FORMING NEW HABITS: AN INTERVENTION TO DECREASE SEDENTARY BEHAVIOR IN MEDICALLY STABLE OLDER ADULTS

by

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Rationale: Sedentary behavior is characterized by too much sitting. It is estimated that 4 out of every 10 Americans never engage in physically active behaviors, and that approximately 60% of an adult's non-sleeping hours are spent in sedentary behaviors. As sedentary behavior increases, so do diagnoses of chronic illnesses such as diabetes, hypertension, cardiovascular disease, and kidney disease. Older adults are particularly at risk for sedentary behavior and the related chronic illnesses due to the challenges they face with balancing physical and/or cognitive limitations, medical conditions, and the requirements to remain physically active. Often times older adults feel that their only option for safe physical activity is low-speed walking. Occupational therapy intervention options that can decrease sedentary behavior in older adults in the community are scarce, thus the Everyday Meaningful Activities (EMA) intervention is proposed. The EMA Intervention combines concepts from Habit Formation Theory and the Ecology of Human Performance model. It is an individualized, client-centered intervention that aims to increase adherence to meaningful active lifestyle behaviors in older adults' lives. Meaningful active lifestyle behaviors are tasks or activities that promote enjoyment in time spent moving around (i.e. cooking, gardening, creating art, etc.). Participants created new habits by attaching these new active lifestyle behaviors to currently existing daily routines. The aims of this study are (1) to investigate the feasibility of implementing the EMA intervention with medically stable older adults, (2) to investigate the effectiveness of the EMA intervention in forming new active lifestyle behavior habits, and (3) to investigate the effectiveness of the EMA intervention in decreasing sedentary time.

Method: Twelve medically stable older adults in the Greenville, NC community were recruited for this pretest/posttest, experimental design study. During six intervention sessions over six weeks, participants selected two new active lifestyle behaviors to make habitual and created action plans for implementation.

Results: The recruitment rate for this study was 18%. The Rapid Assessment Disuse Index (RADI) was found to not be an appropriate measure for sedentary behavior for this population. The Short Blessed Test (SBT) was found to be an appropriate measure for screening cognitive impairment over the phone. Video conferencing was found to be an appropriate delivery method for selected intervention sessions if the participant is comfortable. Participants' subjective report of activity performance times is not a reliable subjective data collection method. The EMA intervention was effective in forming new active lifestyle behavior habits according to the Self-Report Habit Index (SRHI) and in decreasing perceived sedentary time spent according to the Sedentary Behavior Questionnaire (SBQ).

Discussion: The EMA intervention is a viable intervention for decreasing sedentary behavior in medically stable older adults. With minor changes to the assessments used for screening, a well-rounded sample of participants can be created for pilot testing. In future applications of the EMA intervention, more reliable subjective data on activity performance should be collected in order to compare subjective and objective reports of activity performance.

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CHAPTER 1: PROBLEM FORMULATION

It is estimated that only 35-44% of adults aged 75 years and older are physically active and only 28-34% of adults aged 65 years to 74 years are physically active (U.S. Department of Health & Human Services, 2017). A general decline in physical activity is one of the largest predictors of obesity and obesity related diseases that are the number one killer in the United States, and also comes with an annual price tag of 190.2 billion dollars (Michaliszyn, Higgins, & Faulkner, 2018). Obesity related diseases include type 2 diabetes, high blood pressure, heart disease, stroke, sleep apnea, osteoarthritis, fatty liver disease, kidney disease, and many more (National Institute of Health, 2015). All of these diseases combined contribute to overall declining physical health across the general population including the older adult population.

A decline in physical activity is also a major cause of falls in older adults. According to the Centers for Disease Control and Prevention (2017a), more than 25% of adults aged 65 and older fall every year. This equates to approximately 29 million falls, 3 million emergency department visits, 800,000 hospitalizations, and 28,000 deaths. Falls are the leading cause of both fatal and nonfatal injuries among older adults. The number of falls and deaths related to falls will only increase as the baby boomer generation continues to age. Older adult falls also account for $31 billion in annual Medicare spending. Decreasing sedentary behavior and increasing physical activity to improve balance and strength can significantly lower older adults' chance of falling (Centers for Disease Control and Prevention, 2017b).

Occupational therapy practitioners treat people with conditions related to obesity and lack of physical activity; however, a large amount of time, money and resources are still spent triaging these medical issues both within the rehabilitation professions and across the entire landscape of our American healthcare system (Biener, Cawley, & Meyerhoefer, 2017). Our current healthcare structure is reactive to complications caused by lack of physical activity but lacks proactive strategies to prevent complications caused by lack of physical activity and chronic obesity. If coaching individuals to create new, automatic habits is a viable, effective method in promoting physical activity consisting of meaningful occupations, occupational therapy practitioners would be the ideal profession to deliver this intervention method.

The purpose of this thesis is to explore a potential intervention option for increasing physical activity level by forming new habits anchored in existing daily habits.

CHAPTER 2: LITERATURE REVIEW

Sedentary behavior is characterized by too much sitting (Owen, 2017). Previously, the term sedentary was used to describe those who do little or no physical activity or fail to meet physical activity suggested guidelines. Presently, sedentary behavior and lack of physical activity are differentiated by using the term *sedentary* to characterize behaviors involving prolonged sitting and the term *inactive* to describe individuals who are doing little physical activity. Sedentary behavior is also defined using the metabolic equivalent for tasks (METs), the estimates for energy expenditure during different tasks. Most sedentary behaviors involve sitting or reclining in the range of 1.0 to 1.5 METs, whereas moderate-to-vigorous-intensity physical activity typically requires an energy expenditure of 3 to 8 METs (Owen, 2017). While sedentary behavior is a current epidemic in Western cultures, it is especially prevalent in the United States. Approximately 60% of an adult's non-sleeping hours are spent in sedentary behaviors. This corresponds to 9 to 10 hours per day spent in a sedentary state (Diaz et al., 2017).

Sedentary Behavior, Physical Health, and Associate Factors

There are many risk factors associated with prolonged sedentary behaviors such as an older age, male sex, overweight and obese body mass index classifications, and the winter season (Diaz et al., 2017). Another risk factor is residence in the stroke belt, an area comprised of 11 adjoined states including Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Arkansas, Kentucky, Tennessee, and Indiana, where strokes occur at an 18% higher incidence rate than national averages (Hoffman, 2015). Sedentary behavior has an adverse effect on many domains of physical health. As obesity and sedentary behavior increase in the United States, so do diagnoses of cardiopulmonary conditions, diabetes, degenerative musculoskeletal diseases, and many more chronic conditions (Dunstan et al., 2012).

Context is an important risk factor when considering older adults' level of sedentary behavior. Context related to ethnicity and social class is known to be directly associated with the amount of physical activity an individual engages in during leisure time. Low income and ethnic minority adults have the lowest rates of physical activity (Crespo et al., 2000), whereas people in a higher socio-economic position perform more physical activities in their leisure time. This could possibly be true because they have more leisure time to allocate to physical activity (Crespo et al., 2001). Socio-economic position is most commonly defined by education and income in the majority of the existing literature in this field (Gidlow et al., 2006). When considering socio-economic position, physical activity was much lower in rural populations as compared to urban populations (Guthold et al., 2008).

Cultural context is another important consideration for physical health and activity. The International Physical Activity Questionnaire was used to monitor physical activity prevalence across 20 countries (Bauman et al., 2009). High incidence of sedentary behavior is most prevalent in New Zealand, the Czech Republic, the United States, Canada, and Australia. There was a general decline in the level of physical activity in older groups, but in New Zealand, China, Hong Kong, and Saudi Arabia, physical activity levels increase simultaneously with age. Bauman et al. (2009) found this to be due to the value that these cultures place on remaining physically active throughout the lifespan. In those countries where older groups increased their level of physical activity, there was also a large amount of social supports available for this population seeking appropriate physical activities as opposed to in the Americas and most European countries. These factors all contribute to both an individual's interest in physical activity and the amount of value that they place in physical activity.

The most commonly considered factor of sedentary behavior and health is age. Exercise and fitness activities of moderate-to-vigorous-intensity physical activity are prevalent in young adults rather than older adults in the United States (Belanger et al., 2011). Older adults' primary physical activities are domestic or occupational activities, and they often feel that their only option for physical activity is walking. Even if an individual was active at a younger age, they are likely to forfeit these tendencies in fear that the activity, even if adapted, is no longer applicable in their older age. Because of these reasons, the older adult population has been identified as at risk for inactivity and transition to a sedentary lifestyle (Dogra & Stathokostas, 2012).

Older Adult Population

Any adult that is age 65 or older is considered an older adult in the United States. The American older adult population is rapidly growing as individuals are living longer now than ever before (Colby & Ortman, 2014). The 2019 census found that there are approximately 50.9 million older adults in the U.S., with that number projected to rise to 98 million by 2060 (United States Census Bureau, 2019). As adults age, they typically manage two or more chronic conditions including heart disease, cancer, emphysema, stroke, diabetes mellitus, Alzheimer's disease, obesity, high blood pressure, and many more (Office of Disease Prevention, 2019). It is clear that older adults face varying factors that can drastically change their activity levels and daily routines. Older adults do not follow a typical course of aging; rather, they have their own experiences with aging that is impacted by individualistic aspects of their lives (e.g. living condition, family/social support, finances). It is for these reasons that describing any older adult as healthy can be misleading.

Historically, it has been challenging to define the healthy, or not medically at-risk older adult population, because of the variety of health conditions that older adults face as they age. Researchers typically define being healthy based on the body system that they are studying (i.e. no underlying neurological conditions for a study on typical cognition, no recent joint replacements or bone fractures for a study on the healthy musculoskeletal system) and do not define healthy older adults globally across all body systems. Other studies have relied on a physician's note indicating ability to safely participate in research. Some researchers allow their participants to self-report healthy status and confirm that they are able to meet the demands of the study and are not suffering from any chronic condition that would apprehend their performance. One study described healthy older adults comprehensively as individuals without an acute or terminal illness, myocardial infarction in the past 6 months, unstable cardiovascular or metabolic disease, neuromusculoskeletal disorders severely disrupting voluntary movement, limb amputation, upper or lower extremity fracture in the past 3 months, current symptomatic hernias or hemorrhoids, or cognitive impairment (Orr et al, 2006). This is the only readily available definition that views participants globally and clearly defines impairments that classify an individual as unhealthy.

Older adults tend to deviate from former physical activity patterns for a variety of reasons. Hwang (2010) assessed older adults aged 55 years and older in the community using the Health Enhancement Lifestyle Profile to identify healthy lifestyles associated with aging. The study identified and measured exercise, diet, social and productive activities, leisure, activities of daily living (ADLs), stress management, and spiritual participation as components of health enhancement. The author confirmed that, as older adults' identities begin to shift in this stage of life, these areas were becoming challenging to fit into their daily life. This finding is important to older adults' general health because lifestyle choices directly determine health and vitality in older adults living independently in their communities as described in the refined *Model of Successful Aging* (Rowe & Kahn, 1997).

Older adults have also described the task of coordinating their chronic conditions of normal aging process and the appropriate levels of physical activity as if they are balancing on a slackline where any wrong step will result in a complete health or lifestyle imbalance (Bay et al., 2018). Older adults identified with at least one of the following four subthemes to describe their individual relationship with physical activity: enjoying the challenges of physical activity, adapting to physical ability, lacking prerequisites for physical activity, or feeling excluded depending on physical ability. If the appropriate balance with physical activity is not found, older adults may face an uphill battle of fighting chronic diseases, primarily cardiovascular disease (Steca et al., 2017). Healthcare providers, including occupational therapy practitioners, can assist older adults in maintaining or developing healthy lifestyle interventions to support appropriate physical health and activity and decrease sedentary behaviors.

Current Interventions for Sedentary Behavior

Increasing physical activity can improve one's physical health and well-being (World Health Organization, 2009). The United States Department of Health and Human Services has a committee responsible solely for creating and monitoring physical activity guidelines. The Physical Activity Guidelines Advisory Committee reports that physically active people have higher levels of health-related fitness, a lower risk profile for developing a number of disabling medical conditions, and lower rates of various chronic diseases than do people who are inactive (Physical Activity Guidelines Advisory Committee, 2018). Recent literature has also shown that both the total volume of sedentary time and its accrual in prolonged bouts are associated with increased mortality (Diaz et al., 2017). The link between health and physical activity is undeniable.

One study identified the need for a paradigm shift in the way that healthcare providers view physical activity and sedentary behavior (Katzmarzyk, 2010). For the past 70 years, healthcare providers have viewed moderate-to-vigorous intensity physical activity as the gold standard in maintaining a healthy lifestyle. Katzmarzyk (2010) argues that sedentary behavior should be the primary concern of healthcare providers, and sedentary behavior can still exist in individuals who participate in short bouts of moderate-to-vigorous intensity physical activity. Humans are designed for movement, yet most Westernized humans spend most of their time seated and sedentary. Katzmarzyk (2010) calls for active lifestyle habits to be implemented in individual's lives, not just a routine of a short exercise routine.

Community interventions in promoting active lifestyles have been identified as an integral part of the overall strategy to increase physical activity behaviors in the United States (Kahn et al., 2002). Community interventions have been tested to increase physical activity in the greater population, and increasingly more interventions are specifically targeting older adults (Baker et al., 2015). Specifically, these interventions involve general education about why active lifestyle behaviors and physical activity are important in terms of improving physical health status, rather than individualized approach.

The effectiveness of community-wide campaigns for physical activity have been tested in middle aged and elderly people, and these campaigns have demonstrated the individualistic nature of motivation for physical activity (Kamada et al., 2013). Community-wide campaigns for increasing physical activity in older adults typically include highly visible, multi-component strategies that are implemented across different community sectors in generalized group settings

(Kamada et al., 2013). The purpose of a community-wide campaign is to target a specific behavior and identify effective strategies that can be taught to a variety of different people in different types of communities. The goals of the program are to (1) implement effective, generalizable, evidence-based strategies that are easy to educate different populations on and (2) reduce healthcare spending by educating populations on certain information and, as a result, improving overall health outcomes. Kamada et al. (2013) studied the effectiveness of traditional community-wide campaigns in promoting aerobic physical activity. They found that selected individuals respond well to community interventions; however, the majority of older adults prefer individualized approaches that are tailored to their unique circumstances. Although many older adults showed frequent engagement in aerobic physical activity immediately following the community-wide campaigns, follow-up testing at 1-year post community-wide campaign indicated that the community-wide campaigns did not produce long-term increases in aerobic physical activity. Kamada et al. (2013) concluded that community-wide campaigns may be an appropriate supplement to individualized interventions for increasing physical activity and decreasing sedentary behavior but are not effective long-term when used without individualized interventions.

The Otsego-Schoharie healthy heart program identified the residents of three rural counties in New York as at risk for cardiovascular disease due to their physical health state (Nafziger et al., 2001). The authors examined the effectiveness of a hospital-based public health intervention program that aimed to reduce cardiovascular disease risk by providing more health education to isolated populations, specifically cities with populations of 50,000 to 150,000. The intervention included direct education on exercise, healthy diets, risk factor screenings, and smoking by a full-time health educator and a full-time exercise physiologist. Efforts were also made to increase healthy lifestyle demonstrations and tips across media platforms (i.e. radio, newspaper, TV). Lastly, simple health literacy fact sheets were posted in workplaces, grocery stores, medical clinics, and schools, and as paycheck inserts. The intervention was provided over the course of 5 years. Overall, smoking prevalence declined from 27.9% to 17.6%; however, cholesterol and blood pressure levels both remained unchanged and body mass index increased significantly over the 5-year period. Of the domains targeted in this study, only smoking showed improvement. Although the study showed that simple education could improve smoking levels through their long-term intervention, the limitations of this study extend into the financial feasibility and sustainability of hosting education sessions on healthy lifestyles for people in rural areas long-term.

Jenum et al. (2006) also found that community-wide education alone does not have lasting impact on improving physical activity and physical health or in decreasing sedentary behavior, even if it was shown to be effective short-term. The intervention was comprised of a set of strategies that were based in psychosocial and ecological models that promoted physical activity in a low-income, multiethnic district. The intervention was developed through consulting health and welfare workers as well as political leaders to ensure feasibility and future possibility for reimbursement. A group of lay persons was also included in the development process to ensure applicability to the community population. The study aims included increasing awareness of physical activity and sedentary behavior, improving knowledge about physical activity and sedentary behavior, and changing attitudes toward physical activity. Participants were living within a low-income district and were identified by a government agency to be at risk for diabetes mellitus type II and cardiovascular disease. They were provided with specially designed leaflets and both individual counseling sessions and organized group walking sessions.

Investigators also labeled walking trails within the district, had the street lighting improved, and had the paths for walking trails treated in the winter to make the areas more accessible in the event of winter weather. All of these improvements and resources were developed and offered as a resource but were not required to be used by the participants. The process of meeting with district officials and arranging new community resources improved health literacy in the district; however, authors did not find significant positive impacts on sedentary behavior or physical health (Jenum et al., 2006).

While the population within the district as a whole benefitted from the new resources, ultimately the participants did not improve their physical health or decrease their sedentary behavior. The study found that education about health literacy and community resources that support physical activity may make small differences, but ultimately education needs to be coupled with direct, guided, and individualized steps to promote healthy lifestyle behaviors. The most at-risk populations for developing dangerous sedentary behavior are not likely to spontaneously utilize community resources. In summary, although community-wide education interventions may have the positive short-term effects on sedentary behaviors and/or physical health, literature supports that individual approach may be necessary to produce the long-term, sustainable positive changes in those outcomes.

Defining Habits and Habit Formation

The Occupational Therapy Practice Framework defines habits as specific, automatic behaviors that may be useful, dominating, or impoverished (AOTA, 2014). Habits are further defined as automatic behavior patterns that respond directly to a situation in which the behavior has been performed repeatedly and consistently (Wood & Neal, 2009). When a new action is performed in a specific situation, the brain associates the situation and the action or response.

Repetition then reinforces the series of stimuli and responses in the memory that become accessible for when the same stimuli occur again. Proactive behavior change is a long-term process characterized by new, health-promoting behavior and maintenance of this behavior over time (Lally & Gardner, 2013).

New activities are sustainable when they are introduced into an existing routine as a habit (Segal, 2004). New habits are successfully formed when individuals take responsibility for their new habits and experience some level of autonomy over the new habits. For example, college students riding bicycles to school demonstrates how habits and routines intertwine to achieve goals. The actual act of riding a bicycle is considered quite automatic (habitual), but the habitual nature of riding the bicycle is activated by the desire to complete a goal. The student must ride the bicycle to attend lectures on Monday and Wednesday in order to not fail the course. This is the goal, or the reasoning behind the activation of subsequent automatic behavioral steps such as "going to the garage to get the bike" and "turning left at the statue at the corner of the campus." This habit can be viewed as a hierarchical mental representation in which activation of the goal to get to the lecture leads to a number of associated behaviors (i.e. going to get the bike and turning left at the statue) that are lower in the hierarchy. The student's goal to not fail the course requires him to perform this hierarchy of habitual behaviors every Monday and Wednesday. The student does not schedule anything else during this time on Monday and Wednesday because the performance of this hierarchy of habitual behaviors is a part of his Monday and Wednesday routine (Aarts & Dijksterhuis, 2000).

Habit formation interventions and behavior change interventions are heavily guided processes in which healthcare professionals and research investigators focus on adopting new behaviors to be a part of one's life (Jeffery et al., 2000). Habit formation interventions focus on the individual’s current circumstances and address the need for behaviors to become automatic to withstand the future changes in an individual’s circumstances.

The active intervention period of a habit formation intervention is the period of time when one is consciously working toward behavior change using specific guidelines and steps (Jeffery et al., 2000). Research has shown that habits may take approximately 66 days to become automatic (with a range of 18-254 days) and remain long-term habits (Jeffery et al., 2000; Lally et al., 2010). Many physical activity behavior change interventions are neither long enough to support habit formation, nor are they internalized by the individual to the point of becoming habitual behaviors. When the active intervention period ends (when the heavily guided process ends), engagement with the behavior ends as well, supporting the argument that interventions for new active lifestyle behavior habits should consider the client’s individualized interests, dynamic environments, contexts, and abilities outside of the intervention setting (Jeffrey et al., 2000).

Habit formation requires progression through four stages (Lally & Gardner, 2013). First, a decision must be made to take action. Next, the decision to take action must be translated into physical action. An “intention-behavior gap” often occurs in this stage when an individual must progress through many obstacles of planning to close the gap between the intention to perform an action and the implementation of behaviors that produce the action (Webb & Sheeran, 2006). The third stage involves repetition of behaviors and requires continued internal and external motivation. Finally, the new action must then be repeated in a fashion conducive to the development of automaticity. This final stage shows the importance of individualized approaches to habit formation. What one individual finds conducive to development of automaticity will not be the same as another individual (Lally & Gardner, 2013).

Existing literature encourages the formation of healthy habits due to their ability to make healthy behaviors more resistant to unhealthy lapses (Rothman, Sheeran, & Wood, 2009). Habit formation can be a concrete way to ensure that healthy behaviors last beyond the intervention period; other models of behavior change or simple routine maintenance cannot provide the same certainty in maintained change.

Habit Formation as an Intervention for Sedentary Behavior

Most individuals learn about their need to increase physical activity from their primary care physicians, but minimal effective strategies are offered from these physicians (Beeken et al., 2017). Interventions that are designed and implemented within primary care continue to follow group designs that are not individualized. Other disciplines have begun to explore different ways to increase physical activity using routines. These disciplines are finding short-term success, not long-term success because the goals of the intervention are not individualized to the individual or internalized by the participants (van Bree et al., 2016). There are currently no interventions within occupational therapy literature that support active lifestyle behavior habit formation as a method for increasing physical activity or decreasing sedentary behavior in older adults. Instead, most habit formation interventions have occurred within exercise science and sport psychology and have been assumed to be more effective when used in the context of meaningful occupations that are motivational to individuals (van Bree et al., 2016; Fleig et al., 2015).

The most relevant intervention utilizing habit formation is the *Everyday Activity Supports You* (EASY) *Lifestyle integrated Functional Exercise* (LiFE) program that is a theory-based behavior change intervention encouraging participants to incorporate strength and balance exercises into daily routines (Fleig et al., 2015). The study consisted of seven two-hour group sessions and two 30-minute follow up phone calls over the course of four months. A certified exercise physiologist introduced and reviewed balance and strength exercises with participants that would contribute to reduced fall risk. New exercises were added at each session in order to gradually build a comprehensive home exercise program that was well-understood by all of the participants. A health psychologist was involved in this process to assist participants with setting goals, creating action plans, and encouraging self-monitoring. Participants were also encouraged to gradually integrate exercise into their existing routines because this strategy has been shown to be the most effective way to incorporate new active lifestyle behavior with consistency. The study participants were 13 women at retirement age.

The participants were assessed at pretest and posttest. At posttest, participants reported increased use of action planning, increased physical activity habit strength and automaticity, and increased self-identity. The participants also expressed that they felt more “in control” of their health and more stable in the face of balance challenges that increase with age. This program produced statistically significant results supporting habit formation as an effective intervention for increasing physical activity, although it had a small sample size and lacked a control group. The authors further called for an individualized approach that may appeal to the older age groups. One of the limitations of this study was that participants repeatedly noted challenges with making all exercises habitual. They reported being able to incorporate a few select exercises into their routines but struggled to maintain these results long-term. This report demonstrates the concept that forming one new habit is easier than forming multiple at a time. This limitation shows the importance of taking a specific, smaller-scale approach to sedentary behavior and physical activity.

Another study (van Bree et al., 2016) explored the relationship between intention, physical activity, and habits and found that there are many other variables involved in forming novel habits. The purpose of this study was to determine if a general knowledge of the need for physical activity would create self-motivated action planning and habit formation. This intervention required older adults to complete surveys on intention, physical activity, and habits over the course of a year. At baseline, information on the levels of intention, physical activity level, and habit were collected. At three months following baseline, the participants completed surveys on action planning 3 months following the initial session. Physical activity levels were assessed 6 months following the initial session. Finally, at 1 year following baseline, habit was assessed. Overall, spontaneous action planning and habit formation were not observed within the participants. In addition, the participants required a combination of accountability and education to create habits and encountered different personal factors over the course of the year that impeded upon their ability to form healthy lifestyle habits. This study also demonstrated the need to explore variables that may mediate or moderate the habit formation and physical activity relationship. These findings reinforce the need for individualized interventions. In summary, an intervention approach that takes individual's personal roles, routines, and occupations into account with the habit formation component may have the potential to increase physical activity in older adults.

Previous literature demonstrates the need for a guided intervention process that gradually introduces meaningful activities into an individual's life (van Bree et al., 2016). This introduction of meaningful activities should be gradual and focused on individualized application to facilitate long-term adherence to behavior change (Fleig et al., 2015). Additionally, long-term behavior change interventions are most successful when the participants have a balance of external accountability from the intervention team and internal intention and motivation to create new active lifestyle behavior habits (van Bree et al., 2016). Thus, the Everyday Meaningful

Activities (EMA) intervention is proposed to create long-term behavior change through individualized intervention that incorporates habit formation education and guided implementation.

The Everyday Meaningful Activities Intervention

The Everyday Meaningful Activities (EMA) intervention was developed to facilitate the formation of new automatic active lifestyle behaviors that support individuals' physical health by decreasing sedentary behavior (Kim, 2019). It is an individualized intervention that targets the gradual introduction of behaviors into participants' existing daily routines. Active lifestyle behaviors are tasks or activities that promote time spent moving around that can be enjoyable, meaningful, essential, or even menial to an individual (i.e. cooking, gardening, walking the dog, cleaning, etc.). The EMA intervention seeks to decrease sedentary behavior by assisting individuals in selecting specifically meaningful, enjoyable active behaviors to engage in.

Theoretical background. The EMA intervention is developed based on both the Ecology of Human Performance model of practice and Habit Formation Theory (Dunn, 2017; Lally & Gardner, 2013).

The Ecology of Human Performance. Ecology of Human Performance model of practice was developed by occupational therapists for intended use by interprofessional teams as a way to support collaboration (Dunn, 2017). It uses more familiar language that both individuals from other disciplines outside of occupational therapy and lay persons are better able to understand practically (i.e. using the word "task" instead of "occupation"). The primary purpose of this framework is to provide a "framework that emphasizes both the essential role of context in participation and the critical nature of the relationships" (p. 210) among the framework's core constructs: the person, task (occupation), and context. The person consists of past experiences, personal values and interests, sensorimotor, cognitive, and psychosocial skills. The task is defined as a set of behaviors available for the person to accomplish as a goal. There can be different levels of a task dependent upon the size of the sets of behaviors (i.e. laundry versus folding a t-shirt). Context is the conditions surrounding the person, and it can either support or inhibit the performance in the task. Context under the Ecology of Human Performance consists of temporal, physical, social, cultural aspects. Lastly, performance occurs when a person engages in tasks within contexts while these three main components are interacting with each other. The Ecology of Human Performance views the person and their context as a composite that cannot be separated. People change their context when they leave their home to go to work or school for example. Tasks completely surround the person within their context, and the person and context together determine which tasks are acceptable and feasible for them. One unique aspect of this model of practice is the intervention strategies that are to support the needs and interest of the person and person's performance. These intervention strategies include 1) establish/restore intervention, 2) alter intervention, 3) adapt/modify intervention, 4) prevent intervention, and 5) create intervention.

The first strategy, establish/restore intervention aims to improve the person's skills. The person may either establish a new skill or restore a skill that has been lost due to illness or injury. Context features determine the availability of tasks, provide support for performance, and give feedback about the performance necessary to learn. When using the alter intervention approach, the context is the primary focus. The contexts remain the same, but the best match between the person's interests and the demands of their contexts is found. In other words, the alter intervention approach finds the match between an individual's current abilities and the context options that are available for the individual to use their abilities in. The adapt/modify intervention involves changing aspects of the environment and making adjustment to features of the context. The change in context should directly support the individual's performance. The prevent intervention approach focuses on changing parts of person, context, and/or task variables that will prevent negative outcomes. This involves reducing opportunities for symptoms to arise or for future injuries to occur due to faulty performance techniques. Lastly, the create intervention approach focuses on creating new supports that promote optimal occupational performance. This is done by targeting person, context, and task variables together and not assuming that a problem exists or is likely to occur. This intervention focuses on supporting performance for all individuals and populations despite varying abilities. Any of these five intervention approaches can be chosen to have a comprehensive view of intervention options and select the best intervention option.

Habit Formation Theory. Habit Formation Theory focuses on one major foundational concept: automaticity (Bargh, 1996). The four major components of automaticity are unintentionality, unawareness, uncontrollability, and high efficiency (Bargh, 1994). Habits are challenging to form because, in order for them to become habits, they must be automatic. No human can decide one day that they want to make a new action a habit, go to sleep, wake up the next morning and have a new habit. Committing a task to the subconscious in the brain is a process that requires strategies typical individuals may not have within themselves. When a new action is performed, a mental association between the situation and the action is created. Repetition reinforces this association in memory, making alternative actions less accessible in the situation. There are four stages of habit formation for health behavior change: a decision must be made to take action, that decision to act must be translated into an action, the behavior or action must be repeated with continued motivation, and the new action must also be repeated in a specific fashion conductive to the development of automaticity (Lally & Gardner, 2013). The specific fashion conductive to the development of automaticity involves a balance between rewards, consistency, the complexity of the behavior, and cues.

When performance of a behavior is highly rewarding, the likelihood that the behavior is repeated is high (Lally & Gardner, 2013). Habits are thought to develop when rewards are received for each repetition of a behavior. There is a difference between an extrinsic reward and an intrinsic reward in terms of habit formation and behavior repetition (Ryan & Deci, 2000). If an individual repeats a behavior in anticipation of the extrinsic reward, the reward becomes more meaningful than the behavior. When an individual repeats a behavior in anticipation of an intrinsic reward, the behavior performance becomes a self-sufficient process that does not require external resources. Research also indicates that missing one opportunity to perform a behavior has a negligible impact on habit formation (Lally et al., 2010). The need for consistency of behavior encourages structured guidance throughout habit formation interventions that ensures the frequency of behavior repetitions stays above the level of consistency needed to form a habit. Next, the complexity of the behavior has a direct impact on habit formation success. Complex behaviors, when repeated in stable circumstances, result in less automaticity than simple behaviors repeated in stable circumstances. Finally, cues are a necessary aspect of habit formation; when a cue is given, the new behavior should occur directly after. The more salient the cue is, the higher change that a new, planned behavior will be performed, therefore increasing habit formation success. Taken together, intrinsic rewards, behavioral consistency, complexity of behavior, and cue saliency directly impact an individual’s success in forming a new habit.

Intervention features. The EMA intervention adopts the broad scope and the intervention strategies of the Ecology of Human Performance model of practice and four stages and facilitating elements of Habit Formation Theory. This intervention takes an individualized approach and aims to assist participants with forming an active lifestyle habit to promote long-term decreases in sedentary behavior. The intervention takes place over the course of 8-10 weeks. Throughout the intervention sessions, the individual is guided to decide what tasks/active lifestyle behaviors they will form as a habit, create action plans for those activities, and self-implement those action plans based on their abilities and contexts. Interventionists will work with each participant in a one-on-one setting throughout the intervention to create action plans for implementing new behaviors, provide education about habit formation and sedentary behavior, and problem-solve roadblocks that participants may encounter when attempting to create new active habits.

Guidance for this intervention is provided in the participant workbook (Kim, 2019). This is a manual that is given to each participant at the beginning of the intervention. The participant workbook includes all of the education that the participants are provided with throughout the intervention, worksheets for creating a detailed action plan for activity implementation, and the daily activity sheet in which the participants record the times that they performed their activities each day for accountability. Primarily, the participant workbook is a resource for participants to understand the concepts of new habit formation and to record their progress in their active lifestyle behavior implementation. Additionally, the participant workbook is a resource for the interventionists to have a structured, standardized vocabulary to explain the principles of habit formation and sedentary behavior in a coherent manner.

Taken together, the participant workbook and weekly intervention sessions are designed to provide the participants with access to resources that will assist them while forming new active lifestyle behavior habits. The EMA intervention is proposed to fill the gaps of previous behavior change intervention studies and create a long-term solution for active lifestyle behavior change.

Summary

The World Health Organization outlined the need for healthy, active lifestyle behavior habits in the older adult population in the United States in their global health risks publication in 2009 (World Health Organization, 2009). Previous research also indicates a strong need for an effective way to encourage active lifestyle behavior as a method for increasing the overall health of the older adult population (Kahn et al. 2002). In addition, behavioral research that could lead to effective interventions for influencing sedentary behaviors is less developed, especially for older adults (Owen et al., 2011). Therefore, the purpose of this thesis is to further the existing research body by investigating an intervention utilizing habit formation and occupations to develop new active lifestyle behavior habits in order to decrease sedentary behaviors in older adults in the community.

Additionally, there is an overall lack of literature supporting long-term improvement of sedentary behavior levels. Interventions involving habit formation in other disciplines (e.g. clinical psychology, nutrition and weight loss) are being tested to show the effectiveness on maintenance of exercise habits. Occupational therapy could be a successful avenue to decrease sedentary behavior in older adults with its comprehensive view on person, environment, and occupations through models of practice, activity analyses, therapeutic use of self, and cognitive and physical approaches. Incorporating meaningful active lifestyle behaviors (occupations) into occupational therapy intervention may be able to decrease sedentary behavior and increase overall physical health of older adults in the community.

The primary aim of this study is to investigate the feasibility of implementing the EMA intervention with medically stable older adults who are living in the community. Specifically, the objectives of investigating the feasibility of this intervention are to determine (1) the recruitment rate for medically stable older adults in the community for this study, (2) the appropriateness of the Rapid Assessment Disuse Index (RADI) for screening sedentary behavior in older adults over the phone, (3) the appropriateness of the Short Blessed Test for screening sufficient cognitive ability in older adults over the phone, (4) the appropriateness of video conferencing through WebEx on an iPad as an acceptable delivery method of selected intervention sessions, and (5) the reliability of participants' subjective reports of exact times for performing active lifestyle behaviors.

The secondary aims of this study are to determine (1) if the EMA intervention is effective in forming active lifestyle behavior habits and (2) if the EMA intervention decreases perceived sedentary time in medically stable older adults living in the community.

CHAPTER 3: METHODOLOGY

Design

This study was a pretest/posttest, experimental design study with healthy older adults in Greenville, North Carolina. The study occurred over the course of 8 to 10 weeks, with eight sessions including pretest and posttest at the beginning and end of 8 to 10 weeks.

The independent variable for the secondary aims was the EMA intervention. The dependent variables for the primary aim were (1) the recruitment rate calculated using the total number of participants and the total number of referrals, (2) the appropriateness of the RADI determined by the average RADI stair climbing scores compared to the average RADI moving around and sitting scores, (3) the appropriateness of Short Blessed Test determined by comparing it to the Montreal Cognitive Assessment – Blind Version, (4) the appropriateness of video conferencing determined by technical difficulties, and (5) the reliability of subjective report of activity performance determined by the daily activity sheet. The dependent variables for the secondary aims were habit automaticity as determined by the Self-Report Habit Index (SRHI) (Verplanken & Orbell, 2003) and changes in sedentary behavior as determined by the Sedentary Behavior Questionnaire (SBQ) (Rosenberg et al., 2010). It was hypothesized that the participants would show improvement on these secondary outcome measures at the posttest compared to pretest after receiving the intervention.

Participants

Participants were 11 sedentary older adults who were not medically at-risk and were living in the community. The inclusion criteria were (1) age of 65 years or older, (2) intact cognition confirmed by the Short Blessed Test (Katzman et al., 1983) score of 6 or lower, (3) self-report of no physical activity restrictions from the physician, (4) sedentary lifestyle confirmed by the Rapid Assessment Disuse Index (Shuval et al., 2014) score 26 or greater, (5) living 20 miles from and being able to travel to the College of Allied Health Sciences at East Carolina University for designated intervention sessions, (6) having access to a telephone and/or the internet for intervention sessions. The exclusion criteria include having any of the following conditions: an acute or terminal illness, a myocardial infarction in the past 6 months, unstable cardiovascular or metabolic disease, neuromusculoskeletal disorders severely disrupting voluntary movement, limb amputation, upper or lower extremity fracture in the past 3 months, current symptomatic hernias or hemorrhoids, or cognitive impairment (Orr, Vos, Singh, Ross, Stavrinos, & Fiatarone-Singh, 2006). Convenience sampling from Pitt County, North Carolina was used to recruit twelve participants for the study.

Measures

Descriptive measures. The descriptive measures discussed below were only administered at pretest; the descriptive information further informed the data collected from this study's participants.

*Demographic and medical information***.** General demographic and medical information were collected using a form that was created by the research team. Demographic information collected from this form included the participant's date of birth, age, race, gender, highest education level completed, marital status, living status (i.e. independent, independent with spouse, etc.), support system (i.e. receiving any support from anyone), living environment, previous and current occupation, total household annual income, and driving status. Medical information collected from this form included the participants' last admission to the hospital and diagnosis for the admission, length of the hospital stay in days, current geographical location, any history of cardiovascular diseases and type, intervention for cardiovascular diseases over the last 2 years, cardiovascular risk factors, history of other major diagnoses (i.e. CVA, peripheral vascular disease, COPD, dementia, cancer, etc.), and history of receiving rehabilitation therapies.

The Montreal Cognitive Assessment Blind Version (MoCA-B). The Montreal Cognitive Assessment Version 8.1 was designed as a rapid screening instrument for mild cognitive dysfunction, taking less than 10 minutes to administer (Nasreddine et al., 2005). The MoCA assesses eight different cognitive domains, including attention and concentration, executive functions, memory, language, visuoconstructional skills, conceptual thinking, calculations, and orientation. There are 11 subtests in the MoCA: alternating trail making, visuoconstructional skills (cube), visuoconstructional skills (clock), naming, memory, attention, sentence repetition, verbal fluency, abstraction, delayed recall, and orientation. Each subtest is scored based on the standardized instructions given in the manual. All of the subtest scores are summed, and one point is added if the individual has completed 12 or fewer years of formal education. The individual is considered to have normal cognitive function if they score a 26 or above out of 30 possible points.

The MoCA has demonstrated good construct validity and excellent factorial, convergent, and discriminant validity (Freitas et al., 2012). Freitas et al. (2002) composed a sample of 830 participants that were then distributed to a health subgroup and a clinical subgroup. The healthy group was comprised of cognitively healthy, community-dwelling individuals. All of the individuals were over 25 years old and did not have significant motor, visual, or auditory deficits. They had no history of alcoholism, substance use disorder, or neurological or psychiatric diseases. They were also absent of depressive complaints and were not actively taking medication with possible impact on cognition such as psychotropic or psycho-active drugs. The clinical group was comprised of 90 participants with mild cognitive impairment (MCI) and 90 participants with Alzheimer's disease. Participants were absent of high dementia severity, recent pharmacology changes, recent psychiatric comorbidity, and significant motor, visual, or auditory deficits.

Two control subgroups were selected from the healthy group to match each participant on variables that were found to be predictive of the MoCA's performance. These group's participants were additionally matched on gender, resulting in a perfect match between the group with MCI and the control group, and the group with Alzheimer's and the associated control group. The MoCA was then administered to all of the participants across groups. The MoCA had good diagnostic accuracy to discriminate MCI and Alzheimer's participants from the cognitively healthy adults (Frietas et al., 2012). The MoCA also showed good sensitivity and specificity in identifying deficits in the appropriate cognitive domain (i.e. short-term memory, executive function, working memory, etc.).

The MoCA does require the individual taking the test to draw and write during different subtests. Because all screening was done over the phone, the potential participants were not able to complete these subtests. In order to accommodate the phone screening process, we used the Montreal Cognitive Assessment- Blind Version (MoCA-B). The visual requirement of the cognitive assessment has been removed in the MoCA-B, and scores have been accurately adjusted to represent cognitive dysfunction. In the full version, a score of 26 or greater indicates no cognitive dysfunction; a score of 18 or greater indicates no cognitive dysfunction on the MoCA-B (Wittich et al., 2010). This was determined by calculating both the absolute shift and the relative shift. The absolute shift is the number by which the cutoff value is reduced by the absolute value of points that were omitted from the original measure. A total of 8 points were removed from the original measure, making the absolute shift 8. The relative shift is the number to which the cutoff value should be moved in proportion to the total score. This original measure's cutoff score is 25/30, or 83% of the total maximum score. The MoCA blind's relative shift is 18/22, or 82% of the total maximum score to be most comparable to the original MoCA version.

When comparing the MoCA-B to the original MoCA, specificity remains excellent, but sensitivity is reduced (Wittich et al., 2010). Despite the results from tests of sensitivity (100%) and specificity (87%), the MoCA-B remains a valid assessment for telephone screening purposes (Zietemann et al., 2017). When compared to another telephone cognitive assessment, the Telephone Interview for Cognitive Status (TICS), the MoCA-B shows stronger sensitivity to cognitive impairment (Cohen & Alexander, 2017). Overall, research indicates that the MoCA-B is a valid screening tool for cognitive impairment that can be reliably used over the telephone.

The Center for Epidemiology Studies-Depression Scale (CESD). The CESD is an appropriate demographic measure to include when considering participants' risk factors. Creating new habits requires motivation and consistency in scheduling (Lally & Gardner, 2013). Individuals who have difficulty with depressive symptoms or depression may lack both of these essential items to habit formation (Fried et al., 2016).

The CESD measures depressive symptoms in adults (Radloff, 1977). It was designed for use for general population surveys and is a short, self-report measure. The scale was developed to include the major components of depressive symptomatology: depressed mood, feelings of guilt and worthlessness, feelings of helplessness and hopelessness, psychomotor delay, loss of appetite, and sleep disturbance. The possible range of scores is zero to 60, with higher scores indicating more symptoms. A full version of this scale is provided in Appendix B.

Radloff (1997) compared results of the preliminary administrations of the CESD across age, sex, race, and educational subgroups of the population in order to justify the epidemiologic uses of the scale and demonstrate generalizability. High internal consistency was found both with inter-item and item-scale correlations between patient samples and population samples. However, this high internal consistency may be susceptible to some level of response bias if individuals choose to answer all questions in either a positive or negative direction. The extreme of this response bias was not present in data, confirming that response bias is not the major contributor to the reliability of the scale. Test-retest correlations were assessed and found that the CESD was sensitive to possible depressive reactions and changes in an individual's life over time. The CESD is not designed for clinical diagnosis, but it does accurately reflect improvements after psychiatric treatment (Radloff, 1977).

The Activity Measure for Post-Acute Care (AM-PAC). The AM-PAC measures basic mobility, daily activity, and applied cognition in terms of activity limitations defined as a difficulty in the execution of a task or action by an individual (Haley et al., 2004). An activity limitation is a difficulty in the execution of a task or action by an individual. It was originally designed for use in post-acute care but is now widely accepted in other areas of practice. The AM-PAC Outpatient Short Form was used in this study. This form assesses basic mobility, daily activity, and cognition on a 1 (*unable to perform*), 2 (*a lot of difficulty*), 3 (*a little difficulty*), to 4 (*no difficulty*) scale. Sample questions of the scale are provided in Appendix C.

Jette et al. (2007) found the AM-PAC to have excellent psychometric properties in a sample of 1,815 patients with spine, lower extremity or upper extremity impairments who received outpatient physical therapy across five states in the United States. All three subscales demonstrated excellent test-retest reliability between administrations ranging 1 to 7 days but with an average of 3 days. The basic mobility and daily activity subscales demonstrated excellent interrater reliability when administered by two physical or occupational therapists (Andres et al., 2003). The applied cognition subscale demonstrated adequate interrater reliability. Overall, the basic mobility subscale produced better reliability and validity than the daily activity subscale did.

Primary Outcome Measures. The primary outcome measures were used to determine the feasibility of varying aspects of the implementation of the EMA intervention with medically stable older adults.

Recruitment rate. Records of all of the referrals for this study were kept throughout the recruitment process. If an individual who was screened for the study was deemed ineligible, the determining factor was recorded. Data was also recorded about individuals who were screened for the study, deemed eligible, yet declined participation. The primary sources of referrals were also recorded.

Appropriateness of the Rapid Assessment Disuse Index. The Rapid Assessment Disuse Index (RADI) quickly identifies people with high levels of sitting and sedentary behavior and low daily physical activity (Shuval et al., 2014). The RADI can be administered and scored in 5 minutes or less. It allows healthcare professionals to quickly screen for sedentary behavior over the past week, month and year, providing a brief history of sedentary behavior. There are three questions for each of lifestyle activity, including moving around, stair climbing, and sitting, that are reverse scored. Scores range from 9 to 45 with higher scores indicating higher levels of disuse. Individuals who score a 26 or higher on the RADI demonstrate a dangerous level of sedentary behavior. The full version of this assessment is provided in Appendix D. Shuval et al. (2014) found the results on the RADI to directly correlate with sedentary time collected from an accelerometer, showing high criterion validity. The RADI also had excellent test-retest reliability. The study also demonstrated the ability of the RADI to distinguish between individuals with high levels of sedentary time and those with lower levels.

Depending on a potential participant's access to stairs, the second question on the RADI ("About how many flights of stairs do you typically climb UP each day? Let 10 steps = 1 flight.") could skew the results to either point towards much higher levels or lower levels of sedentary behavior. The average scores of the RADI's three questions were compared to identify large differences between questions about sedentary level and stair activity.

Appropriateness of the Short Blessed Test. The Short Blessed Test (SBT), also called the 6-Item Orientation-Memory-Concentration Test, is a validated measure of cognitive impairment (Katzman et al., 1983). It includes six questions that are scored by multiplying the number of errors made in answering the question and the predetermined question weight assigned to the question. The products of the errors and question weights are then summed to find the total score. A score of 6 or less is a "normal" score, indicating normal cognition (Brooke & Bullock, 1999). Participants were eligible for the study if they achieved a score of 6 or less. It was originally validated on senior citizens residing in skilled nursing facilities and in the community; the SBT was found to be a valid and reliable measure of mild, moderate, or severe cognitive impairment (Katzman et al., 1983). The SBT has also demonstrated excellent test-retest reliability when administered 3 weeks apart (Fuld, 1978). Although the SBT is sound in detecting cognitive impairment, it should never be used as the sole measure to diagnose dementia and dementia-related diseases.

The SBT was used in this study to screen participants for cognitive function whereas the MoCA-Blind (Nasreddine et al., 2005) was used to further identify potential cognitive decline in eligible, participating individuals. The results of the SBT were compared to MoCA-Blind to determine the reliability and feasibility of using the SBT as a screening measure to detect cognitive impairment in potential participants of this study.

Appropriateness of video conferencing. During the EMA intervention, Intervention Sessions 2 and 5 do not require the interventionist and participant to meet face-to-face. Every other session was designed in such a way that the meetings should be face-to-face in order to administer assessments, provide the ActiGraph watch to the participant, or collect the ActiGraph watch from the participant. In an attempt to lighten the load of both the participant and interventionist, iPads equipped with Cisco WebEx were provided to the participants. Any technical difficulties with the iPads were tracked to determine the feasibility of meeting virtually for two of the intervention sessions. The nature of the technical difficulties was also collected to further investigate trends in the success or failure of the participants and interventionists to use the iPads as an intervention delivery method.

Reliability of subjective report of activity performance. The EMA intervention aims to decrease sedentary behavior in increments by introducing active lifestyle behaviors that require 30- to 45-minute to perform. In order to investigate the effectiveness of the intervention in forming habits at consistent time points during the day, data on the specific time every day that participants completed their active lifestyle behaviors were needed. These data were to be compared to the physical activity level collected through ActiGraph watch. Therefore, participants were asked to record the specific time every day when they completed their active lifestyle behaviors using the daily activity sheet provided by the study. To examine the reliability of this subjective data collection method, the percentage of how many times each participant recorded their exact activity performance time was calculated.

Secondary Outcome Measures. The secondary outcome measures were used to investigate the effectiveness of the EMA intervention in forming active lifestyle behavior habits and in decreasing perceived sedentary time.

The Self-Report Habit Index (SRHI). The SRHI (Verplanken & Orbell, 2003) was designed to measure the features of habits which include repetition, automaticity, and expressing identity. The SHRI is a 12-item index of the strength of existing habits. This scale is unique from others in its realm because it discriminates between differences in habit strength versus behavioral frequency. Habits are automatic whereas behavioral frequency is simply the amount of times an individual participates in a behavior during a defined amount of time (Johnsen, Westli, Espevik, Wisborg, & Brattebo, 2017). Measures of behavioral frequency typically use either observation or objective registration of behavior to obtain an estimate of behavior frequency or self-reports of past behavioral frequency (Verplanken et al., 2003). Self-reports of behavioral frequency typically begin with the stem template "how many times during the past *period of time* did you *perform this action*?" Behavioral frequency measures have the danger of being unreliable in situations where it is difficult to retrieve episodic memories or when the behavior itself is unclear (i.e. eating healthy foods). The SRHI is different than a behavioral frequency measure because it measures habit strength based on history of repetition of behavior, the difficulty of controlling behavior, the lack of awareness, efficiency, and identity. These four factors are distinguished as distinct and independent features by which an automatic process might be characterized (Bargh, 1994; Bargh, 1996).

The items in the SRHI began with the stem "Behavior X is something…" and is then followed by 12 statements rated on a scale from 1 *(very strongly disagree*) to 7 *(very strongly agree)*. Sample items include, "I do frequently", "I do automatically", and "I do without having to consciously remember." A full version of this scale including all items is provided in Appendix E.

Verplanken and Orbell (2003) conducted four studies on the reliability and validity of the SRHI. All four studies were implemented in undergraduate student populations at three different universities in the Netherlands. It was used as a filler task in an unrelated experiment. The studies inspected test-retest reliability, convergent validity with the response-frequency measure (Verplanken et al., 1994), convergent validity with a general behavioral frequency measure, and the ability of the SRHI to discriminate between weekly and daily personal habits.

In study 1, participants were asked about bicycle use in town as a possible mode of transportation. Ninety-three undergraduate students were assessed at time 1; 86 (92% of the original sample size) of the participants returned one week later at time 2 to retake the SRHI. Study 1 found that the SRHI has high test-retest reliability with a correlation of .91 between the pretest and posttest indexes.

Study 2 found that the SHRI has high convergent validity with the response-frequency measure of habit, an older alternative measure of the automatic qualities of habitual behavior (Verplanken et al., 1994). Study 2 measured transportation mode use similarly to study 1, except that the target behavior was taking the bus instead of riding a bicycle. The response-frequency measure of habit was administered as the first filler task in an unrelated experiment. The 86 students took the SRHI later in the unrelated experiment. The size of the correlation (r=.58, p<.001) demonstrates high convergent validity with the response-frequency measure of habit.

Study 3 investigated the convergent validity of the SRHI with subjective estimates of past behavioral frequency and also the ability of the index to differentiate between behaviors in terms of habit strength. Undergraduate students were paid for their participation in two sessions 3 weeks apart. There were 143 students at the first session and 133 students at the second. Participants were asked to rank 26 behaviors by the frequency in which they engaged in the behaviors at the first session. Three behaviors were selected for the second session that varied in reported frequency. The behaviors included one that was executed about three times per month, one that was executed four to five times a week, and one that was executed about twice per day. The SRHI was administered 3 weeks later at time 2 regarding these three behaviors. The SRHI was found to correlate strongly (r=.74, p<.001) with the subjective behavioral frequency measure and also to differentiate between habits that varied in strength (frequency of participating in the behavior).

Study 4 expanded on the SRHI's generalizable ability to differentiate between habits that varied in strength, specifically behaviors performed weekly and daily. This study also studied a unique habit for each participant. Participants were 76 undergraduate students who participated in two sessions separated by 1 week. Participants identified weekly and daily habits at the time 1. Habits were selected for each participant from their given behaviors at time 1. At time 2, the SRHI was administered for the individualized selected habits for each participant. The results supported the SRHI's sensitivity to habit frequency; habits performed three times daily are statistically stronger than habits that are performed three times weekly (daily, M=27.02, weekly, M=3.07; t(72)=4.81, p<.001).

The SRHI was administered 5 times to each participant. For the first active lifestyle behavior implemented through the intervention, the SRHI was administered at time 1 (Intervention Session 1), time 2 (Intervention Session 4), and time 3 (posttest). For the second active lifestyle behavior implemented through the intervention, the SRHI was administered at time 2 (Intervention Session 4) and time 3 (posttest). Means and standard deviations were calculated to detect change in habit strength over time, with lower scores indicating stronger habits.

Sedentary Behavior Questionnaire (SBQ). The SBQ (Rosenberg et al., 2010) assesses time spent on nine behaviors: watching television, playing computer/video games, sitting while listening to music, sitting and talking on the phone, doing paperwork or office work, sitting and reading, playing a musical instrument, doing arts and crafts, sitting and driving/riding in a car, bus, or train. The items of this measure ask the participant to provide the amount of time that they spend on a typical weekend day and weekday participating in various sedentary behaviors. Response options are none, 15 minutes or less, 30 minutes or less, 1 hour, 2 hours, 3 hours, 4 hours, 5 hours, or 6 hours or more. Total scores of sedentary behaviors are provided for weekday and weekend activities. The complete measure is provided in Appendix F.

Rosenberg et al. (2010) assessed concurrent validity and test-retest reliability in a 2010 study. Excellent reliability is demonstrated by a Spearman's rho range of 0.586 to .925 across SBQ items. Concurrent validity is excellent (r=.54) when comparing the SBQ to the International Physical Activity Questionnaire (IPAQ). The IPAQ is another measure of sedentary behavior, but it only assesses sitting in general and driving/riding in motor vehicles. It provides no information on other common types of sedentary behavior as the SBQ does. The IPAQ was considered an improvement on the Flemish Physical Activity Computerized Questionnaire which lack information on a wide variety of sedentary behavior. The SBQ has improved researchers' abilities to assess sedentary behavior across the nine major themes found in American citizens (Owen et al., 2011).

The SBQ was administered at the end of Intervention Session 1 and posttest. Means and standard deviations were calculated to detect change in perceived sedentary time, with lower scores indicating lower levels of sedentary behavior.

Procedure

After receiving the approval from the University and Medical Institutional Review Board, flyers describing the study and its benefits were posted in local senior centers in the surrounding area. When potential participants were referred to the study, a member of the research team contacted the potential participants over the telephone to provide information on the study and verify their eligibility for the study. For those who were determined eligible for the study, a researcher met with each participant individually in their home, at East Carolina University, or at an agreed upon meeting location to review and obtain signature on the informed consent, administer the Center for Epidemiology Studies- Depression Scale (CESD) and Activity Measure for Post-Acute Care (AM-PAC), and complete the demographic and health information questionnaire.

Additionally, the participants also received an ActiGraph GT9X Link watch (ActiGraph, 2018) to wear for 7-10 days. The ActiGraph watch is a medical-grade accelerometer and data filtering monitoring device. It can be worn at all times. It measures raw acceleration, energy expenditure, MET rates, steps taken, physical activity intensity, activity bouts, sedentary bouts, sleep latency, total sleep time, wake after sleep onset, and sleep efficiency. Only data on physical activity and sedentary time and total activity count were collected from the watch. The ActiGraph watch was used in this study to objectively measure the participants' sedentary time spent during the times of the day that they reported performing their newly implemented active lifestyle behaviors. Participants wore the ActiGraph watch at three different time points during study participation, as noted further in this section.

Seven to ten days following the initial home visit, the participant and interventionist met again for Intervention Session 1. During Intervention Session 1, the participant returned the ActiGraph watch, was assessed with the Sedentary Behavior Questionnaire (SBQ) and the Self-Report Habit Index (SRHI) and began the 6-week intervention, one session per week. Participants then received education on Habit Formation Theory, the Ecology of Human Performance model of practice, and the intervention process. Education in the theoretical background of the intervention is provided for those participants that may be curious in the literature supporting the creation of this intervention.

Following education on the theoretical background of the intervention, participants engaged in a semi-structured interview with the interventionist to identify active lifestyle behaviors that the participant would like to potentially make as their habit. The Canadian Occupational Performance Measure (COPM) was used for the interview. The COPM was developed for occupational therapists to assess client outcomes in areas of ADLs (Law et al., 1990); however, the COPM was used in this study as a tool to identify meaningful active lifestyle behaviors for each of the participants. The importance rating scale assisted the participants to rank which behaviors would be most interesting and purposeful to them. These behaviors were between 1.6-3.9 MET levels and required approximately 30 to 45 minutes to complete. Then, the participant and the interventionist selected one active lifestyle behavior and one contextual cue after which the participant performed the active lifestyle behavior. A MET is a physiological measure of energy cost of physical activities and is defined as the ratio of metabolic rate during an activity. For reference, Ainsworth et al. (2011) lists common MET equivalents of occupational activities in their most recent compendium of physical activities. A sample of these activities is listed in Appendix H.

Based on these selections, the researcher and the participant made an action plan by considering the person, task, and context factors as well as five intervention strategies of the Ecology of Human Performance model of practice. Then, the participant was asked to implement the action plan and integrate it into their daily routines throughout the study participation.

Intervention Session 2 was delivered remotely over the telephone or tablet. The participant and the interventionist reviewed the implementation of the action plan and made any necessary changes. The participant was also educated on MET levels and benefits of physical activity. During Intervention Session 3, the interventionist visited the participant in their home, at East Carolina University, or other agreed-upon location and delivered the ActiGraph watch. The participant wore the ActiGraph watch for 7-10 full days. The data from this wear period served as the baseline data for the second active behavior implemented. Lastly, the participant and the interventionist reviewed the implementation of the action plan and made any necessary changes.

During Intervention Session 4, the participant and interventionist met again in-person. The participant returned the ActiGraph watch and was assessed with the COPM and the SRHI. The participant and the interventionist selected another active lifestyle behavior and another cue situation immediately after which the participant would perform the active lifestyle behavior. They made another action plan for the newly selected behavior and cue situation. Then, the participant was asked to implement the action plan and integrate it into their daily routines over the next 3 weeks.

During Intervention Sessions 5 (over telephone or tablet) and 6 (in-person), the participant and the interventionist reviewed the implementation of the action plans for both active lifestyle behaviors, made any necessary changes, and completed the Intervention Sessions (see Table 1). Participants were asked to self-monitor their behavior repetition using a daily activity sheet modified from Gardner et al. (2012). During Intervention Session 6, the interventionist delivered the ActiGraph watch to the participant. The participant wore the ActiGraph watch for 7-10 full days. During the post-intervention session, the participant returned the ActiGraph watch, was assessed with the COPM, SRHI, and SBQ, and debriefed for the completion of the study participation. A summary of this procedure is provided in Table 1.

Table 1.
The Everyday Meaningful Activities Intervention Session Breakdown

Session	Intervention Plan
Pre-Intervention	**In person session at participants' homes** Obtain signature on informed consent. Obtain health and demographic information by administering the CESD, AM-PAC, and demographic and health information form. Give ActiGraph watch and begin wearing for 7-10 full days to collect baseline data.
Intervention Session 1 (Week 1)	**In person session at East Carolina University** Collect the ActiGraph watch. Administer the SBQ. Provide 30-minute education session on the Habit Formation Theory, Ecology of Human Performance model of practice, and intervention process. Identify active lifestyle behaviors by administering the COPM. Administer the SRHI. Select one active lifestyle behavior and one cue situation to incorporate into daily routine. Create an action plan and a backup plan for the selected active lifestyle behavior.
Intervention Session 2	**Over the phone session** Review implementation action plan and make necessary changes.

(Week 2)	Educate on the MET level and benefits of physical activity.
Intervention Session 3 (Week 3)	**In person session at participant's homes** Review implementation action plan and make necessary changes. Give ActiGraph watch to wear to monitor sedentary behavior for 7-10 full days.
Intervention Session 4 (Week 4)	**In person session at East Carolina University** Collect the ActiGraph watch. Re-administer the COPM and SRHI. Select one more active lifestyle behavior and one cue situation to incorporate into daily routine along with the active lifestyle behavior that has been monitored. Create an action plan and a backup plan for the newly selected active lifestyle behavior.
Intervention Session 5 (Week 5)	**Over the phone session** Review implementation action plan and make necessary changes.
Intervention Session 6 (Week 6)	**In person session at participant's homes** Review implementation action plan and make necessary changes. Give ActiGraph watch to wear for the next 7-10 full days.
Post-Intervention	**In person session at East Carolina University** Collect ActiGraph watch. Re-administer the COPM, SRHI, and SBQ. Debrief.

Note. Developed by Dr. Young Kim at East Carolina University. CESD=Center for Epidemiologic Studies Depression Scale; AM-PAC=Activity Measure for Post-Acute Care; SBQ=Sedentary Behaviour Questionnaire; COPM=Canadian Occupational Performance Measure; SRHI=Self-Report Habit Index; MET=Metabolic Equivalent for Task.

Data Analysis

Statistical analyses were conducted using IBM SPSS Statistics, Version 24.0. Statistical significance was set at $p < .05$. Due to the personnel restrictions and feasibility testing objectives, a power analysis was not conducted. Rather, the maximum number of participants with whom the members of the research team were able to perform the intervention with were recruited for this study.

Demographic Information, Descriptive Measures, and Recruitment Rate. The demographic information and descriptive measures were analyzed through descriptive statistics. The recruitment rate for this study was determined by dividing the total number of participants by the total number of referrals received for the study. Determining factors for ineligibility were recorded for reference.

Appropriateness of the RADI. The data was not normally distributed according to Kolmogorov-Smirnov test for normality. After visual inspection, it was challenging to determine whether the data was normally distributed due to the small sample size; therefore, non-parametric Wilcoxon signed-ranks test was used. The mean and median scores for each of the three questions of the RADI were calculated (minimum score of 3, maximum score of 15). The mean and median scores of the questions were compared to identify large differences between questions. Means and medians of question 1 (amount of time spent moving around per day) were compared to question 2 (about how many flights of stairs climbed up per day). Means and medians of question 2 were compared to question 3 (amount of time spent sitting per day). Lastly, means and medians of question 1 and question 3 were compared.

Appropriateness of the SBT. Two different percentages were calculated to determine the differences, if any, between results of the SBT and the MoCA-Blind. The percentage of participants with no cognitive impairment according to both assessments and the percentage of participants with no cognitive impairment according to the SBT but with cognitive impairment according to the MoCA-Blind were calculated.

Appropriateness of Video Conferencing as a Delivery Method. To determine the feasibility of two video conference meetings, the total number of intervention sessions with technical difficulties (with using Cisco WebEx on the iPad) was divided by the total number of intervention sessions.

Reliability of Participants' Subjective Report of Behavior Times. To examine the reliability of our subjective data collection method, the percentage of how many times each participant accurately reported their behavior performance time in comparison to all of the days in which they wore the ActiGraph watch was calculated. Participant subjective reports were considered accurate if they listed the exact activity performance time (e.g. 7:42am-8:27am) or rounded to whole 5-minute increments (e.g. 7:40am-8:30am). Participant subjective reports were considered inaccurate if they listed the same exact time every day (e.g. 7:30am-8:00am, for all 7 days), if they wrote "yes" or "no" in the daily activity sheet instead of the time, or if they did not record anything for the day.

Effectiveness of EMA Intervention in Forming New Habits. The effectiveness of the EMA intervention in forming new habits is quantified by results of administration of the SRHI. For the first behavior, results on the SRHI were compared from time 1 (pretest) to time 2, time 2 to time 3 (posttest), and from time 1 (pretest) to time 3 (posttest). For the second behavior, results on the SRHI were compared from time 2 to time 3 (posttest). The data was normally distributed according to Kolmogorov-Smirnov test for normality, but upon visual inspection of a histogram, the data was not normally distributed. Due to the inability to determine the normal distribution of the data, the Wilcoxon signed-ranks test was used.

Effectiveness of EMA Intervention in Decreasing Perceived Sedentary Time. The effectiveness of the EMA intervention in decreasing perceived sedentary time is quantified by results of administration of the SBQ. Results on the SBQ were compared from time 1 (pretest) to time 3 (posttest). The data was not normally distributed according to Kolmogorov-Smirnov test for normality; thus, the Wilcoxon signed-ranks test was used.

CHAPTER 4: RESULTS

Demographic and Medical Information and Descriptive Measures

The mean age of the study's participants was 72.7 years (SD=5.78). The majority of the participants were white (72.7%) and female (72.7%), had a high school or higher education (100%), and lived with someone else (72.8%). The mean of the Center for Epidemiologic Studies Depression Scale was below the cutoff score (≥16) for depressive symptoms. Table 2 provides the demographic information for the participants and the results of the descriptive measures. It is notable that none of the participants reported a history of the following major diagnoses: cerebrovascular accident, peripheral vascular disease or bypass, chronic obstructive pulmonary disease, dementia, cancer, traumatic brain injury, or multiple sclerosis. Table 3 provides the relevant medical history for the participants.

Table 2. Demographic information and descriptive measures results (N = 11).

Age (year), M (SD)	72.73 (5.78)
Race, N (%)	
White	8 (72.7)
African American	2 (18.2)
Other	1 (9.1)
Sex, N (%)	
Female	8 (72.7)
Male	3 (27.3)
Marital status, N (%)	
Married	8 (72.7)
Single, never married	2 (18.2)
Divorced	1 (9.1)
Level of education, N (%)	
Master's degree	5 (45.5)
Bachelor's degree	3 (27.3)

Associate degree	2 (18.2)
Some college (1-4 years, no degree)	1 (9.1)
Living status, N (%)	
Lives with spouse	6 (54.5)
Lives alone	3 (27.3)
Lives with sister or brother	1 (9.1)
Lives with grandchildren	1 (9.1)
Previous occupation, N (%)	
Healthcare support occupations	3 (27.3)
Business and financial operations	2 (18.2)
Community and social service	2 (18.2)
Legal occupations	1 (9.1)
Arts, design, entertainment, sports, and media	1 (9.1)
Healthcare practitioners and technical occupations	1 (9.1)
Food preparation and serving related occupations	1 (9.1)
Current occupation, N (%)	
Retired	7 (63.6)
Healthcare support occupations	1 (9.1)
Community and social service	1 (9.1)
Building and grounds cleaning and maintenance	1 (9.1)
Not employed	1 (9.1)
Household annual income, N (%)	
Over $100,000	3 (27.3)
$80,000 - $89,000	1 (9.1)
$70,000 - $79,000	1 (9.1)
$60,000 - $69,000	0 (0)
$50,000 - $59,000	3 (27.3)
$40,000 - $49,000	0 (0)
$30,000 - $39,000	1 (9.1)
$20,000 - $29,000	0 (0)
$10,000 - $19,000	1 (9.1)
Less than $10,000	1 (9.1)

MoCA-B, M (SD)	18.36 (2.69)
CES-D, M (SD)	6.91 (3.48)
AM-PAC basic mobility, M (SD)	65.54 (4.87)
AM-PAC daily activity, M (SD)	60.16 (6.99)
AM-PAC applied cognitive, M (SD)	48.53 (6.25)

Note. MoCA-B = Montreal Cognitive Assessment – Blind version; CES-D = Center for Epidemiology Studies - Depression scale; AM-PAC = Activity Measure for Post-Acute Care.

Table 3. Medical history of participants (N = 11).

Risk factors history	
Smoking	
Smoking history	3 (27.3)
No history of smoking	8 (72.7)
Alcohol	
Alcohol use history	7 (63.6)
No history of alcohol use	4 (36.4)
Hypertension (≥ 140/90 mmHg)	
Hypertension history	7 (63.6)
No history of hypertension	4 (36.4)
Diabetes	
Diabetes history	1(9.1)
No history of diabetes	10 (90.9)
Myocardial infarction	
Myocardial infarction history	0 (0)
No history of myocardial infarction	11 (100)
Hyperlipidemia	
Hyperlipidemia history	4 (36.4)
No history of hyperlipidemia	7 (63.6)
History of major diagnoses	
Hypothyroidism	
Controlled hypothyroidism history	1 (9.1)
Uncontrolled hypothyroidism history	3 (27.3)

No history of hypothyroidism, controlled or uncontrolled	8 (72.7)
Depression	
Depression history	5 (45.5)
No history of depression	6 (54.5)
Anxiety	
Anxiety history	3 (27.3)
No history of anxiety	8 (72.7)

Note. Values are presented as frequency (%).

Primary Objectives

Recruitment Rate. Study recruitment began in May of 2019 and concluded in January of 2020. Participants were recruited for two different intervention periods. The first period was from September of 2019 until December of 2019, and the second period was from January of 2020 until May of 2020. The research team did not actively recruit participants during October and November of 2019. During these recruitment periods, the team received 67 referrals for a recruitment rate of 18%. The majority of the referrals for this study were received from local senior centers and from the assisted living and independent living sections of a local multi-tier care retirement community.

Of the 12 participants that began the study, one participant dropped out of the study due to a combination of health conditions, scheduling concerns, and concerns with video conferencing as a delivery method for two intervention sessions. A full description of the referrals, individuals screened, and participants is provided in Figure 1.

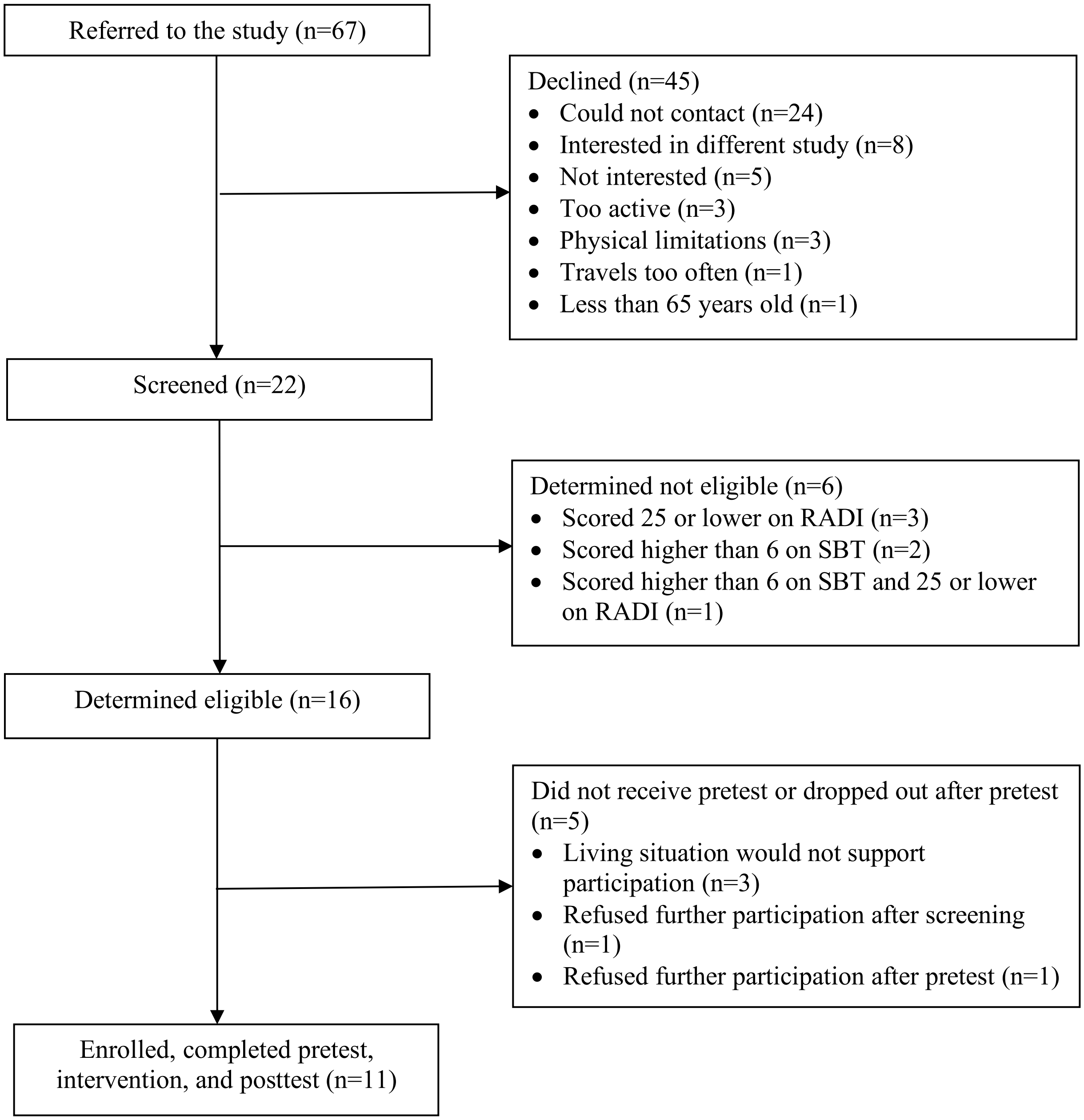

Figure 1. *Flow chart depicting referral process, screening, process, and study completion.*

Appropriateness of the RADI. Both the mean of question 1 (amount of time spent moving around per day) and mean of question 3 (amount of time spent sitting per day) were lower than the mean of question 2 (about how many flights of stairs climbed up per day). According to the Wilcoxon signed-ranks test, questions 1 and 2 of the RADI were significantly different (z = -2.565, p = .01). There were also significant differences between questions 2 and 3 (z = -2.221, p =.026). There were no significant differences between questions 1 and 3 (z = -.054, p =.957). Further test statistics are listed in Table 4.

Table 4. Test statistics of primary and secondary outcome measures.

	n	M (SD)	Mdn (Q1-Q3)	p-value
Rapid Assessment Disuse Index				
Question 1	11	9.27 (2.10)	9.0(9.00-12.00)	Questions 1-2 p = .01*
Question 2	11	12.82 (1.40)	12.0(12.00-15.00)	Questions 2-3 p = .026*
Question 3	11	9.27 (3.66)	9.0(6.00-12.00)	Questions 1-3 p = .957
Self-Report Habit Index				
Behavior 1				
Time 1	10	66.40 (17.18)	68.0(46.50-84.00)	Time 1-2 p = .007**
Time 2	11	40.73 (8.97)	45.0(33.00-47.00)	Time 2-3 p = .126
Time 3	10	34.7 (11.93)	30.5(25.75-48.25)	Time 1-3 p = .008**
Behavior 2				
Time 2	11	54.64 (16.95)	50.0(41.00-73.00)	Time 2-3 p = .083
Time 3	10	44.70 (19.03)	46.0(31.50-59.00)	
Sedentary Behavior Questionnaire				
Time 1	11	82.34 (28.21)	64.5(62.50-106.25)	Time 1-3 p = .016*
Time 3	11	65.86 (20.35)	62.5(50.75-85.25)	

Note. $^{*}p < .05$, $^{**} p<.01$

Appropriateness of the SBT. According to the SBT, no eligible participants showed any sign of cognitive impairment (0%). According to the MoCA-B, one eligible participant showed signs of mild cognitive impairment that was not detected by the SBT (9%).

Appropriateness of Video Conferencing as a Delivery Method. All 11 participants received an iPad to use during Intervention Session 2 and Intervention Session 5. Of the 22 video conferencing sessions (2 video conferencing sessions per participant), 64% (n=14) of the video conferencing sessions occurred as planned and were successful with the iPad as a delivery method. Of the 36% (n=8) of video conferencing sessions during which participants and/or interventionists experienced technical difficulties, 18% (n=4) occurred during intervention session 2 and were able to be resolved before intervention session 5. The remaining 18% (n=4) of video conferencing sessions that experienced technical difficulties occurred at both Intervention Session 2 and Intervention Session 5. A description of the intervention sessions that did and did not experience technical difficulties is provided in Figure 2.

The majority (64%) of virtual intervention sessions were delivered via Cisco WebEx on an iPad that was loaned to the participants through the Department of Occupational Therapy and East Carolina University. There was a total of 8 virtual intervention sessions out of 22 that did not occur according to the plan using Cisco WebEx on the iPad. These intervention sessions were delivered either via telephone or via FaceTime on the participant's personal cell phone device.

Reliability of Participants' Subjective Report of Activity Times. Participants accurately reported their behavior performance times 45% of the time for both the first active lifestyle behavior and the second active lifestyle behavior. This percentage is based off of the 3 periods of 7 days in which the participants wore the ActiGraph watch while reporting their active lifestyle behavior performance times. On average, of the 14 days that the participants wore the ActiGraph watch for behavior 1, on only 6 of the 14 days were behavior performance times accurately recorded. On average, of the 7 days that the participants wore the ActiGraph watch for behavior 2, on only 3 of the 7 days were behavior performance times accurately recorded.

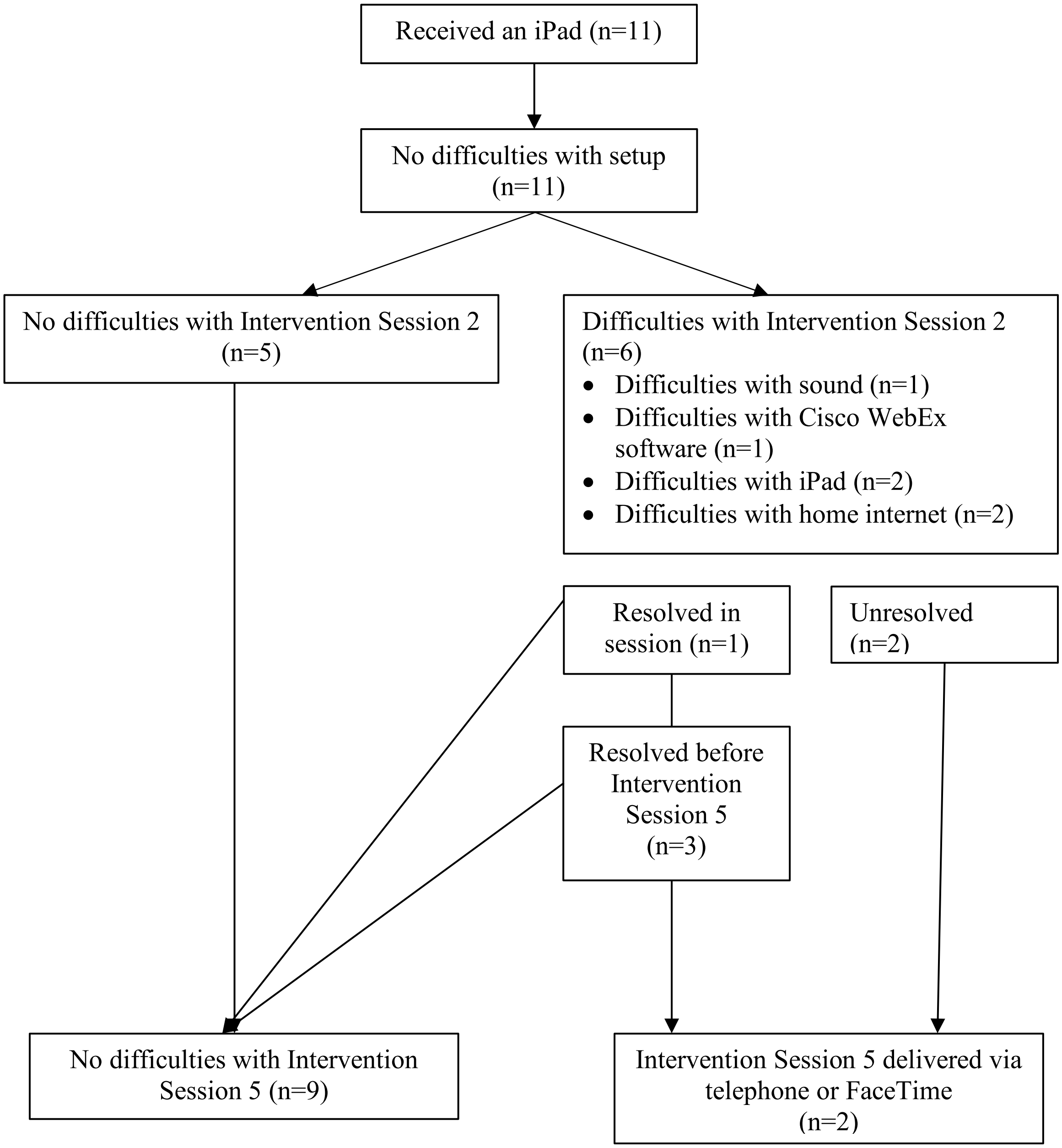

Figure 2. *Flow chart depicting video conferencing technical difficulties.*

Secondary Objectives

Effectiveness of the EMA Intervention in Forming New Habits. According to the Wilcoxon signed-ranks test, the first active lifestyle behavior habit strength significantly increased from time 1 to time 2 (z = -2.703, p =.007); however, the first active lifestyle behavior did not significantly differ in habit strength from time 2 to time 3 (z = -1.532, p =.126). The first active lifestyle behavior habit strength significantly increased from time 1 to time 3 (z = -2.666, p =.008). The second active lifestyle behavior habit strength did not significantly differ from time 2 to time 3 according to the Wilcoxon signed-ranks test (z = -1.735, p =.083). Further test statistics are listed in Table 4.

Effectiveness of EMA Intervention in Decreasing Perceived Sedentary Time. The mean scores of the SBQ decreased from time 1 to time 3. Lower scores on the SBQ indicate less time spent in sedentary behaviors. According to the Wilcoxon signed-ranks test, there was a significant difference of perceived sedentary time at time 1 and at time 3 (-2.401, p=.016). Further test statistics are listed in Table 4.

CHAPTER 5: DISCUSSION

This study was conducted to answer the question of the feasibility of implementing the EMA intervention with medically stable older adults living in the community. Both primary and secondary aims were used to answer this research question. The objectives of investigating the feasibility of this intervention are to determine (1) the recruitment rate for medically stable older adults in the community for this study, (2) the appropriateness of the Rapid Assessment Disuse Index (RADI) for screening sedentary behavior in older adults over the phone, (3) the appropriateness of the Short Blessed Test for screening sufficient cognitive ability in older adults over the phone, (4) the appropriateness of video conferencing through WebEx on an iPad as an acceptable delivery method of selected intervention sessions, and (5) the reliability of participants' subjective reports of exact times for performing active lifestyle behaviors.

The secondary aims of this study are to determine (1) if the EMA intervention is effective in forming active lifestyle behavior habits and (2) if the EMA intervention decreases perceived sedentary time in medically stable older adults living in the community.

Primary Objectives

The eligibility criteria that the research team used to define medically stable older adults living in the community were extensive (i.e. two standardized assessments, a number of disqualifying diagnoses, and criteria for geographic location), creating a need for a larger number of referrals. Most of the participants in this study were referred from the local senior centers and from a local multi-tiered care retirement community. Potential participant names and phone numbers were collected from the individuals directly at the centers' meetings in the morning. The multi-tiered care retirement community includes a memory unit (operated as an assisted living facility) and independent living with access to clubhouse resources (i.e. cleaning service, food service, physical activity programs). Residents in independent living were referred.

Individuals who were referred from the local senior centers and contacted for screening were generally not reliable in returning screening phone calls. Individuals who were referred from the local multi-tier care retirement community and contacted for screening generally reported that they were too busy for the study or too active already with the physical activity programs at the community. The recruitment rate of 18% and the retention rate of 100% through senior centers and the retirement community indicate that it may be necessary to increase the number of referral sources, such as local churches and primary care physician offices to increase the initial number of referrals. However, once individuals begin participation in the EMA intervention, participants are generally satisfied with the program, resulting in a low dropout rate.

The entire Rapid Assessment Disuse Index (RADI) may not be an appropriate screening measure for sedentary behavior in this population. There were significant differences between the answers of question 2 (how many flights of stairs [approximately 10 steps] do you typically climb up each day) and the answers of questions 1 and 3 (how many hours do you spend moving around each day; how many hours do you spend sitting, respectively). Individuals who were screened typically answered the question 2 based on their access to stairs, not their choice to navigate stairs. As mentioned previously, a multi-tiered care retirement community was one source of referrals for this study. At this community, stair access is sparse. Residents of this community may garden, do their laundry, run errands in the community, and walk to the main building of the community for meals in one day while never encountering a flight of stairs. Thus, the individual may inaccurately qualify for this study because they answered “0 flights” to question 2 on the RADI. Conversely, an individual who labors to climb the stairs in their home twice to three times daily as their only source of physical activity may answer “4-6 flights” to question 2 on the RADI and not qualify for the study because their activity level is too high.

The RADI is the first screening tool for sedentary behavior that is designed to work quickly in the clinical setting (Dabholkar, Naik, & Dabholkar, 2018). Shuval et al. (2014) found that the RADI has excellent test-retest reliability, but reliability across populations is only fair. The RADI may be an appropriate screening measure in other medically stable populations in the community but is inconsistent with the older adult population in Greenville, North Carolina. More context about the individual’s access to opportunities for physical activity in their environments and their occupations is necessary.

When screening older adults for their appropriate cognitive ability, the SBT is a feasible screening measure for cognitive dysfunction. When the results of the SBT were compared to the MoCA-B, the MoCA-B found only 1 participant out of 11 to have a mild cognitive impairment where the SBT did not. The MoCA-B was selected as a comparison for the SBT because of its ability to be administered over the telephone. The number of questions and ease of administration were both features that made the SBT a more feasible screening measure to perform over the phone. Considering its shorter administration duration with less burden to potential participants and relatively high accuracy, the SBT is an appropriate screening measure of cognitive dysfunction for the EMA intervention. In relation to the 18% recruitment rate, the inclusion of a screening tool that is less burden to potential participants will be important to maintain or improve future recruitment rate.

Video conferencing through Cisco WebEx was an acceptable intervention delivery method for the majority of the relevant intervention sessions and participants. Of all of the relevant intervention sessions, technical difficulties were unresolved for only 18% of sessions, during which other methods were used to meet remotely (telephone or FaceTime). Factors that influenced the participants' ability to use the Cisco WebEx app on the iPad included the internet connection at participants' homes, their general familiarity with technology, and their familiarity with the iPad operating system. Some participants were more comfortable trouble shooting technical difficulties independently without help from the research team, and some were completely dependent on the research team to remotely remedy technical difficulties. When participants were unable to use the tablet and/or the Cisco WebEx app, the interventionists either spoke to the participant over the phone or over FaceTime on the participant's personal device. The interventionists reported comparable, sufficient results from telephone intervention sessions, FaceTime intervention sessions, and Cisco WebEx intervention sessions.

The two remote intervention sessions are designed to be check-in sessions. No assessments are administered during these sessions and no action plans are created. The purpose of these sessions is to verify participant's confidence in their action plan and needs to make no changes and offer information about forming new habits as necessary. The face-to-face interaction over a video conferencing platform is useful to better connect to the participants during these two sessions. However, the set up and use of the video conferencing software was challenging for some of the participants. In future applications, giving the participants choices on which remote meeting platform they would prefer (i.e. over the telephone, using FaceTime on their personal device, or using Cisco WebEx on a tablet) could save time in troubleshooting technical difficulties and participant frustration. However, it should be noted that Cisco WebEx may be the most secure option of intervention delivery (it is a HIPAA compliant platform), followed by the telephone and FaceTime on their personal device.

To measure the participants' performance of their selected active lifestyle behaviors, the participants recorded their active lifestyle behavior performance times every day on the Daily Activity Sheet provided in the intervention workbook. Additionally, they wore the ActiGraph GT9X Link watch accelerometer at three different time points. Data from the watch was intended to be collected just from the times that the participants reported performing their active lifestyle behaviors on the Daily Activity Sheet. This aspect of the original study design was to (1) compare subjective data (participant report of behavior performance time) and objective data (ActiGraph watch data on sedentary levels during behavior performance time), and (2) observe change over time in objective data (decreased sedentary levels during behavior performance time throughout the intervention).

The comparison between the objective and subjective data for this aim of the study was not feasible. Participants inaccurately reported their active lifestyle behavior performance times for 55% of the days that they were wearing the ActiGraph watch for comparison. Participants had difficulty remembering to fill out the Daily Activity Sheet, they estimated their times, or they simply wrote "yes" or "no" if they performed the activity that day instead of the time. Participants who were successful in recording their behavior performance times found strategies such as placing the Daily Activity Sheet close to the supplies needed for their activity or setting a phone alarm to record their performance time to be helpful. Participants who were unsuccessful in recording their behavior performance times reported that they did not remember the original instructions or that they did not understand the purpose of the Daily Activity Sheet. For future applications, various reminder systems can be useful. Automated text messages or emails throughout the day reminding the participant to record their performance times could be useful to improve the compliance of the recording. In addition, requiring phone calls to the research team by the participant after completing their lifestyle behaviors may improve the compliance, although this additional step may be cumbersome to the participants.

Secondary Objectives

The SRHI showed that the EMA intervention was successful in increasing the strength of new active lifestyle behavior habits. Overall, scores on the SRHI followed a downward trend as the intervention progressed, with lower scores indicating stronger habits. There were significant increases in reported habit strength for active lifestyle behavior 1 from time 1 to time 2 and from time 1 to time 3. However, there was not a significant increase in habit strength for active lifestyle behavior 2 from time 2 to time 3. This suggests that habit strength for the first behavior increased over time, with more of an increase at the initial implementation of the behavior that trailed off throughout behavior implementation. It also suggests that participants did not feel that they had formed a second active lifestyle behavior habit at the end of their participation in the study.

Though these results of habit strength may seem confounding, they are consistent with previous literature on the typical course of habit formation and behavior change. Rebar et al. (2016) found in a systematic review of the effects of non-conscious regulatory processes (habits) on physical activity that there is a strong interdependency between physical activity behaviors, habits, and intentions. Many individuals had overall strong intentions of engaging in active lifestyle behaviors, but the intention-behavior relationship was typically only modest. Habits have been shown to be a strong mediator in the intention-behavior relationship, meaning that when intentions were translated into habits, individuals were more successful in integrating a new active lifestyle behavior into their routine. Researchers also found that individuals who had stronger intentions were able to form stronger physical activity habits than individuals who had weaker intentions or no intentions (Gardner, de Bruijn, & Lally, 2011; Rebar et al., 2016).

These findings (Gardner et al., 2011; Rebar et al., 2016) could explain why the participants in the EMA intervention experienced significant changes between time 1 and time 2, but not between time 2 and time 3. When a new active lifestyle behavior habit is being formed, the individual must begin with strong intentions. The strong intention is the driving force for behavior performance at the beginning of implementation as habit strength is weak or nonexistent. When a behavior has become habitual, intention is weak or nonexistent due to the automatic, non-conscious nature of habits. Once a habit is formed, an individual should no longer need to intend to carry out that behavior.

In the process of habit formation, individuals experience a midpoint where intention strength is decreasing, but habit strength is increasing. This creates a plateau phase where the decrease in intention decreases the cognitive attention that the behavior was once receiving. Because automaticity is a non-conscious feature of habit formation, individuals do not initially experience the feeling of increased habit strength. The drop in cognitive intention creates a false sense that the behavior is not progressing as it should. The progression of the intention-behavior-habit relationship is displayed in Figure 3.

Some participants in this study found it challenging to think of a second active lifestyle behavior to implement at time 2 in the intervention. Because these participants may have not been as invested in this second behavior, not had strong intentions to continue the second behavior after study completion, and/or not been truly sedentary, their weak intention from the beginning translated to weak habit strength at time 3. This indicates a need to screen potential participants for motivation and intention, as well as screen more accurately for sedentary behavior, to adopt a new behavior.

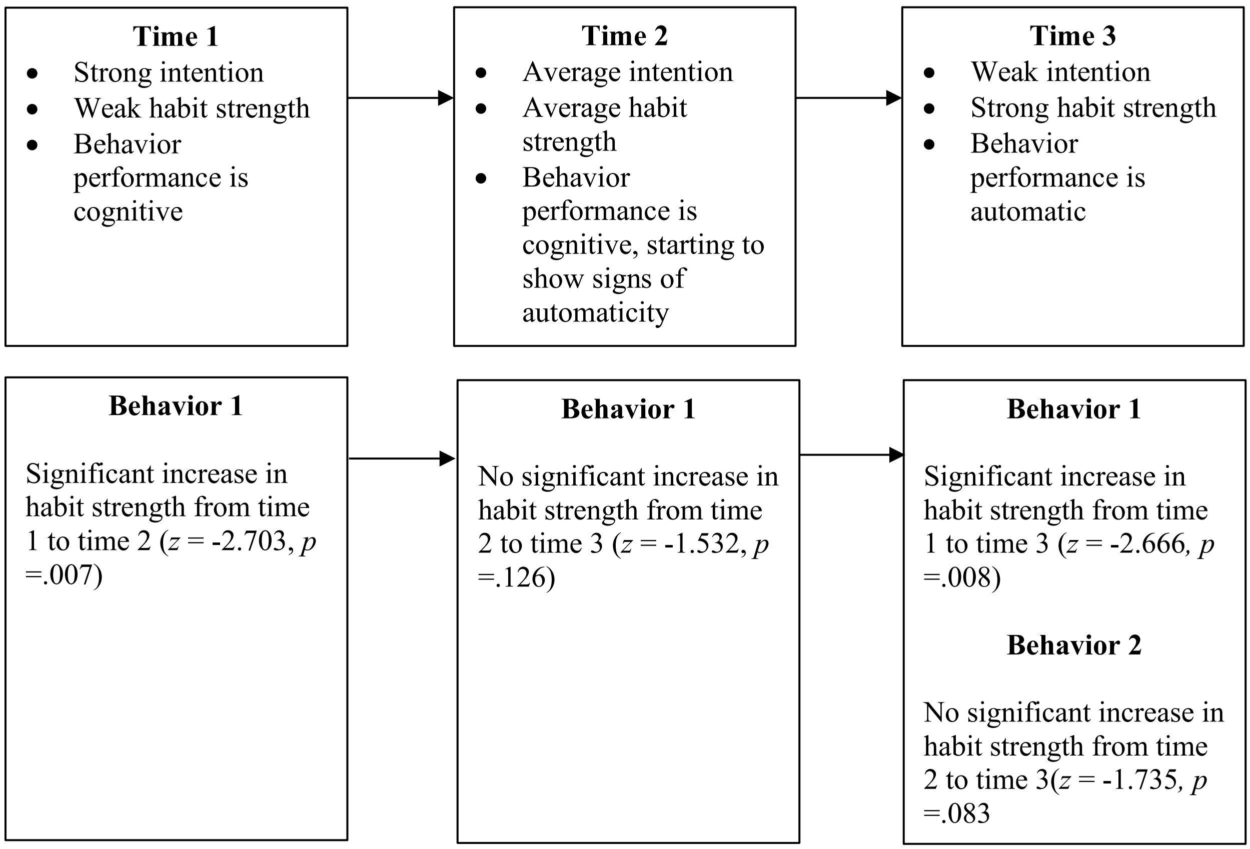

Figure 3. *Progression of intention and habit strength*

Additionally, when individuals attempt to create a new habit, a median of 66 days is needed to develop habit automaticity and, as a result, lasting habits (Lally et al., 2010). Taking this into consideration, it is important to note that we did not follow the participants for full 66 days that may have been necessary to create a new habit. In addition, the EMA intervention was 6 weeks in duration. The first active lifestyle behavior was implemented for 6 weeks; the second active lifestyle behavior was implemented for only 3 weeks. Although not all of the scores on the SRHI were significant compared to previous time points, the general downward trend demonstrates the need to reassess the participants at a later timepoint. If the SRHI is administered 4 weeks after study completion (10 weeks since the beginning of the intervention), more significance may have been found.

Finally, the participants of the EMA intervention reported spending less overall time in sedentary behaviors during the weekdays and weekends after participating in the intervention compared to those before their participation. There was a significant downward trend in scores on the SBQ from time 1 to time 3, with lower scores representing less sedentary time spent. However, due to the participants' inconsistency in reporting their actual active lifestyle behavior performance times, this subjective data (SBQ) could not be confirmed by objective data (ActiGraph).

The EMA intervention was designed to integrate two new active lifestyle behaviors into the participants' existing daily routine. With each behavior taking approximately 30-45 minutes to complete, the participants were incorporating 1-1.5 hours of physical activity into their routines. This small daily change of time spent may have been enough to change the perceived amount of sedentary time potentially outside of the 1-1.5 hours of physical activity completed as a part of the EMA intervention. This may have been the byproduct of education received through the EMA intervention. Through the education at the beginning of the EMA intervention using the Participant Workbook, the interventionists encouraged the participants to spend less time of their day in sedentary behaviors. The education included MET levels, how to incorporate higher MET levels into their day, and the benefits of physical activity.

Overall, the participants in this study subjectively reported less sedentary behavior after participating in the EMA intervention. However, we were unable to verify their subjective reports of sedentary behavior through objective data (i.e. ActiGraph).

Although this was one of the objectives of the study, an impediment to the EMA intervention itself presented during the screening and intervention process. Individuals with potential cognitive impairment may not be as successful in achieving goals of the EMA intervention as those without cognitive impairment. Because the EMA intervention involves action planning, problem solving, intention, motivation, and internalization of the concepts of habit formation, those with cognitive impairment may not be able to easily understand the process. Although we do not have the data to support this, the interventionist subjectively reported that the participant who was identified as cognitive impaired by MoCA-B but not by SBT showed difficulty following through the directions and the participant's report of the repetition of target behaviors was in question.

Another group of individuals who may not be successful in achieving goals of the EMA intervention are those that reported being too busy either during the screening process or throughout the intervention. These individuals had many obligations (work, volunteer opportunities, meetings with community organizations, standing lunches with friends, etc.) that filled their days and faced a variety of challenges with the intervention. One of the main objectives of the EMA intervention is to repeat the active lifestyle behavior at a specific time each day. If the participant's schedule was irregular and they were unable to complete the activity at the same time each day, the habit would not be as successful in forming. In the screening process, these individuals reported being sedentary because the majority of these obligations were sedentary in nature.

CHAPTER 6: LIMITATIONS

Because the participants in this study were recruited using convenience sampling, the sample may not be an accurate representation of the population as a whole. The participants were representative of medically stable older adults making physical activity changes in Greenville, North Carolina, but the sample may have had different characteristics than older adults in other areas of the United States. Although the characteristics of many older adults in Eastern North Carolina fit the description of common risk factors for sedentary behavior (residence within the stroke belt, male gender, obese body mass index, etc.), this is not necessarily representative of the United States older adult population as a whole.

Although a power analysis for the appropriate number of participants was not conducted for this feasibility study, the data would have been more well-rounded if there was a larger sample size. Due to the nature of the feasibility study, it was determined that 11 participants would be sufficient to test the feasibility objectives. In addition, the time constraints of the research team dictated the number of participants that we were able to admit to the study. The intervention itself was time-intensive and requires a larger research team to admit more participants to the study. Had the research team been larger to accommodate a larger participant pool, the word of mouth referrals would have been explored further.

Lally et al. (2010) found that habits require approximately 66 days to form. A limitation of this study is that we did not follow the participants after the 6-week intervention concluded to assess habit strength at the 66-day (10-week) timepoint. The recruitment periods, pretesting and posttesting, and intervention were all designed to be conducted within an academic semester (16 weeks) at East Carolina University. Had this process been conducted in a rolling period that did not to begin and conclude within 16 weeks, the research team may have been able to follow up with the participants after they completed the 6-week intervention.

Additionally, it would be ideal to follow the study participants for a period of time after study discontinuation to monitor the longevity of their habits. This information could inform the changes that need to be made to the active intervention period in the future as well. The ultimate purpose of the EMA intervention is the generalization of learned skills that can decrease sedentary behaviors. In the future studies, to identify the realization of the generalization, long term follow-up of the recipients of the EMA intervention will be required.

Intention was discussed earlier as an important piece of success with habit formation. Therefore, it will be important to include the screening criterion of intention or motivation for change. At the same time, it will be important to consider the effect of incentives on the participant pool during participant recruitment. Some of our participants may have been driven to participate due to the monetary incentives offered upon study completion. This could have resulted in the participant pool with lower intention, affecting the effectiveness of the EMA intervention. Therefore, careful considerations of intention screening criterion and study participation incentives should be given in the future studies.

Future studies should also find a reliable way to collect objective data on physical activity level during the active lifestyle behavior performance times. Our findings showed that self-tracking of performance times cannot be used to collect these data. Identifying a more straight-forward and reliable way, such as pre-post behavior text or phone calls or quick reports through a readily available app to collect data from participants about their exact behavior performance times could ensure that the ActiGraph watch data can be used.

Lastly, with modifications to the EMA intervention to account for those individuals with cognitive impairment or busy schedules, the intervention would be able to be used more widely. Creating a variety of versions of the EMA intervention to apply to different populations of people would be an appropriate future direction for this intervention once more pilot testing is completed.

CHAPTER 7: IMPLICATIONS FOR OCCUPATIONAL THERAPY PRACTICE

This study has the potential to expand the occupational therapy base of knowledge regarding habit formation for decreasing sedentary behavior. Findings from this study can impact the way that occupational therapy practitioners approach rehabilitation in populations that have experienced a major medical event (e.g., stroke, heart attack, fracture). Occupational therapy services can be indicated for new populations, especially cardiac populations in the community, in order to increase physical activity and promote active lifestyles.

Although this was a feasibility study, the EMA intervention has demonstrated that meaningful, active lifestyle behaviors can potentially become habits through guided intervention. Through learning about sedentary behavior, the risks of sedentary behavior, the benefits of physical activity, and the straight-forward process of forming new active habits, the participants in this study were motivated to decrease their overall daily sedentary behavior level. The EMA intervention was successful in forming active lifestyle behavior habits, thus adding to the options of small number of successful, long-term behavior change interventions.

This research adds to the body of evidence that supports the need for holistic, client-centered approaches to decrease adverse health outcomes related to sedentary behavior. This intervention focused on creating individualized solutions to behavior change through habit formation. The action plans that were created with each participant were designed to be easy to implement and repeat every day. It was useful for our participants to have heavy, individualized guidance at the beginning of the action planning phase to ensure success. This again reinforces the need to approach behavior change in older adults in a client-centered, individualized manner.

There is a growing population of community-residing older adults who may not be considered “sick enough” to be referred to occupational therapy services, or do not have the traditional diagnoses associated with occupational therapy services. Even if individuals have preexisting conditions such as chronic cardiopulmonary or neurological conditions but are living independently in the community, they may not be eligible for services. This is the population that would benefit the most from habit formation interventions that promote healthy lifestyle choices to prevent a major health event from occurring before it is too late. The results of this research add to the body of evidence for reimbursable occupational therapy services in preventative care. The participants in this study were encouraged to leave their house more often and engage in social interactions as a result of this intervention as well. The increase in social interaction, physical activity, and cognitive stimulation experienced through the EMA intervention can all contribute to an overall increased health-related quality of life that limits the risk for negative health outcomes in the future.

In addition to preventive medicine, the EMA intervention can be implemented as a feature of already occurring services in home health, outpatient clinics, nursing facilities, and long-term care facilities with clients who are cognitively able. The EMA intervention can be used as a method to promote independence in ADLs and decrease sedentary behavior. The EMA intervention, when administered with specific goals in these settings, can be a reimbursable solution for intervention. The EMA intervention is appropriate for the above-mentioned practice settings to prepare clients more holistically for discharge and the challenges that come with implementing therapeutic strategies after therapeutic intervention ends.

The EMA intervention can be tailored to be administered in a group setting in the future. Although it was individually delivered in our study, the group setting could make this intervention more feasible to carry out with a larger number of clients at once, decreasing the demand on the leading occupational therapist. With the correct screening and outcome tracking materials, this intervention can become a reimbursable solution in geriatric care (i.e. senior centers, assisted living facilities, senior living communities), behavioral health, cardiac care, and other specialized areas other than traditional preventative medicine.

CHAPTER 8: CONCLUSION

The EMA intervention is one of the first interventions of its kind to integrate psychological theories of habit formation and behavior change (Lally & Gardner, 2013; Jeffery et al., 2000) with occupational therapy models of practice (Dunn, 2017) to create a sustainable approach to decreasing sedentary behavior in older adults. This intervention can be applied to other populations to answer the need for lasting, habitual changes in an individual's lifestyle to prevent, remediate, and/or compensate for adverse health outcomes. Through this study, we demonstrated that the EMA intervention is a feasible option for achieving long-term habit formation.

With adjustments to the screening criteria, the participant pool could be better fit for the intervention in its current state. The RADI may not be an appropriate screening measure for sedentary behavior as it is not sensitive to potential participants' access or inaccess to stairs. The SBT is an appropriate over-the-phone screening measure for cognitive impairment compared to other longer standardized cognitive assessments. Consideration should be given to integrating a screening measure for intention/motivation to change behaviors. When screening for intention and/or motivation, future applications should also consider the role of compensation for participation.

The EMA intervention was preliminarily shown to be effective in forming active lifestyle behavior habits and decreasing the participants' perceived time spent in sedentary behaviors. The intervention was successful in increasing habit strength and decreasing sedentary behavior levels due to the 6-week education and training that prepared participants to be self-sufficient in forming habits at the intervention's conclusion. The participants were provided with the training and resources to implement the tenets of the EMA intervention with any healthy or active lifestyle behaviors in the future.

The limited available time from interventionists on the research team restricted the number of participants that were able to be admitted into this study. With a larger sample size, the generalizability of the findings can be improved. Additionally, gathering objective data about sedentary levels through the reliable time record method and ActiGraph watch can only better inform the effectiveness of the EMA intervention in the future.

This research has the potential to be applied to preventive care in order to prevent negative health outcomes associated with sedentary behaviors. The EMA intervention is also fit to be implemented as a feature of existing care in home health, outpatient clinics, and long-term care facilities. It also reinforces the need for client-centered approaches to creating lasting habit formation. The client-centered nature of the EMA intervention can be easily applied to an occupational therapy practice through the shared model of practice that guides intervention. Overall, the EMA intervention provides an avenue for adults to contribute to their own involvement in healthy, active behaviors that increase health-related quality of life.

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APPENDIX A

IRB Approval Letter

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board
4N-64 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** ·
rede.ecu.edu/umcirb/

Notification of Amendment Approval

From: Social/Behavioral IRB
To: Melissa Dale
CC: Young Joo Kim
Young Joo Kim
Date: 1/15/2020
Re: Ame3 UMCIRB 19-001365
UMCIRB 19-001365
Habit formation in older adults

Your Amendment has been reviewed and approved using expedited review on 1/14/2020. It was the determination of the UMCIRB Chairperson (or designee) that this revision does not impact the overall risk/benefit ratio of the study and is appropriate for the population and procedures proposed.

Please note that any further changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a Final Report application to the UMCIRB prior to the Expected End Date provided in the IRB application. If the study is not completed by this date, an Amendment will need to be submitted to extend the Expected End Date. The investigator must adhere to all reporting requirements for this study.

Approved consent documents with the IRB approval date stamped on the document should be used to consent participants (consent documents with the IRB approval date stamp are found under the Documents tab in the study workspace).

The approval includes the following items:

Document	Description
Extend the expected end date from 2/28/2020 to 2/26/2021.	

For research studies where a waiver of HIPAA Authorization has been approved, each of the waiver criteria in 45 CFR 164.512(i)(2)(ii) has been met. Additionally, the elements of PHI to be collected as described in items 1 and

2 of the Application for Waiver of Authorization have been determined to be the minimal necessary for the specified research.

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418

APPENDIX B

Center for Epidemiology Studies Depression Scale (Radloff, 1977).

During the past week…		Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	All of the time (5-7 days)
1.	I was bothered by things that usually don't bother me	0	1	2	3
2.	I did not feel like eating; my appetite was poor	0	1	2	3
3.	I felt that I could not shake off the blues even with help from my family	0	1	2	3
4.	I felt that I was just as good as other people	0	1	2	3
5.	I had trouble keeping my mind on what I was doing	0	1	2	3
6.	I felt depressed	0	1	2	3
7.	I felt that everything I did was an effort	0	1	2	3
8.	I felt hopeful about the future	0	1	2	3
9.	I thought my life had been a failure	0	1	2	3
10.	I felt fearful	0	1	2	3
11.	My sleep was restless	0	1	2	3
12.	I was happy	0	1	2	3
13.	I talked less than usual	0	1	2	3
14.	I felt lonely	0	1	2	3
15.	People were unfriendly	0	1	2	3
16.	I enjoyed life	0	1	2	3
17.	I had crying spells	0	1	2	3
18.	I felt sad	0	1	2	3
19.	I felt that people disliked me	0	1	2	3
20.	I could not "get going"	0	1	2	3

Note. The Center for Epidemiologic Studies Depression Scale is anchored by a frequency response scale and should contain four response options from 0 (*rarely or none of the time)* to 4 (*all of the time)*. It is scored by adding all of the scores on all items. Higher scores indicate more depressive symptoms.

APPENDIX C

Activity Measure for Post-Acute Care (Haley et al., 2004).

How much difficulty do you currently have… (If you have not done an activity recently, how much difficulty do you think you would have if you tried?)		Unable	A Lot	A Little	None
Daily Activity					
1.	Tying shoes?	1	2	3	4
2.	Sewing on button?	1	2	3	4
3.	Pounding a nail in straight with a hammer to hang a picture?	1	2	3	4
Applied Cognitive					
1.	Understanding familiar people during ordinary conversations?	1	2	3	4
2.	Making yourself understood to other people during ordinary conversations?	1	2	3	4
3.	Remembering things such as steps to complete daily activities, people's names, etc.?	1	2	3	4
Basic Mobility					
1.	Moving from sitting at the side of the bed to lying down on your back?	0	1	2	3
2.	Moving up in bed (e.g., reposition self)?	0	1	2	3
3.	Standing for at least one minute?	0	1	2	3

Note. Each subtest is scored individually. Each raw score for each individual subtest is converted to a standardized score that is used for score interpretation. The basic mobility subtest is scored on a 0 (*unable*) to 3 (*none*) scale, but all other subtests are scored on a 1 (*unable*) to 4 (*none*) scale.

APPENDIX D

Rapid Assessment Disuse Index (Shuval et al., 2014).

About how many hours a day do you typically spend MOVING AROUND ON YOUR FEET? Include moving around on your feet during work related activities, household work (like cleaning), yard work (like mowing the lawn/raking), walking (from place to place or for leisure/sports), and running at a slow or fast pace.	In the Past WEEK	In the Past MONTH	In the Past YEAR
5= less than 1 hour/day 4= 1 hour/day to less than 3 hours/day 3= 3 hours/day to less than 5 hours/day 2= 5 hours/day to less than 7 hours/day 1= 7 or more hours/day			
About how many flights of stairs do you typically climb UP each day? Let 10 steps equal one flight.	In the Past WEEK	In the Past MONTH	In the Past YEAR
5= none 4= 1 to 4 flights 3= 5 to 8 flights 2= 9 to 12 flights 1= 13 or more flights			
About how many hours a day do you typically spend SITTING? Include sitting at work/home, watching TV and video/DVDs, on the computer at home and work, eating meals, etc.).	In the Past WEEK	In the Past MONTH	In the Past YEAR
5= none 4= 1 to 4 flights 3= 5 to 8 flights 2= 9 to 12 flights 1= 13 or more flights			
Total of each column			
Sum of column totals			

Note. The columns scores are first totaled. A final raw score is produced by adding the column total for the week column, the month column and the year column. A score of 26 or above demonstrates harmfully high sedentary behavior.

APPENDIX E

Self-Report Habit Index (Verplanken & Orbell, 2003).

Behavior X is something…		Very Strongly Agree	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Very Strongly Disagree
1.	I do frequently.	1	2	3	4	5	6	7
2.	I do automatically.	1	2	3	4	5	6	7
3.	I do without having to consciously remember.	1	2	3	4	5	6	7
4.	That makes me feel weird if I do not do it.	1	2	3	4	5	6	7
5.	I do without thinking.	1	2	3	4	5	6	7
6.	That would require effort not to do it.	1	2	3	4	5	6	7
7.	That belongs to my (daily, weekly, monthly) routine.	1	2	3	4	5	6	7
8.	I start doing before I realize I'm doing it.	1	2	3	4	5	6	7
9.	I would find hard not to do.	1	2	3	4	5	6	7
10.	I have no need to think about doing.	1	2	3	4	5	6	7
11.	That's typically "me."	1	2	3	4	5	6	7

12.	I have been doing for a long time.	1	2	3	4	5	6	7

Note. This Self-Report Habit Index is anchored by an agree/disagree response scale and should preferably contain five or more response options from 1 (*strongly agree)* to 7 (*strongly disagree)*. It is scored by adding all of the scores on all items. Lower scores indicate stronger habits.

APPENDIX F

Sedentary Behavior Questionnaire (Rosenberg, Norman, Wagner, Patrick, Calfas, & Sallis, 2010).

On a typical WEEKDAY, how much time do you spend (from when you wake up to when you go to bed) doing the following?		None	15 min. or less	30 min.	1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	6 hrs. or more
1.	Watching television (including videos on VCR/DVD)	0	.25	.50	1	2	3	4	5	6
2.	Playing computer or video games	0	.25	.50	1	2	3	4	5	6
3.	Sitting listening to music on the radio, tapes, or CDs.	0	.25	.50	1	2	3	4	5	6
4.	Sitting and talking on the phone.	0	.25	.50	1	2	3	4	5	6
5.	Doing paperwork or computer work (office work, emails, paying bills, etc.).	0	.25	.50	1	2	3	4	5	6
6.	Sitting reading a book or magazine.	0	.25	.50	1	2	3	4	5	6
7.	Playing a musical instrument.	0	.25	.50	1	2	3	4	5	6
8.	Doing artwork or crafts.	0	.25	.50	1	2	3	4	5	6
9.	Sitting and driving in a car, bus, or train.	0	.25	.50	1	2	3	4	5	6
On a typical WEEKEND DAY, how much time do you spend (from when you wake up to when you		None	15 min. or less	30 min.	1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	6 hrs. or more

go to bed) doing the following?										
10.	Watching television (including videos on VCR/DVD)	0	.25	.50	1	2	3	4	5	6
11.	Playing computer or video games	0	.25	.50	1	2	3	4	5	6
12.	Sitting listening to music on the radio, tapes, or CDs.	0	.25	.50	1	2	3	4	5	6
13.	Sitting and talking on the phone.	0	.25	.50	1	2	3	4	5	6
14.	Doing paperwork or computer work (office work, emails, paying bills, etc.).	0	.25	.50	1	2	3	4	5	6
15.	Sitting reading a book or magazine.	0	.25	.50	1	2	3	4	5	6
16.	Playing a musical instrument.	0	.25	.50	1	2	3	4	5	6
17.	Doing artwork or crafts.	0	.25	.50	1	2	3	4	5	6
18.	Sitting and driving in a car, bus, or train.	0	.25	.50	1	2	3	4	5	6

Note. The time spent performing each activity is summed to create a sedentary behavior score.

APPENDIX G

Canadian Occupational Performance Measure (Law, Baptiste, McColl, Opzoomer, Polatajko, & Pollock, 1990).

Problems		Importance	Performance	Satisfaction	IMP x PERF	IMP x SAT
1.	Brisk walking	9	1	1	9	9
2.	Stretching	7	2	1	14	7
3.	Weight lifting	3	4	6	12	18

Note. The client chooses 3 physical activity goals and records them. The client then scores the problem's importance, current performance, and satisfaction with the current performance using scoring card guidelines. Scores range from 1-10. Scores are then weighted by multiplying importance and performance as well as importance and satisfaction.

APPENDIX H

MET Level Examples (Ainsworth et al., 2011)

Specific Activity		Major Heading	METS
1.	Lying quietly and watching television	Inactivity quiet/light	1
2.	Kneeling in church or at home, praying	Religious activities	1.3
3.	Watering lawn or gardening, standing or walking	Lawn and garden	1.5
4.	Ironing	Home activities	1.8
5.	Washing or waxing car	Home activities	2
6.	Playing the piano, sitting	Music playing	2.3
7.	Driving tractor	Lawn and garden	2.8
8.	Making bed, changing linens	Home activities	3.3
9.	Horseback riding, walking	Sports	3.8
10.	Table tennis, ping pong	Sports	4
11.	Golf, general	Sports	4.8
12.	Walking, 2.9 to 3.5 mph, uphill 1-5% grade	Walking	5.3
13.	Walk/run play with children vigorous	Volunteer activities	5.8
14.	Climbing hills, no load	Walking	6.3
15.	Jogging, general	Running	7
16.	Carrying groceries upstairs	Home activities	7.5
17.	Hockey, ice, general	Sports	8
18.	Walking downstairs, carrying objects 100 lbs+	Occupation	8.5
19.	Climbing hills with 42+ lb load	Walking	9
20.	Running, 6 mph (10 min/mile)	Running	9.8
21.	Bicycling, 14-15.9 mph, fast, vigorous	Bicycling	10
22.	Swimming, breaststroke, general, training	Water activities	10.3
23.	Ballroom dancing, competitive, general	Dancing	11.3
24.	Rowing, stationary, 200 watts, very vigorous	Conditioning exercise	12
25.	Skiing, cross country, 2.0-7.9 mph, vigorous	Winter activities	12.5
26.	Bicycling, mountain, uphill, vigorous	Bicycling	14
27.	Bicycling, > 20 mph, racing	Bicycling	15.8
28.	Running, 11 mph (5.5 min/mile)	Running	16

29.	Running, 14 mph (4.3 min/mile)	Running	23

Note. Activities are divided into the following major headings: bicycling, conditioning exercise, dancing, fishing and hunting, home activities, home repair, inactivity quiet/light, lawn and garden, miscellaneous, music playing, occupation, running, self-care, sexual activity, sports, transportation, walking, water activities, religious activities, and volunteer activities.