research demonstrates that promoting PA in primary care for older adults is feasible, the most effective means to achieve this goal continues to be a challenge for researchers. Adding to this challenge is the difficulty with enrolling the more vulnerable older adults ≥ 85 , as well as older adults representative of minority populations.

Table 3.1.*Categories of data collection*

Design	Participant Characteristics	Interventions	Interventionist	Use of Theory
-Allocation to group	-Age	-Automated phone calls	-Physicians	-Social cognitive theory
-PA outcome measure	-Number of comorbidities	-Journaling	-Nurses	-Health belief model
-Pre-, post-test design	-Gender	-Motivational interviewing	Trainers	-Behavioral choice theory
-Experimental design	-Prior PA level	-Exercise prescriptions	-Physical and Occupational Therapists	-Empowerment theory
-Type of control group	-Educational level		-Peer Leaders	-Theory of planned behavior
	-Race/ethnicity			
	-Use of assistive device			

Table 4.1
Included Two-group Studies

Author, Year, Location	Design	Theory	Sample Characteristics	Intervention	Results
Coultas et al., 2018 United States	Randomized controlled trial	Transtheoretical Model Social Cognitive Theory	Mean age of all participants: 70.3 N=205	Intervention Duration (Months): 18 Interventionist: Intervention: Phone Counseling, workbook, pedometer	Outcome Measure: RAPA Results: Greater percentage of participants in the treatment group were persistently active at 18 months
Dolovich et al., 2019 Canada	Randomized controlled trial	None Noted	Tx Mean age: 79.06 Con Mean age: 78.06 N=312	Intervention Duration (Months): 6 Interventionist: Physicians, Trained Community Volunteers Intervention: home visits	Outcome Measure: IPAQ No difference between groups on goal attainment Intervention group did have fewer hospitalizations
Dubbert et al. (2008) United States	Randomized controlled trial	Social Cognitive Theory	Mean age: 71.7 N=224	Intervention Duration (Months): 10 Interventionist: Nurse Intervention: In-person exercise counseling provided by nurse (EXC) vs another health topic provided by a nurse (EDUC)	Outcome Measures: Accelerometer Results: More EXC participants (64% vs 46%) EDUC participants who averaged 30 min/day of moderate or higher intensity physical activity ($p = .03$)

Author, Year, Location	Design	Theory	Sample Characteristics	Intervention	Results
Herghelegiu et al., (2017) Romania	Randomized controlled trial	Transtheoretical Model	Tx Mean age: 74.8, n=100 Con Mean age: 75, N=100	Intervention Duration (Months): 6 Interventionist: Geriatrician Intervention: Monthly 15-30-minute counseling sessions	Outcome Measures: International PA Questionnaire (IPAQ) Intervention: PA increased by a median of 180.0 MET minutes/week (95% confidence interval (CI) 43.4±316.6, $p = 0.01$) Control group: PA decreased by a median of 346.5 MET minutes/week (95% CI 178.4±514.6, $p < 0.001$) due to seasonal effect
Illife et al., 2014 United Kingdom	Randomized controlled trial	None Noted	Mean age: 71 N= 1256	Intervention Duration (Months): 12 Interventionist: Physician, peer Intervention: Falls Management Exercise (FaME) program, home-based exercise Otago Exercise Programme (OEP)	Outcome Measures: CHAMPS Results: FaME arm increased time spent in PA. Both arms had improvements in balance confidence

Author, Year, Location	Design	Theory	Sample Characteristics	Intervention	Results
Kerse et al., 1999 New Zealand	Randomized controlled trial	None Noted	Intervention: Tx Mean age: 72.9 Con Mean Age: 74.2 N= 233	Intervention Duration (Months): 2-3 Interventionist: General Practitioners Intervention: Educational Program	Outcome Measures: Survey Results: Increase of 88 min of PA/2 weeks
Kolt et al., 2007 Australia	Randomized controlled trial	Social Cognitive Theory	Intervention: Tx Mean age: 74.1 Con Mean Age: 74.3 N= 186	Intervention Duration (Months): 6 Interventionist: Physician, counselor Intervention: Telephone counseling, goal setting, rewards	Outcome Measures: Auckland Heart Study PA Results: More participants in the intervention group reached 2.5 hours of PA per week than in the control group
∞ McMurdo, et al., (2010) United Kingdom	Randomized controlled trial	Self-regulation Theory	Mean age of all groups: 77.3 BCI n=68 BCI + pedometer N=68 Con N= 68	Intervention Duration (Months): 6 Interventionist: Trained study coordinators Intervention: Group1: Behavioral Change Intervention (BCI) Group 2: (BCI) plus pedometer Group 3: CON	Outcome Measure: Accelerometer reading Results: PA at 3 months was higher in the BCI group than in the control group ($p=.002$) and the pedometer plus group ($p=.04$). No significant difference between BCI group and BCI + pedometer

Author, Year, Location	Design	Theory	Sample Characteristics	Intervention	Results
Morey et al., 2006 United States	Randomized controlled trial	Social- Cognitive Theory	Tx Mean age: 78.5 Con Mean age: 78.1 N=179	Intervention Duration (Months): 6 Interventionist: Physician and Health Counselor Intervention: Identified stages of Change, Counseling	Outcome Measures: CHAMPS Results: Significant increase in PA
Morey et al., 2009 United States	Randomized controlled trial	Transtheoretical Model of Change and Social Cognitive Theory	Mean age: 77.7 N=398	Intervention Duration (Months): 24 Interventionist: Counselor Intervention: In-person and phone counseling	Outcome Measures: CHAMPS Results: Participants in the intervention group increased their exercise frequency from 15.9 per week to 112.4 per week
Morgan et al., 2019 United Kingdom	Randomized controlled trial	Self- Determination	Mean age: 74.1 N=51	Intervention Duration (Months): Interventionist: Trained community member Intervention: Phone calls, Motivational Interviewing	Outcome Measures: Accelerometer Results:

Author, Year, Location	Design	Theory	Sample Characteristics	Intervention	Results
Mutrie et al., (2012) United Kingdom	Randomized controlled trial	Social Cognitive Theory	Intervention mean age:71.6 Con mean age of 70.0 N=41	Intervention Duration (Months): 3 Interventionist: Nurse Intervention: Two 30-minute nurse led counseling sessions, use of pedometer Control group: received intervention 12 weeks later	Outcome Measures: Sealed pedometers and an <i>activPAL</i> ^{tm} Monitor. Results: 12 Weeks: Intervention increased step counts by 2119 steps/day ($p = .001$)
8 Pérula et al., 2012 Spain	Randomized controlled trial	None Noted	Tx Mean age: 76.30 Con Mean age: 76.48 N=404	Intervention Duration (Months): 12 Interventionist: Nurse, Physician, Physiotherapist Intervention: Counseling, Supervised exercise session, Workbook	Outcome Measures: IPAQ short Results: Tx group: 66.2% increased their PA and 73.6% continued with the exercise program

Author, Year, Location	Design	Theory	Sample Characteristics	Intervention	Results
Sims et al., 1999 United Kingdom	Pre/Post- Test	None Noted	Mean age: 72.3 N= 20	Intervention Duration (Months): 2 Interventionist: Nurse Intervention: Nurse and patient developed and activity schedule and plan	Outcome Measure: Minutes with heart rate>100 bpm Results: Increase in moderate activity was significant with Mean baseline: 3.05 Mean at outcome: 5.0 ($p=0.015$)
Stuck et al., 2015 Switzerland	Randomized controlled trial	Transtheoretical Model of Change Self-Efficacy	Tx Mean age: 74.5 Con Mean age: 74.5 N= 2284	Intervention Duration (Months): 24 Interventionist: Nurse and Physician Intervention: Health Risk Assessment Questionnaire used to motivate participants nurse counseling	Outcome Measures: Lifestyle Questionnaire Results: 70 % of the intervention group were physically active compared to 62% of control group
Tarazona-Santabalbina et al., 2016 Spain	Randomized controlled trial	None Noted	Tx Mean age: 79.7 Con Mean age: 80.3 N= 100	Intervention Duration (Months): 6 Interventionist: Nurse or Physiotherapist Intervention: Supervised exercise	Outcome Measures: Previously validated tool adapted for this study Results: 77.5% of participants in intervention group performed 3-6 hours/week of PA. 90% of control group performed 3 hours or less PA. Reduction of primary care visits was significantly reduced in the exercise group

Author, Year, Location	Design	Theory	Sample Characteristics	Intervention	Results
Weinstock et al., 2011 United Kingdom	Randomized controlled trial	None noted	Tx Mean age: 70.8 Con Mean age: 70.9 N= 1650	Intervention Duration (Months): 60 Interventionist: Nurse Intervention: Telehealth visits, pedometer	Outcome Measures: DSC- PA Results: Less decline in PA over time with telehealth visits Pedometers introduced after two years contributed to long term effects of intervention

Table 4.2
Included Single-group Studies

Author, Year, Location	Design	Theory	Sample Characteristics	Intervention	Results
Bickmore, et al., (2013) United States	Randomized controlled trial	None noted	Mean age of all participants: 71.3 Treatment N=263	Intervention Duration (Months): 12 Interventionist: Embodied Conversational Agent Intervention: Coaching daily for 2 Months, then intermittently for 10- month maintenance phase	Outcome measure: Steps via pedometer Statistically significant increase at 2 months ($p=.01$) No longer significant at 12 months ($p =.09$)
Gibbs et al., 2019 Canada	Pre/Post test	None noted	Mean age: 81 N=44	Intervention Duration (Months): 6 Interventionist: Physical Therapist Intervention: Integrating strength and balance into normal routines	Outcome Measure: IPAQ Results: No significant changes in moderate to vigorous PA outcomes

Author, Year, Location	Design	Theory	Sample Characteristics	Intervention	Results
Kolt et al. (2012) New Zealand	Cluster randomized controlled trial	None noted	Intervention: Tx Mean age: 73.9, n=165 Con Mean age: 74.3, N=165	Intervention Duration (Months): 3 Interventionist: Physician Intervention: Group 1: Green Prescription (exercise prescription)/ Pedometer/telephone counseling sessions Group 2: Green/ Prescription/telephone counseling sessions No pedometer	Outcome Measure: Auckland Heart Study PA Results: Group 1 (pedometer- based) increased leisure walking by 63.0 min/wk on average, more than double the increase in Group 2 (no pedometer) of 30.9 min/wk at 3-4 months
Mackenzie & Clemson, 2014 Australia	Pre/Post test	None noted	Mean age: 81.3 N= 8	Intervention Duration (Months): 2 Interventionist: Occupational, Physical Therapists and Physician Intervention: Home visits using Otago exercise program	Outcome Measures: PASE Results: Minimal improvements in PASE score; however, there were significant improvements in physical functioning

Author, Year, Location	Design	Theory	Sample Characteristics	Intervention	Results
Marki et al. (2006) Switzerland	Pre/Post Test	Transtheoretical Model of Change	Mean age: 74.1 N=29	Intervention Duration (Months): 2 Interventionist: Physician Intervention: Baseline PA assessment followed by counseling session	Outcome Measures: Physician interview Results: Minutes PA at baseline: M=247, SD=275 Minutes PA at Follow up: M=436 (SD=361) Counseling led to increase in PA
Pfeiffer et al., 2001 United States	Randomized controlled trial	None noted	Mean age: 74 N=76	Intervention Duration (Months): 1.5 Interventionist: Physician Intervention: Verbal advice or verbal advice plus prescription	Outcome Measures: Researcher-designed questionnaire Results No significant difference between verbal advice or verbal advice plus prescription
Sugden et al., 2008 United Kingdom	Randomized controlled trial	Self-regulation theory	Mean age: 76 N=54	Intervention Duration (Months): Interventionist: Physician, Nurse Intervention: Pilot study-Pedometer plus theory; Theory-based intervention alone	Outcome Measures: Accelerometer Results: Non-significant increase in PA in only one subgroup with the goal to increase PA by 20%. The groups with lower goals did not increase PA

Table 4.3*Characteristics*

Characteristic	Number of Comparisons	Mean (SD)
Age	27	75.08 (3.50)
Percentage Women	25	55.80 (27.4)
Percentage Minority	11	22.05 (21.42)
Percentage Married	14	50.54 (14.09)
Length of Intervention in days	36	278.99 (329.34)
Sample Size	28	187.4 (283.21)

Table 4.4*Effect Sizes*

Group	<i>k</i>	<i>d</i>	95% CI	SE	Q	I ²	<i>p</i>
Two-group Treatments versus Control, Post Intervention	24	0.27	0.15,0.39	0.06	117.56	80.44	0.00
Two-group Pre- and Post- Intervention	24	0.27	0.14,0.40	0.07	121.58	81.08	0.00
Single-Group Pre- Post-	9	0.14	0.04,0.23	0.05	13.09	38.89	0.00

Note. *k* =number of comparisons, *d* = standardized mean difference (random effects model), CI = confidence interval, SE =standardized error, Q=Cochrane's Q, I² = heterogeneity test statistics.

Table 4.5*Description of variables*

Variables for Moderator Analysis	Description
Use of Theory	Study-based interventions on a behavioral or cognitive theory
Goal Setting	PA goals were either set for the participant by the interventionist or the participant set their own goals
Problem Solving	Making available a variety of response to deal with problems that prevent participation in PA. Report must say problem-solving
In-person counseling	Includes an in-person two-way conversation or discussion between participant and interventionist with the goal of increasing PA
Barrier Management	Assisting the participant to overcome challenges or barriers to PA
Feedback	Participants given feedback based on their PA performance
Action Planning	Process where participants are asked to plan the steps required to accomplish their PA goals. Report must say action planning
Diary	Participants keep track of their time spent in PA
Decisional Balance	Assisting the participant to weigh the pros and cons of participation in PA
Use of risk assessment	Health risk appraisal, lifestyle risk or safety assessment completed by the interventionist and results are shared with the participant
Education	Participant educated regarding the recommendations of PA levels for older adults
Supervised Exercise	Interventionist-supervised or -led group PA sessions

Variables for Moderator Analysis	Description
Physician Interventionist	Physician provided education, demonstration of exercises, counseling, encouraging phone calls, prescription, risk assessment or encouraged participation in study
Physician Recruited	Physician asked patients to participate in study or sent letters asking for participation
Nurse Interventionist	Nurse provided education, demonstration of exercises, counseling, encouraging phone calls, prescription, risk assessment or encouraged participation in study
Therapist Interventionist	Physical or Occupational therapist provided education, demonstration of exercises, counseling, encouraging phone calls, prescription, risk assessment or encouraged participation in study
Length of Intervention	Number of total days over which intervention was delivered
# fact-to-face counseling sessions	Number of counseling sessions delivered face-to-face
# phone calls	Number of total phone calls made includes automated or video phone calls
# counseling sessions	Number of sessions including face-to-face counseling or phone calls

Table 4.6.*Moderator analysis of dichotomous variables.*

Variable	<i>k</i> studies containing the variable	<i>k</i> studies missing the variable	<i>d</i> studies containing the variable	<i>d</i> studies missing the variable	Q between	<i>p</i> value
Use of Theory	15	10	0.24	0.30	0.33	0.57
Use of Counseling	20	5	0.17	0.60	8.26	0.00
Goal Setting	13	12	0.23	0.32	0.47	0.50
Problem Solving	6	19	0.33	0.25	0.28	0.60
In-person counseling	13	12	0.16	0.41	3.70	0.05
Phone Calls	14	11	0.27	0.30	0.03	0.85
Pedometer	6	19	0.16	0.30	0.73	0.40
Barrier Management	8	17	0.36	0.23	0.88	0.35
Feedback	3	22	0.12	0.30	0.57	0.45
Action Planning	6	19	0.26	0.28	0.02	0.89
Diary	6	19	0.24	0.29	0.14	0.71
Decisional Balance	2	23	0.16	0.28	0.12	0.72
Use of Risk Assessment	8	17	0.11	0.33	2.37	0.12
Education	11	14	0.26	0.29	0.05	0.83
Supervised Exercise	3	22	0.18	0.29	0.33	0.57
Exercise Referral	4	21	0.70	0.18	10.87	0.00
Physician Interventionist	17	8	0.22	0.42	1.96	0.16
Physician Recruited	12	13	0.24	0.30	0.22	0.64
Nurse Interventionist	9	16	0.40	0.20	2.89	0.12
Therapist Interventionist	5	20	0.52	0.20	4.145	0.04
Intention to treat	14	11	0.32	0.2	0.99	0.32
Assessors Blinded	11	14	0.17	0.33	1.44	0.23
Objective Measure	7	18	0.17	0.29	0.58	0.45

Note. *k*= number of studies, *d* = standardized mean difference

Table 4.7.*Moderator Analysis of Continuous Variables*

Variable	<i>k</i>	Standardized Meta- regression Coefficient	Standard Error (SE)	P value
Age	22	0.03	0.02	0.10
Length of Intervention	24	-0.00	0.00	0.18
# face-to-face interactions	13	0.02	0.03	0.51
# phone calls	12	0.01	0.01	0.09
Percentage of women	22	0.00	0.00	0.66
# counseling sessions	18	0.02	0.01	0.01

Note. *k*= number of studies

Table 4.8.

Assessment of Bias Using the PEDro Scale

PEDro Criteria	Eligibility criteria specified	Subjects randomly allocated to groups	Allocation concealed	Groups similar at baseline	Subjects blinded	Interventionist blinded	Assessors blinded	>85% of key outcome measured	Intention-to-treat analysis on outcome	Between-group comparison outcome	Point measures/measure variability
Burton et al., 1995	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Campbell et al., 1999	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes
Coultas et al., (2018)	Yes	Yes	Yes	Yes	No	No	Yes	No	No	Yes	Yes
Dolovich et al., (2019)	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
Dubbert et al., (2008)	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Herghelegiu et al., (2017)	Yes	Yes	No	Yes	No	Yes	Yes	Yes	No	Yes	Yes
Illife et al., (2014)	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes
Kerse et al., (2005)	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes
Kerse et al., (1999)	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Kolt et al., (2007)	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
McMurdo, et al., (2010)	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Morey et al., (2009)	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Morey et	Yes	Yes	No	Yes	No	No	Yes	Yes	No	Yes	Yes

al., (2006)

PEDro Criteria	Eligibility criteria specified	Subjects randomly allocated to groups	Allocation concealed	Groups similar at baseline	Subjects blinded	Interventionist blinded	Assessors blinded	>85% of key outcome measured	Intention-to-treat analysis on outcome	Between-group comparison outcome	Point measures / measure variability
Morgan et al., (2019)	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Mutrie et al., (2012)	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Pérula et al., 2012	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Sims, et al., (1999)	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Tarazona et al., (2016)	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes
Weinstock et al., 2011)	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Witham et al., (2012)	Yes	Yes	No	Yes	No	No	Yes	No	Yes	Yes	Yes

Figure 4.1

Flow diagram of meta-analysis study selection.

Note: PA=physical activity. Adapted from Moher D, Liberati A, Tetzlaff J, Atman DG, PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Medicine, 6(6), e1000097. doi:10.1371/journal.pmed1000097dapted

Figure 4.2

Forest Plot

Note. Forest plot of 2-group post-test physical activity outcomes. Random effects size model used for calculation. Rectangles denote proportion of study weight. Table 4.3 details effect size for the two-group comparisons, as well as the pre-post comparisons.

Figure 4.3

Funnel Plot of Publication Bias.

Note. Funnel plot indicates the presence of publication bias. Egger's regression was not statistically significant ($t=1.6$, $p < 0.12$). Classic Fail-safe N reports that 451 studies would be needed to yield an insignificant p value.

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CHAPTER 5

SUMMARY

Motivating older adults to participate in PA is a global problem as evidenced by the number of countries represented in the studies reviewed for this dissertation research. Older adults should participate in 150 minutes of moderate activity, but many older adults do not meet these requirements (United States Department of Health and Human Services (USDHHS), 2018). Increasing participation in PA for the older adults has multiple physical and psychological benefits, including preventing disease, promoting independence, and maintaining cognition (Marques et al., 2019; Ramos et al., 2019; Reis et al., 2019). The results of this systematic review and meta-analysis demonstrate that PA interventions used in primary care are effective for increasing levels of PA in older adults.

Effects of Primary Care Interventions

The many benefits of participation in PA for the older adult make a compelling case for incorporating PA interventions into primary care. Primary care providers are accustomed to providing health promotion measures, as well as care based on the effects of lifestyle choices. Primary care providers have the benefit of multiple interactions with the older adult patient so interventions can be provided during care. Finding interventions that are effective and that can be provided economically are an important aspect of promoting PA in older adults.

This meta-analysis demonstrated an overall effect size of 0.27 ($p=0.00$) representing a small-to-moderate positive effect for interventions used in primary care to facilitate PA. This positive effect size (ES) indicates that interventions used in primary care to promote PA are effective. This ES represents a clinically significant positive change in the health of older adults as the result of primary care intervention. Previous research has found that small increases in PA

can have positive effects in the health of older adults (Marques et al., 2019; Orrow et al., 2012). This meta-analysis yielded similar results to other meta-analysis describing PA interventions by Chase ($d=0.18$) and by Conn et al. ($d=0.19$) (Chase, 2015; Conn et al., 2011).

Interventions

Frequently used interventions include goal setting, barrier management, risk assessment tools, pedometers, motivational interviewing, action planning, feedback, and exercise diaries. Primary care providers should use a variety of interventions when promoting PA in older adults as more intensive interventions are generally more successful (Conn, et al., 2002). Receiving written materials is generally appreciated by the older adult (Pfeiffer, et al., 2001). The use of theory as a basis for interventions did not positively affect the effect size of the individual studies in this meta-analysis. However, studies often did not explicitly state how consistently or completely the theory was applied to the intervention. Unfortunately, the use of theory is often not well articulated in intervention studies and how the researchers operationalize the theory is often not described (Michie & Prestwich, 2010). Common theories used in the studies in this meta-analysis included the transtheoretical model of change and social cognitive theory.

Delivery Methods

Researchers used a variety of delivery methods to deliver their interventions including in-person sessions, telehealth, live phone calls and automated phone calls (Dubbert et al., 2008; Morey et al., 2009; Coultas et al., 2018). When interventions involved a higher number of counseling sessions they were more effective. Fortunately, primary care providers have the flexibility of providing interventions in person or by phone to help manage time restraints. Technological advances and the increasing ability of the older adult to navigate technology may

provide convenient, economical and effective intervention delivery options in the future. The use of technology in the future may help to reduce amount of time needed to provide interventions.

Interventionists

Another way to reduce the time burden of providing interventions is to utilize an interdisciplinary team to provide interventions. While physicians are a source of support and encouragement to their patients, referring to exercise specialists such as physical and occupational therapists is a good option. These referrals have the benefit of positive influence of physician approval combined with the expertise of providers that are experts in the field of exercise. Older adults value the expertise these exercise experts can provide. Utilizing exercise specialists can help improve the older adult's self-efficacy for exercise thus reducing another potential barrier. The most common barrier to PA is poor health (Baert et al., 2011). Understandably, this meta-analysis found that those studies than enrolled patients with chronic conditions had less of an effect on PA levels.

Nurses were interventionists in many of the studies often in conjunction with the physician. Utilizing ancillary personnel such as nurses, health counselors, exercise trainers and volunteers to deliver PA interventions can free up time for the primary care. Peer support and peer leaders hold promise as exercise interventionists and have the added benefit of improving socialization for the older adult (Gibbs et al., 2019; Kerr et al., 2018; Illife et al., 2014). Further studies are needed to explore the effectiveness of these interventionists.

Conclusion

Promoting healthy behaviors in primary care is a difficult and complicated process and, when the patient is an older adult, it adds additional challenges. The primary care provider is a

trusted source of health information for the older adult and has the potential to provide effective PA interventions. Primary care PA intervention can improve levels of PA to impact the health of older adults and are an important part of health promotion. A variety of behavior change strategies and techniques can contribute to the overall effectiveness of interventions. Future research is needed to incorporate technological advances into PA interventions, as well as the enrollment of participants of color and adults ≥ 85 . Future research should also examine health care cost savings related to increasing PA in older adults to provide support for incentives for providing PA interventions. Interventions offered in primary have the potential to promote PA in older adults using a team approach and drawing on the primary care provider's experience and expertise in health promotion.

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