The Role of Self-regulation Influencing the Physical Activity of Older Adults

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Abstract

Title: The Role of Self-regulation Influencing the Physical Activity of Older Adults

Purpose and Background: Falls are detrimental to the older adult population in the United States. Despite the evidence that physical activity can reduce falls and their negative effects, the majority of older adults are not participating. To address this gap, motivational content, specifically interpersonal behavior change strategies, were integrated into an evidenced-based physical activity protocol. Preliminary study results showed that older adults who received this intervention, compared to those who did not, significantly increased their physical activity. However, it remains unclear why the intervention worked. Thus, the purpose of this study was to assess whether or not this intervention elicited increased self-regulation, a motivational construct targeted by the intervention, and in turn, whether or not self-regulation mediated intervention effects on physical activity.

Conceptual Model: The conceptual model used in this secondary analysis was developed by Siobhan McMahon (2012) and represents the focus of this paper: the relationship between the intervention, the targeted motivational construct—self-regulation—, and physical activity. This model was based on the Wellness Motivation Theory (WMT), which predicts that increases in social contextual resources and behavioral change processes, including self-regulation, lead to increases in healthy behaviors, such as physical activity.

Methods: This mixed-methods secondary analysis drew data from a parent study which included community-dwelling older adults from the Minneapolis and St. Paul metro areas (n=102, 75% female). Data used in this secondary analysis is from the group of participants in this study that received an intervention comprised of an evidence-based physical activity protocol and interpersonal behavior change strategies (e.g. social comparison, social support). The

interpersonal strategies targeted several motivational constructs, including self-regulation. The focus of this paper is the assessment of how well the intervention elicited self-regulation strategies among participants and whether self-regulation mediated intervention effects on physical activity. Additionally, 25 post-intervention interviews were analyzed to explore participants' perspectives regarding the intervention and if/how they used those strategies to self-regulate increased physical activity.

Results: Participants who received this intervention, compared to those who did not, increased their self-regulation and their physical activity immediately post-intervention. Additionally, participants identified self-monitoring and maintaining a positive mental mindset as strategies that increased their motivation to engage in physical activity.

Conclusions: Overall, quantitative and qualitative results indicated that self-regulation could play a role in the initiation of increased physical activity in community-dwelling older adults. This intervention increased self-regulation through facilitated conversations between participants. These interpersonal strategies are different from traditional physical activity interventions among younger adults that typically involve more intrapersonally-oriented strategies, such as goal setting, to elicit increases in self-regulation and physical activity. The participants indicated that self-monitoring and positivity play a role in self-regulation. Both quantitative and qualitative findings highlight the need for additional research that assesses and explores the motivational and psychosocial mechanisms of change in older adults' physical activity. In conclusion, results of this secondary analysis were consistent with the findings in the literature that support the statement that self-regulation may increase motivation for physical activity in general populations, including older adults. However, the results suggest that self-regulation may by elicited differently in older adults than younger populations.

Background

As the population of the United States ages, interventions to keep American people healthy will have to change based on what is effecting the 65 and older population, such as the preventable event of falling (Markle-Reid et al., 2015). Falls are the number one cause of injurious deaths in the 65 and older population (WISQARS, 2011). When not fatal, falls still have significant consequences for older adults including fractures, traumatic brain injuries, lacerations, breaks, and a fear of falling (Bell, Talbot-Stern, & Hennessy, 2000). Although many interventions have been effective in reducing falls, such as group exercise programs and at-home exercise, fewer than 17% of older adults regularly participate in recommended strengthening exercises, and fewer than 23% regularly participate in the recommended level of aerobic exercise (Gillespie et al., 2012).

Despite strong evidence supporting the idea that physical activity can reduce falls, older adults are not participating as a majority (Gillespie et al., 2012). To address this gap, researchers have begun to investigate if targeting motivational determinants of physical activity with behavior change strategies, combined with evidenced-based physical activity protocols increase older adults' participation in recommended physical activity (Anderson et al., 2006). However, evidence to date is scarce and inconclusive, making it difficult to know which constructs should be targeted in interventions designed to increase older adults' physical activity. In the general population, self-regulation, more than other motivational constructs, explains increases in physical activity (Rhodes & Pfaeffli, 2010). The motivational construct self-regulation represents strategies people can use to gauge and evaluate their progress toward achieving goals. In older adults, the relevance of self-regulation has come into question by meta-analyses that report that

interventions targeting self-regulation tend to produce smaller effects on physical activity

(French, Olander, Chisholm, & Sharry, 2014, O'Brian et al., 2015).

In line with this field of inquiry, the parent study was conducted using a 2x2 factorial

design to test the individual and combined effects of two sets of behavior change strategies—

interpersonal (e.g. social support, social comparison) and intrapersonal (e.g. barrier-management,

action-planning)—on the quantity of older adults' physical activity. Both sets of strategies

targeted the psychosocial constructs of social support, self-efficacy, readiness, self-regulation,

and goal attainment. The Wellness Motivation Theory (WMT) and empirical evidence guided

the development of this intervention. According to the WMT (Perez & Fleury, 2009) and prior

research, (Baert, Gorus, Mets, Geerts, & Bautmans, 2011; van Stralen, De Vries, Mudde,

Bolman, & Lechner, 2009; Yeom & Fleury, 2014) the behavior change strategies used and the

constructs they targeted represent key social contextual resources and behavioral change

processes that, together, influence physical activity. The initial evaluation of the two sets of

behavior change strategies revealed that older adult participants who received the interpersonal

behavior change strategies, compared to those who did not, significantly increased their physical

activity as well as their functional strength and balance; both immediately and six months post-

intervention. Conversely, the provision of intrapersonal behavior change strategies did not elicit

significant increases in physical activity or functional strength and balance at either time point.

In the current study, a secondary analysis was conducted to begin to investigate why the

interpersonal behavior change strategies worked to increase older adults' physical activity. The

purpose of this mixed-methods study is to determine whether or not an intervention comprised of

an evidence-based physical activity protocol and interpersonal behavior change strategies elicited

increased self-regulation, and in turn, if self-regulation explains increases in physical activity.

The specific aims of this study are to:

- Evaluate if the intervention elicits self-regulation

- Explore whether changes in self-regulation helped to explain the changes in physical activity, immediately post-intervention

- Ascertain how self-regulation helped, or did not help, participants' motivation for and performance of recommended physical activities.

Purposeful physical activity is important to prevent falls (Gillespie et al., 2012), thus motivating older adults to increase their physical activity by increasing their self-regulation skills may make an impact on falls and may ultimately reduce disability and enhance quality of life.

Because falls can be physically and socially devastating, identifying strategies that improve fall prevention interventions is a crucial problem for nurses to solve as they are in the unique position of promoting health and wellness among community-dwelling older adults. Examining the effectiveness of this intervention may enhance the health promotion practices of nurses, particularly as they work with older adults with fall risk.

Literature Review

Self-Regulation

Motivation for physical activity among older adults is complex and influenced by many factors such as social support, self-efficacy, and self-regulation. Among these factors, however, self-regulation has been found to have the strongest effect on physical activity among general adult populations (Anderson et al., 2006). Self-regulation is a broad construct that represents how people gauge and evaluate their progress toward achieving goals and adjust their actions accordingly. People self-regulate their physical activity by setting goals, self-monitoring their behavior and outcomes, managing their time, utilizing social support for exercise, and preventing

relapses (Umstattd, 2006). Self-knowledge regarding the power individuals have to engage in physical activity is essential to self-regulation as are skills such as problem-solving and planning, particularly to: (a) flexibly achieve goals, (b) anticipate challenges and failures and react appropriately, and (c) recognize that the participant plays a large role in the behavior change (Brawley, 2003). Facilitating increased self-regulation is possible according to prior literature. For example, interventions that combine physical activity training with strategies that facilitate other motivational factors including self-regulation, are effective (Yeom, 2014). Therefore, further exploring the relationship is worthwhile.

Factors Influencing Self-regulation

Numerous studies have identified factors that influence self-regulation (Bandura, 2005; Keller, Fleury, Gregor-Holt, & Thompson, 1999; Umstadtt et al., 2006, Umstadtt et al., 2008). For example, some studies have found that self-regulation skills are used more often when the participant has a higher level of education, higher income, lower BMI, better overall health, greater self-efficacy, greater social support, and higher levels of current physical activity (Umstadtt et al., 2008, Umstadtt et al., 2006). The relationship between self-regulation and psychosocial indicators needs to be further explored, but may indicate a bi-directional relationship between utilizing self-regulation strategies and living an active lifestyle.

Additionally, older adults who use self-regulation strategies participate in moderate-to-vigorous physical activity more than their peers do, and using self-regulation strategies has been found to be a significant predictor of moderate-to-vigorous physical activity (Umstadtt et al., 2008). Further, older adults with greater use of self-regulation strategies were more likely to be participating in several types of physical activity, specifically moderate to vigorous physical activity, recreational and sporting activities, and walking (Umstadtt et al., 2008). The trend also

continues as those with better health had better self-regulation strategies (Umstadtt et al., 2006).

The positive relationship between those with better health also utilizing self-regulation strategies

may be due to the link between self-regulation and self-efficacy.

Self-regulation and Self-efficacy

There have also been many explorations between self-regulation and self-efficacy. Self-

efficacy has been defined as, "One's confidence in her ability to perform a certain behavior"

(Keller et al., 1999, p. 19). Umstadtt et al. (2006) found that self-regulation strategies were used

more often by individuals with greater self-efficacy. In addition, self-efficacy has been identified

as one of the most influential factors impacting physical activity adoption and maintenance for

all age groups, including older adults (Conn et al., 2003). Self-efficacy and self-regulation are

both key constructs of Albert Bandura's Social Cognitive Theory, which has been used

extensively to "promote" physical activity in older adults and other populations. However, self-

efficacy has been studied more extensively than self-regulation. Umstadtt et al (2006)

hypothesized that older adults use self-efficacy strategies to decide whether to adopt or maintain

a behavior such as physical activity while utilizing self-regulation skills to make the decision.

This suggests that, self-regulation and self-efficacy are very closely linked. However, more

research needs to be done to clarify how each variable separately influences behavior change,

specifically with older adults and physical activity.

Physical Activity and Fall Prevention

It is recommended by the American College of Sports Medicine and the American Heart

Association that older adults participate in moderate aerobic physical activity for 30 minutes five

days a week or 20 minutes three days a week if the exercise is vigorous (Physical Activity and

Public Health, 2007). In addition to the health benefits, exercise interventions and physical

activity such as exercise programs including muscle strength and balance training have been

found to be effective in preventing falls (Gillespie et al., 2012). Gillespie and his colleagues have

also found that group and home-based exercise programs, which usually contain strength and

balance components, effectively reduce falls (Gillespie et al., 2012). Therefore, including

physical activity as a general health incentive as well as a fall prevention intervention in

conjunction with self-regulation strategies may reduce the amount of falls experienced in the

older adult population.

Conceptual Model

The intervention developed for this study by Dr. Siobhan McMahon of the University of

Minnesota School of Nursing, is based on the Wellness Motivation Theory (WMT). According

to the WMT (Figure 1) social contextual resources such as social support and physical

environmental factors, together with behavioral change processes, such as self-knowledge,

readiness, and self-regulation influence healthy lifestyle behaviors, such as physical activity

(Perez & Fleury, 2009). Although prior research shows interventions guided by the WMT elicit

increases in physical activity (McMahon et al., 2015; Yeom & Fleury, 2014), research has not

addressed the mechanism through which these interventions have worked. In this study, the

focus in on the WMT constructs self-regulation and physical activity. In particular, it was tested

to examine if the effects of an intervention on physical activity are mediated by self-regulation.

This mixed-methods study included quantitative and qualitative analyses to address the

overarching question regarding why the intervention with interpersonal behavior change

strategies worked. The quantitative analysis began by first testing intervention effects on self-

regulation in community-dwelling older adults, displayed as the A path in Figure 2. Second, the

association of self-regulation and physical activity were tested, displayed as the B path in Figure

2. Third, the simultaneous effects of A and B paths, or the effect of the intervention on self-regulation and the effect of self-regulation on physical activity were tested to estimate the indirect effect of self-regulation on physical activity, which is considered the AB path. The + signs on the left and right arms of the model indicate the hypotheses in this study. The qualitative analyses began by exploring these relationships using content analysis of narrative data from post-intervention interviews with participants.

Hypotheses and Research Question

To address the quantitative portion of this study, two hypotheses were tested using a sample of 102 community-dwelling older adults aged 70-92 years old. The hypotheses include:

Hypothesis 1: The intervention will elicit increased self-regulation among community-dwelling older adults.

Hypothesis 2: Self-regulation will have an indirect effect on physical activity (e.g. mediate the interpersonal strategy-physical activity relationship).

To address the qualitative component of this study, 25 post-intervention interviews were examined addressing two research questions:

Research Question 1: What aspects of the intervention helped community-dwelling older adults increase their physical activity?

Research Question 2: What was the participants' perception of how self-regulation facilitated, or did not facilitate their physical activity?

Conceptual Definitions of Terms

For the purposes of this study, physical activity is defined as any bodily movement produced by the skeletal muscles that result in energy expenditure (Physical Activity and Public Health, 2007). Older adults are defined as 70 years or older as defined by the parent study. This

study will use the World Health Organization's definition of a fall which is "inadvertently coming to rest on the ground, floor or other lower level, excluding intentional change in position to rest in furniture, wall or other objects" ("World Health Organization Global Report on Falls", 2007, p. 1). In this study, self-regulation is defined as, "personal regulation of goal directed behavior or performance" (Umstattd et al., 2008, p. 116).

Assumptions

This study assumes that the interventions and outcomes will be able to be applied to community dwelling adults over the age of 70 years old living in the United States. Additionally, it assumes that the measures used to assess self-regulation (Yeom & Fleury, 2011) are valid and reliable instruments in this population.

Methods

Study Design

The design of this mixed-methods secondary analysis uses quantitative data to address Aims 1-2 and qualitative narrative data collected from a subset of participants to address Aim 3. The parent study included 102 community-dwelling older adults who were randomized into one of four experimental conditions that followed a 2x2 factorial experimental design. This design enabled assessing the combined and unique effects of two sets of behavior change strategies, interpersonal and intrapersonal, targeting motivational constructs. Details about this factorial design and analysis of primary outcomes has been previously described (McMahon et al., 2017). Because results from the primary analysis suggest interpersonal strategies, not intrapersonal strategies, increased physical activity, the focus of the current secondary analysis is on one factor: receipt of interpersonal intervention strategies (Yes/No). In other words, this study focuses on a comparison of intervention effects among participants who received the

interpersonal intervention strategies (Columns b+d in Table 1) with those who did not receive the interpersonal intervention strategies (Columns a+c in Table 1).

The interpersonal strategies used in this intervention included the facilitation of social support for physical activity and friendly social comparison and are explicitly explained in a later section. These interpersonally oriented behavioral change strategies targeted the following motivational constructs: social support, readiness, self-efficacy, and self-regulation.

All study participants were assigned to small groups comprised of 4-6 participants who had been randomized to the same condition. Each group met weekly for 90 minutes, over the course of 8 weeks. Each weekly session included time for discussion and education consistent with the treatment condition as well as a weekly progression of the Otago Exercise Program (Gardner et al., 2001) to ensure participants were progressively mastering the exercises. Each participant was given a $20 gift at the end of each data collection session and was invited to keep their Fitbits at the end of the study.

The quantitative portion of this secondary analysis was designed to examine the effect of the intervention with interpersonal behavior change strategies on self-regulation and whether or not self-regulation helped to explain changes in physical activity. The qualitative portion explored 25 participants' perceptions about physical activity after participating in the study and if/how self-regulation facilitated, or did not facilitate, their physical activity.

Study Setting

The parent study took place in the community setting at four community centers in the Minneapolis and St. Paul metro areas. Participants were recruited using newspaper advertisements printed in community newspapers. When a participant indicated interest in the study, he or she was screened to ensure he or she met the enrollment criteria. Enrollment criteria

included living independently in an urban community, having the ability to walk, having low

levels of physical activity, speaking English, not having a diagnosis of a neurocognitive disorder

or a score of <21 on the telephone version of the Mini-Mental State Exam, and being at least 70

years old. Those who qualified reviewed the purpose, procedures, risk and options of the study

and provided written and verbal consent prior to enrollment. Older adults were excluded from

the study if they had an infection, an injury on an extremity, surgery in the last six months,

engaged regularly in recommended levels of physical activity, had an inability to walk with or

without a walking aid, and/or had a diagnosis of a neurocognitive disorder. This study was

approved by the University of Minnesota's Institutional Review Board (#1402S47802).

Intervention

The intervention delivered to participants in this study included the receipt of physical

activity monitors, the receipt of an evidence based physical activity protocol, Otago, and the

receipt, or not, of interpersonal intervention strategies. Each participant in the study received a

commercially available physical activity monitor, Fitbit One^{TM} (Fitbit Inc., San Francisco, CA,

USA). Basic operational instructions for using the physical activity monitors (e.g. how to wear,

charge, read displays) were provided during the baseline data collection period, then reviewed

and reinforced at and between intervention meetings as needed.

The Otago physical activity protocol, adapted for small groups includes four types of

exercises and movements: 5 leg-strengthening; 12 balance-challenging; 5 flexibility; and 10-

minute increments of walking. Exercises were gradually introduced, demonstrated,

individualized, and practiced within the small group settings over the 8-week intervention period.

Daily walking was also encouraged, at a usual pace for up to 30 minutes, broken into 10-minute

sessions, to increase physical capacity. Mastery to practice the physical activities independently,

outside of the small group meetings, was facilitated via initial guidance for each exercise and

movement, safe walking, as well as periodic check-ups. In addition to learning and practicing

within the small group meetings and walking every day, participants were encouraged to practice

the exercises and movements on their own twice per week between the intervention meetings and

then three times per week after completing the intervention.

The five main interpersonal strategies used for this intervention component required

discussion between group members about physical activity-related ideas, experiences, and

knowledge to elicit individual change. The first two strategies included facilitating the give-and-

take of social support for fall-reducing physical activity, and identifying one's self as a role

model. The third strategy included problem-solving social and environmental barriers to physical

activity. The fourth strategy was to facilitate the integration of physical activity into social

routines, including the use of community resources. The fifth strategy was friendly, non-

competitive social comparisons of personal physical activity practices and data trends obtained

from monitors (McMahon et al., 2015). Participants in groups/conditions that did not include

interpersonal intervention strategies received either a) general information about aging and

health or b) traditional intrapersonal strategies such as help developing personally meaningful

goals.

Measures

There were three quantitative measures and one qualitative measure used in this study.

The first quantitative measure was the Index of Self-Regulation , which is comprised of nine

items. All item responses are based on Likert scales in which the participant reports the degree to

which he or she agrees or disagrees, on a scale of 1 (not at all) to 5 (very often). Responding

according to the scale, these nine items capture the frequency with which a participant thought

about the personal benefits of fall-reducing physical activity; self-monitored and evaluated

personal behavioral outcomes; and integrated fall-reducing physical activity into everyday life

(Yeom et al., 2011). This instrument was determined to be reliable within the parent study with a

Cronbach's alpha coefficient of .85. The Index of Self-Regulation was also found to be valid

when it was found that there was 88.9% of significant correlations among items (Yeom et al.,

2011) compared to the WMT.

The second measure, Barriers Self-Efficacy Scale, assessed self-efficacy via 13 items that

inquired about how confident a person is to perform physical activities that promote strength and

balance as well as walking when faced with common barriers such as pain or bad weather.

Response scales for each item range from 0 (no confidence) to 100 (complete confidence).

Cronbach alpha in this study was a= .90.

The third quantitative measure used was the duration of physical activity, captured as

average daily step count captured using participants' Fitbit Ones and a secure research

application that analyzed, reduced, and stored all Fitbit data. The Fitbit One^{TM} is an external

monitoring device that measures a participants' number of steps and has been found to be an

accurate measure of steps when compared to observing steps or self-reporting (Paul et al., 2015).

The qualitative measure was a guide used to conduct 25 semi-structured interviews with

9 main questions and related probes 6 months post-intervention (Appendix). Each question was

selected to reflect participants' experiences with WMT constructs targeted by the intervention.

This secondary analysis focused on self-regulation data specifically.

Data Collection

The quantitative data for this study were collected by a trained research assistant (RA).

At baseline, 8 weeks (immediately post-intervention), and 6 months post-intervention, each

participant was interviewed in person by an RA who verbally asked the participant the Index of

Self-Regulation and Barriers Self-Efficacy questions and recorded the participant's answers on a

computer tablet. The data were then managed with REDcap software. The Fitbit^{TM} data were

also collected by the RAs at baseline and at 8 weeks immediately post-intervention. The Fitbit^{TM}

data were measured in average daily steps and were accessed through the online Fitbit

application.

The qualitative data were collected six months after the 8-week intervention was

completed. Twenty-five participants assigned to a condition that included the interpersonal

behavioral change strategies participated in semi-structured interviews to discuss the

intervention. The purpose, procedures, risks and options of the portion of the study were

reviewed again with participants to ensure their ongoing consent. Interviews were conducted in

private settings within the community center where their intervention took place, recorded by the

interviewer, and transcribed professionally. Participant privacy was protected using their study

number in place of their name. Additionally, each participant was assured that all of the data

used in the study was in a locked area with no identifying information linked to the data.

Data Analysis

Participant characteristics are were described using means, medians, modes, and standard

deviations (SD). Next, ANOVA and Fisher's Exact Tests were used to assess the differences in

gender, age, and education level. Mediation analysis was conducted with Haye's SPSS

PROCESS v.2.15 macro 45 which is consistent with approaches described by MacKinnon and

colleagues (2008). In mediation models, this macro uses ordinary least squares regression

analyses. Models test the association between an independent variable and a potential mediator

(A path). Models also test the association between the variable designated as a potential

mediator, and the outcome variable, controlling for the independent variable (B path). Finally,

models test the simultaneous effects of the A and B paths which represent the indirect effect of

the independent variable on the outcome variable through the potential mediator variable (AB

path). The significance of A and B paths are estimated and reported in this paper using

unstandardized coefficients, standard errors, and probability values. The significance of the AB

path, or indirect effect, is estimated by developing 5000 bootstrapped samples of this effect. The

resulting bias-corrected bootstrapped means and 95% confidence intervals are reported as the

estimated indirect effect. A confidence interval that does not include zero is considered

significant and indicates a significant indirect effect (e.g., mediation has occurred). All models

tested controlled for baseline values of self-regulation and physical activity.

The qualitative data included transcribed interviews stored, managed and analyzed using

NVivo software (NVivo 10, 2012). To start the qualitative descriptive analysis, codes were

developed for narrative data and categorized according to constructs in the WMT such as social

support, use of community resources, self-efficacy, readiness, self-regulation, and physical

activity. These initial codes and categories were co-created by two research assistants, including

the primary author, and the investigator. For the purpose of this study, data from the category

self-regulation and physical activity were further analyzed which led to the creation of additional

sub-categories. This subset of narrative data were compared and contrasted visually using

matrices organized by indicators of self-regulation and indicators of physical activity post-

intervention. This visual analysis resulted in two main categories, monitoring is motivating and

positive mental mindset, reflecting participants' perspectives of how they used self-regulation

skills to support their physical activity.

Results

Quantitative Results

One hundred and two participants participated in this study and 101 participants completed baseline data collection. The participants were primarily White (75%) and women (75%) who have at least some college education (50%). Differences in participant characteristics were not statistically significant between participants who received and did not receive the intervention with interpersonal strategies.

Table 2 illustrates raw means of the Index of Self-Regulation and self-efficacy self-ratings and physical activity measured as average daily step count at baseline and immediately post-intervention, by study condition. Immediately post-intervention participants who received interpersonal intervention strategies, compared to those who did not, significantly increased their average daily step (see Table 2), as evidenced by statistically significant unstandardized coefficient; 799.12, p = .005. Similarly, participants who received interpersonal intervention strategies compared to those who did not, reported significantly higher levels of self-regulation (see Table 2), as evidenced by results of the A path test that showed a statistically significant unstandardized coefficient of .30, p= .03 (See A path in Table 3). The relationship between self-regulation and physical activity controlling for the receipt or non-receipt of the intervention with interpersonal content, the B path test, was not statistically significant (See B path in Table 3). Finally, the intervention effect on physical activity among participants who received interpersonal intervention strategies compared to those who did not was mediated, in part, by self-regulation as evidenced by results of the AB path test that showed a statistically significant unstandardized coefficient of 99.23 with a 95% CI that did not include zero [2.94 to 161.96] (See AB path in Table 3).

Qualitative Results

Overall, the narrative data from the 25 post-intervention interviews from participants who received interpersonal intervention strategies revealed that self-regulation was identified as behavior that can be used to increase physical activity. Two main categories emerged from data analysis: monitoring is motivating and positive mental mindset. The first main category, monitoring is motivating, reflected participants' views that monitoring one's physical activity was valuable. By self-monitoring their physical activity, participants were aware of their actual, versus assumed, levels of physical activity, held accountable to their goals, and given feedback about their personal goal attainment. The second main category, positive mental mindset, reflected participants' views that physical activity precipitates positivity or a good feeling which in turn motivates additional physical activity. The two themes are described in the following two paragraphs.

Monitoring is Motivating: Among the narrative data, a majority of participants identified a variety of ways that they monitored their physical activity and health. In turn, by actively monitoring themselves, they were motivated to increase their physical activity and maintain or improve their health. For example, participants noted that monitoring their steps using a Fitbit was motivating. One participant stated, *"Yes I checked it there every day and it went up and up and up. That's what kept me going. I said tomorrow it'll go further."* Other participants noted that the Fitbit's kept them accountable in a friendly way. *"I love the Fitbit because if I don't track it I don't do it."* Other participants monitored their health by how they were feeling or by their level of independence. *"I am able to do so much more, I can keep—I want to stay independent for as long as possible"* Whether participants were using their Fitbit or

their current state of health, most reported using some form of monitoring that motivated them to increase or maintain their level of physical activity and their overall wellbeing.

        Positive Mental Mindset: Participants also explained that maintaining a positive mental mindset was an integral aspect of self-regulation. Participants reported that maintaining a positive mental mindset helped them stay motivated—*"...in order for me to get to the point I need to be at in my life, or to be able to do things I want to in my life, I have to do it myself. So that helps to motivate me to keep working harder."* Other participants maintained a mindset that ensured they did not succumb to debilitating aspects of aging. *"The mental attitude that I can do it and that I'm not going to let 84—I'm not going to think about the age. I'm not going to think about it."* Other participants found thinking about the positive rewards of physical activity, despite its challenges, such as general improvement in their life to be motivating.*"So my mindset is that if I exercise, if I do what I'm supposed to, I should be doing, it will help me to live longer, help me to get around better."* The self-regulation strategy of maintaining a positive mental mindset was motivating to participants to take control of their health and their overall function.

Discussion

        The purpose of this mixed-methods study was to determine whether or not interpersonal strategies can elicit self-regulation, and in turn, if self-regulation explains increases in physical activity. Overall, quantitative and qualitative results indicated that self-regulation could play a role in the initiation of increased physical activity in community-dwelling older adults. In particular, an interpersonal intervention elicited increases in self-regulation, which in turn partially mediated the interpersonal intervention's effect on physical activity. Although quantitative results were statistically significant, they were small in magnitude. These findings

address both Aims 1 and 2. The narrative qualitative data helped in understanding what aspects

of self-regulation specifically helped participants increase their physical activity.

       The findings related to Aim 2 are unique in that they support the role of self-regulation in

physical activity among older adults. Currently, the literature reveals mixed results regarding the

role of self-regulation pertaining to older adults. Although self-regulation has been found to

explain increases in physical activity among the general population (Rhodes & Pfaeffli, 2010),

French and his colleagues (2014) recommend using caution when applying self-regulation

strategies to older adults because their meta-analysis revealed that interventions with strategies

that presumably promote self-regulation were associated with lower effects on physical activity.

The authors speculate this may be due to age-related changes in executive functioning or because

self-regulation may need to be elicited among adults and older adults differently. Intervention

investigators have thus begun to assess the association of self-regulation and physical activity;

findings are positive across age groups (Olson & McCauley, 2015, Hall, Fong, Epp, & Elias,

2008). It may be that self-regulation has a role in physical activity of older adults, but it is

elicited in a different manner than in young and middle age adults. In this study, the interpersonal

intervention attempted to elicit self-regulation by facilitating a dynamic conversation among

participants regarding their personal goals and their progress versus individual reflection that has

been done with young adults. In summary, results of this secondary analysis were consistent with

findings in the literature that support the statement that self-regulation increases the motivation

for physical activities that reduce fall risk in older adults (McMahon and Fleury, 2012) which

positively supported both hypotheses.

       Analysis of the narrative data addressed Aim 3 and answered the research question as it

added to our findings by providing a possible explanation about the perspectives of participants

regarding different aspects of self-regulation. In particular, participants explained that positivity and self-monitoring play a role in the self-regulation of older adults. These explanations raise our awareness that there may be psychosocial constructs related to affect or attitude that help to explain increases in physical activity among older adults. They also raise questions about whether monitoring behavior and/or outcomes are influential. Additional qualitative data will need to be gathered to further explore the relationship between self-regulation and physical activity in older adults.

Limitations

While the results of this study were significant, there are limitations. First, the study and sample size were not designed to assess the precise mediation effects of all targeted psychosocial constructs. To better understand the psychosocial mechanisms through which interventions work, future studies should be designed with enough statistical power to conduct thorough mediation analyses. Second, the data may not be representative of the general population as the sample was not diverse. Third, because of the nature of qualitative data, inferences cannot be made about the general population regarding the participants' responses. Additionally, there is no pre-intervention qualitative data for which to compare responses. Fourth, the interpersonal interventions also included intrapersonal strategies. Specifically, through one to one coaching, participants were encouraged to develop goals and plans that supported their physical activity. Therefore, it is difficult to isolate the impact the interpersonal intervention alone had on participants' self-regulation and their physical activity. Despite the limitations, the role of the qualitative data analysis was to begin to understand the perspectives of participants regarding self-regulation, and their significant responses indicate a need for further research.

Conclusions and Recommendations

The results of this study indicate that self-regulation may play a role in the physical activity of older adults. Strategies such as finding social support for physical activity and friendly social comparison may facilitate self-regulation skills such as problem solving, planning to achieve goals, and overcoming barriers. Nurses play a key role in encouraging older adults to use the strategies that participants discussed in this study. The nurse-patient relationship is one that enables discussions about personal goals and progress, which in turn, may facilitate self-regulation of physical activity. Moreover, if an older adult is interested in initiating or increasing their level of physical activity, a nurse can also introduce a physical activity monitor to track these changes. By assisting the patient with how to use the physical activity monitor and ensuring they interpret their personal data according to their own personal abilities and goals, the nurse-patients relationship, combined with the monitor, may also facilitate maintaining or increasing physical activity. Because social support is a self-regulation strategy, nurses can also encourage and help their older adult patients to connect with their peers to help them meet people who also value physical activity. Further research is needed to explore the engagement between participants and the dynamic context of self-regulation to further understand the relationship between self-regulation and physical activity among older adults and how that can be promoted by nurses.

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Table 1.
Baseline Characteristics of Participants

Variable	Receipt of intervention with interpersonal behavior change strategies	
	Yes (n = 51)	No (n = 50)
Age, Mean (SD)	78 (5.90)	79 (7.1)
Education Attainment > HS, n (%)	33 (65%)	40 (80%)
Female, n (%)	38 (75%)	38 (76%)

Table 2.
Mean values of mediation and outcome variables

Variable	Receipt of intervention with interpersonal behavior change strategies	
	Yes (n = 51)	No (n = 50)
Index of Self-Regulation: Mean (SD)		
Baseline	3.2 (.88)	3.0 (.77)
Immediately post-intervention	3.66 (.80)	4.10 (.69)
Barriers Self-efficacy Scale: Mean (SD)		
Baseline	73.74 (15.16)	71.67 (15.10)
Immediately post-intervention	72.33 (16.13)	72.82 (10.81)
Average daily step count: Mean (SD)		
Baseline	3525.41 (1766)	3222.90 (2882)
Immediately post-intervention	4661.05 (2543)	3429.37 (2585)

Table 3.

Single Mediation Model Results: Effects of the Interpersonal Intervention on Average Daily Step Count with Potential Mediation by Self-regulation

	A path (se)	B path (se)	Indirect Effect (95% CI)
Self-regulation immediately post intervention	.18 (.07)*	277.33 (190.54)	**48.73 [3.09 to 155.00]**

Notes: unstandardized coefficients, se = standard error; PROCESS macro used for all analyses where A and B paths are estimated using ordinary least squares regression, and AB path is estimated by developing 5000 bootstrapped samples of this effect. Bold typeface indicates 95% bias corrected bootstrap interval exclusive of zero
*p<0.05

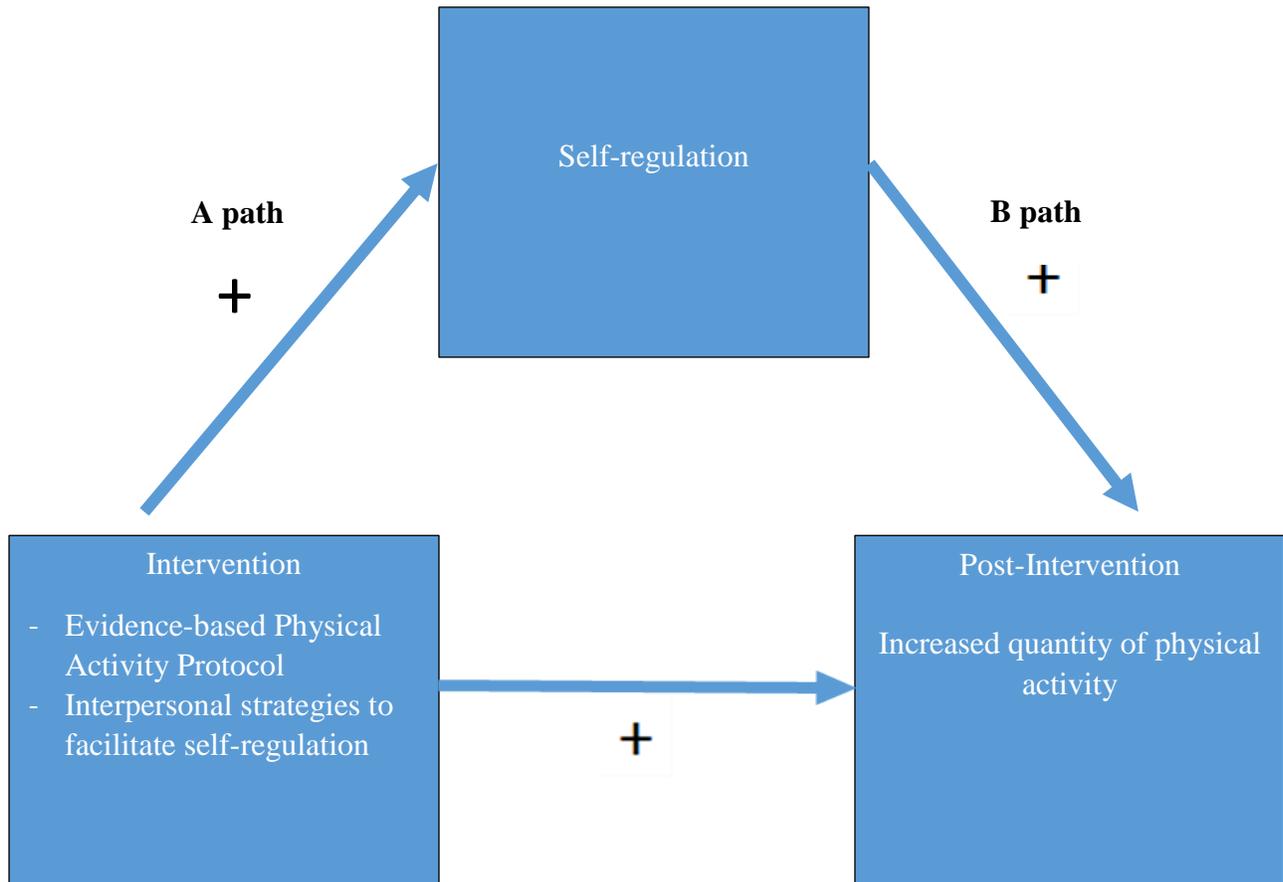*Figure 1.* Visual representation of the Wellness Motivation Theory.

Figure 2. Visual representation of the independent variable, self-regulation, and the outcome variable, physical activity.

Appendix

Semi-structured Interview Guide

1. How did you become interested in participating in the Ready~Steady program?

- Possible probes:

    o Did you see an ad or flier?

    o Did you hear about the program from another person?

2. What made it possible for you to participate in the Ready~Steady program?

- Possible probes:

    o Was the program at a time and day that worked for you?

    o Was the program in a location that was acceptable to you?

    o What did you think of holding the programs in small groups?

3. Since participating in the Ready~Steady program have you been involved in any other

programs in your neighborhood or community that help you to stay active?

- Possible probes:

    o By programs –I mean anything formal or informal –like going to a center,

      walking with friends, neighbors or family

4. Tell me about how the people in your life (like family, neighbors, friends and even your health

care providers) are supportive of your physical activities, and your involvement with programs

like Ready Steady?

- Possible Probes:

    o Does your provider, your doctor or nurse, encourage you to stay active?

    o Does anyone worry about your activities or advise you against them?

5. Talk about your personal expectations and hopes for being physically active now.

- Possible probes:

    - Do you have personal goals you have set yourself?

    - When you look forward to the next year do you have priorities or hopes about your activities and physical abilities?

6. We have learned that many people have unique ways of monitoring and or evaluating their own activity levels and progress. What do you think about this?

- Possible probes:

    - Do you monitor your activities?

    - A lot of people do this in their heads—do you evaluate yourself and activities. I'll give you an example.

7. Tell me what you thought about the Fitbit.

- Possible probes

    - Did you find it helpful?

    - Do you continue to use it?

8. Tell me about when and how you practice the Ready Steady activities now?

- Possible probes

    - Are there certain locations you prefer?

    - Are there certain times of the day or week you prefer?

9. How might the program be improved?