

SOCIAL COGNITIVE THEORY-BASED PHYSICAL ACTIVITY INTERVENTION  
DELIVERED BY NON-SUPERVISED TECHNOLOGY IN PERSONS WITH MULTIPLE  
SCLEROSIS

BY  
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DISSERTATION

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## ABSTRACT

Physical inactivity has been considered an issue in persons with multiple sclerosis (MS) despite the well-documented evidence supporting benefits of physical activity (Debolt & McCubbin, 2004; Motl, McAuley, & Snook, 2005; Ng & Kent-Braun, 1997; Plow, Mathiowetz, & Lowe, 2009; White & Dressendorfer, 2004). This highlights the importance of developing behavioral interventions for increasing physical activity among persons with MS. The primary purpose of the current study was to examine the efficacy of a 6-week, theory-based intervention (i.e., social cognitive theory [SCT]) delivered by newsletters and telephone calls for increasing physical activity in persons with MS who were physically inactive and had middle levels of self-efficacy. The intervention group received SCT-based newsletters and phone calls whereas the control group received newsletters that did not include any physical activity information (i.e., stress management, nutrition, and allergies) over the 6 weeks. Pedometer and log book were provided to the intervention group for the purpose of self-monitoring physical activity. Phone calls were delivered to both groups, but there was no discussion about physical activity for the control group. The results of this study indicated that the intervention group who received SCT-based intervention materials appeared to be more physically active based on self-reported physical activity ( $d = 0.56$ ,  $p = .02$ ) over the 6 weeks compared with the control group that received materials including non-physical activity ( $d = -0.13$ ,  $p = .45$ ). Additionally, only goal setting was changed by the intervention ( $d = 0.68$ ,  $p \leq .01$ ) and identified as a significant mediator of change in self-reported physical activity ( $\beta = 0.35$ ,  $p = .007$ ). Overall, the current study provides initial evidence for the potential benefit of theory-based interventions delivered by newsletters and phone calls for promoting self-reported physical activity in persons with MS who are inactive and have middle levels of self-efficacy.

## TABLE OF CONTENTS

LIST OF FIGURES .....	vi
LIST OF TABLES .....	vii
ACKNOWLEDGEMENTS .....	viii
CHAPTER I: INTRODUCTION.....	1
MULTIPLE SCLEROSIS .....	1
IMPORTANCE OF PHYSICAL ACTIVITY IN MS .....	1
PHYSICAL INACTIVITY IN MS .....	2
SOCIAL COGNITIVE DETERMINANTS OF PHYSICAL ACTIVITY BEHAVIOR .....	2
STUDY PURPOSE .....	4
STUDY HYPOTHESES .....	5
CHAPTER II: LITERATURE REVIEW .....	6
CHARACTERISTICS OF MS.....	6
<i>What is MS?</i> .....	6
<i>Type of MS</i> .....	7
<i>MS Symptoms</i> .....	7
PHYSICAL ACTIVITY IN MS.....	8
<i>Importance of Physical Activity and Exercise</i> .....	8
<i>Physical Activity Levels in MS</i> .....	11
<i>Physical Activity Measurement</i> .....	14
<i>Supervised Behavioral Interventions in MS</i> .....	17
<i>Exercise versus Lifestyle Physical Activity</i> .....	25
SOCIAL COGNITIVE VARIABLES IN PHYSICAL ACTIVITY BEHAVIOR .....	27
<i>Social Cognitive Theory</i> .....	27
<i>Social Cognitive Determinants of Physical Activity</i> .....	28

<i>Physical Activity Interventions on SCT</i> .....	34
THEORY-BASED BEHAVIORAL INTERVENTIONS DELIVERED THROUGH NON-SUPERVISED	
TECHNOLOGY .....	43
<i>Telephone-delivered Physical Activity Interventions</i> .....	44
<i>Print-based Physical Activity Interventions</i> .....	48
<i>Telephone- and Print-based Physical Activity Interventions</i> .....	51
SUMMARY OF LITERATURE REVIEW .....	56
CHAPTER III: METHODS.....	59
RECRUITMENT .....	59
MEASURES.....	60
<i>Physical Activity</i> .....	60
<i>Accelerometry</i> .....	61
<i>Self-Efficacy</i> .....	62
<i>Outcome Expectations</i> .....	62
<i>Functional Limitations</i> .....	63
<i>Goal-Setting</i> .....	64
<i>Social Support</i> .....	64
<i>Disability</i> .....	65
INTERVENTION MATERIALS .....	65
<i>Printed Newsletters</i> .....	65
<i>Pedometer</i> .....	66
<i>Telephone Calls</i> .....	67
CONTROL MATERIALS .....	67
PROCEDURES .....	67

<i>Initial Screening, Baseline Assessment, and Random Assignment</i> .....	67
<i>Intervention Delivery</i> .....	68
<i>Post Assessment</i> .....	69
<i>Compensation</i> .....	69
STATISTICAL ANALYSES .....	69
CHAPTER IV: RESULTS .....	71
<i>Participants</i> .....	71
<i>Group Comparison of Pretrial Values for Physical Activity and Social Cognitive Variables</i> .....	73
<i>Effects of the Intervention on Physical Activity</i> .....	74
<i>Effects of the Intervention on Possible Social Cognitive Mediator Variables</i> .....	75
<i>Mediator Analysis</i> .....	76
<i>Exploratory Analysis for Possible Causal Agents of Change in Self-Reported Physical     Activity in the Intervention Group</i> .....	77
CHAPTER V: DISCUSSION .....	79
SUMMARY OF CURRENT STUDY .....	79
HYPOTHESIS 1 .....	79
HYPOTHESIS 2 .....	81
NOVEL ASPECT OF STUDY .....	83
REFERENCES .....	87

## LIST OF FIGURES

Figure 1 Consort diagram .....	71
Figure 2 Step counts from pedometer over the 5 weeks for the intervention group.....	75

## LIST OF TABLES

Table 1 Topics covered by each SCT-targeted newsletter.....	66
Table 2 Demographic and clinical data at baseline for the intervention and control groups....	72
Table 3 Physical activity and social cognitive mediator variables in pretrial and post-trial for intervention and control groups .....	73
Table 4 Bivariate correlations (r) between changes ( $\Delta$ ) in self-reported physical activity and mediator variables .....	77

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## CHAPTER I: INTRODUCTION

### Multiple Sclerosis

Multiple sclerosis (MS) is a neurological disease of the central nervous system (CNS; i.e., the brain, spinal cord and optic nerve) that affects approximately 2.5 million people in the world and 1 per 1000 persons in the US (Mayr et al., 2003; Page, Kurtzke, Murphy, & Norman, 1993). It typically presents in young adults, especially women between ages of 20 and 50 years (Compston & Coles, 2002).

MS is an inflammatory disease that results in a deficiency in the transmission of nerve impulses. The abnormal nerve transmission causes unpredictable motor and sensory symptoms, varying from person to person. Most common symptoms include abnormal fatigue, numbness, loss of balance, and muscle coordination (National Multiple Sclerosis Society, 2005; Reipert, 2004). Psychological symptoms such as anxiety and depression further are prevalent in persons with MS (Goldman Consensus Group, 2005; Patten, Beck, Williams, Barbui, & Metz, 2003). Such MS-related symptoms result in unwanted outcomes, including functional loss and mobility disability as well as low quality of life.

### Importance of Physical Activity in MS

There is a wealth of evidence for the benefits of physical activity in persons with MS. Aerobic and resistance exercise has been associated with an improvement in cardiorespiratory and morphologic fitness among persons with MS (Debolt & McCubbin, 2004; Plow, Mathiowetz, & Lowe, 2009). Physical activity has been effective for managing and improving function in persons with MS (White & Dressendorfer, 2004) and also provides positive effects on quality of life and psychological well-being (Oken et al., 2004; Petajan et al., 1996; Rasova et al., 2006;

Sutherland, Andersen, & Stooove, 2001). Collectively, physical activity is a potentially important behavioral strategy for improving physical and mental health among persons with MS.

### Physical Inactivity in MS

Physical inactivity in persons with MS has been identified as a significant issue. One study indicated that persons with MS are less physically active than even sedentary persons without MS (Ng & Kent-Braun, 1997). One meta-analysis also reported that persons with MS are more physically inactive (Standard deviation = 1) compared to non-diseased populations (Motl, McAuley, & Snook, 2005). This underscores the importance of designing interventions for increasing physical activity among persons with MS.

### Social Cognitive Determinants of Physical Activity Behavior

It is important for interventions to be based on theoretical models that effectively explain and predict physical activity (Baranowski, Anderson, & Carmack, 1998). Social cognitive theory (SCT) has been one of the most predominant theoretical frameworks in physical activity interventions. Generally, SCT posits that personal, environmental, and behavioral factors are reciprocally influential in determining behavior and behavior change (Bandura, 1997).

The sociocognitive causal model from SCT explains these relationships in a way that self-efficacy influences behavior both directly and by its impact on goals, outcome expectations, and facilitators/impediments (Bandura, 2004). Self-efficacy, which is defined as a situation-specific belief that person can successfully perform a specific behavior, shapes outcome expectations that people expect the outcome to be produced, addressing that positive outcomes are expected from high self-efficacy. Self-efficacy also determines how impediments are perceived. For example, people who are low-efficacious tend to easily give up in the face of difficulties and impediments. Other social cognitive variables, including outcome expectations,

goal setting, and facilitators/impediments have been also associated with physical activity among the general population (Rovniak, Anderson, Richard, & Stephens, 2002; Wojcicki, White, & McAuley, 2009).

SCT has been applied in research examining the correlates of physical activity among persons with MS. It is reported that persons with MS having higher self-efficacy are more physically active compared to those who have lower self-efficacy (Morris, McAuley, & Motl, 2008; Motl, Snook, McAuley, Scott, & Douglass, 2006; Stroud, Minahan, & Sabapathy, 2009). Self-efficacy further plays a role in mediating relationships between physical activity and quality of life among persons with MS (Motl & Snook, 2008). Additional study indicated that outcome expectations are one of the predictors of physical activity among persons with relapsing-remitting MS (Suh, Weikert, Dlugonski, Sandroff, & Motl, 2011). Goal setting is another influential variable for understanding physical activity behavior, and positive association of goal setting with physical activity has been observed among persons with MS (Rovniak et al., 2002; Suh, Weikert, Dlugonski, Balantrapu, & Motl, 2011). Collectively, social cognitive variables derived from the sociocognitive causal model may help researchers develop more effective interventions through greater understanding the underlying mechanisms of physical activity among persons with MS.

#### Theory-based Physical Activity Intervention through Interactive Technology

Researchers have recently begun examining approach for increasing physical activity in MS, and using media such as print materials and telephone calls is one way that could be involved as alternative approaches. Both print media and telephone calls have been considered as promising approaches to health promotion in the diseased population (Bombardier et al., 2008; Weinberger, 1998). There is existing evidence supporting that intervention delivered by print

media is effective for physical activity change and adherence (Marcus, Bock, et al., 1998) as well as encouraging self-regulatory behavior and reducing time and efforts to reach large numbers of participants (Napolitano & Marcus, 2002). Telephone interview has also effects on improvement in health promoting activities, including physical activity among persons with MS (Bombardier et al., 2008).

Another consideration for the approaches is to utilize the sociocognitive causal model and threefold stepwise implementation model in developing interventions for increasing physical activity (Bandura, 2004). Tailored-print material and telephone counseling based on the social cognitive variables from the causal model is possibly effective for increasing desired behavior, and this may be more efficacious for those who had middle levels of self-efficacy (i.e., individuals at the second level) but fail to maintain positive outcomes in the face of impediments compared to those who are at the first and third levels according to the threefold stepwise implementation model (Bandura, 2004). Presumably, providing interactive feedback through newsletters and telephone interview based on SCT could be helpful to motivate and guide health behavior change such as physical activity among persons with MS.

#### Study Purpose

The purpose of this study was to examine the efficacy of SCT-based intervention delivered by newsletters and telephone calls for increasing physical activity in persons with MS who had middle levels of self-efficacy to engage in physical activity. The intervention material developed with agents in SCT was delivered by weekly newsletters and telephone calls, and it was expecting that the intervention might provide some guidance to adopt physical activity behaviors among persons with MS.

## Study Hypotheses

It was hypothesized that:

- 1) The intervention delivered by newsletters and telephone calls might help to increase physical activity behaviors in persons with MS who were physically inactive and had middle levels of self-efficacy compared with persons in the control group.
- 2) The intervention in this study would work by possible mediators of physical activity behaviors, including self-efficacy, outcome expectations, goal setting, and facilitators/impediments in persons with MS.

## CHAPTER II: LITERATURE REVIEW

This chapter includes a review of literature that is extended from each primary topic pointed out in the introduction. It consists of four categories; characteristics of MS; physical activity in MS; social cognitive variables in physical activity behavior; theory-based behavioral interventions delivered through non-supervised technology. The last section summarizes the entire literature review.

### Characteristics of MS

#### *What is MS?*

MS is considered as an inflammatory demyelinating disease in the central nervous system (CNS; the brain, optic nerves, and spinal cord). It is a non-traumatic and chronic disorder that is one of the leading neurological diseases in the United States (Mayr et al., 2003), occurring with an inflammation that causes plaques or lesions mainly found in the white matter of the CNS. This inflammatory process is followed by myelin destruction, which insulates nerve cell fibers in the brain and spinal cord. The destruction of myelin results in interference with the correct transmission of nerve signals to the CNS (Reipert, 2004).

MS affects approximately 1 per 1000 persons in the United States and 2.5 million people are suffering from MS worldwide. The majority of MS cases occur in women between 20 and 50 year of age, affecting two times more than men (NMSS, 2005). Evidence also demonstrates that MS is the most common among persons with northern European ancestry and the least common among people of African, Asian, and Hispanic backgrounds (Compston et al., 2006; NMSS, 2005).

### *Type of MS*

MS is classified according to frequency and severity of neurologic symptoms, ability of the CNS to recover, and accumulation of damage. There are four main types of MS; relapsing-remitting, secondary progressive, primary progressive, and progressive relapsing. The most common type of MS is a relapsing-remitting MS (RRMS). Around 80% of people have this type of MS at the time of initial diagnosis. It is characterized by acute symptoms, or exacerbations, followed by periods of full or partial recovery or remissions (Lublin & Reingold, 1996; NMSS, 2005). Secondary progressive MS (SPMS) occurs approximately 50% of person with MS, and it represents a steady progression of clinical neurological damage. It is the second phase from RRMS causing less frequent remissions and declining nerve and muscle function over months (Lublin & Reingold, 1996).

Primary progressive MS (PPMS) occurs approximately 10-15% of patients with MS, which is characterized by a gradual progression of the disease involving a decline in physical abilities without clear relapse or remissions. Sometimes, the decline seems to stop with some minor relief (Fraser, Clemmons, & Bennett, 2002; Reipert, 2004). Finally, progressive relapsing MS (PRMS) is a rare type of MS, which is developed by a steady decline of neurologic function from the time of disease onset interspersed with brief periods of acute exacerbations of symptoms (Lublin & Reingold, 1996).

### *MS Symptoms*

The disruption of myelinated axons within the CNS results in a variety of symptoms. Symptoms of MS are unpredictable and variable from person to person. Typical symptoms of MS include fatigue, spasticity, cognitive dysfunction, bladder and bowel problems, pain, and depression (Crayton, Heyman, & Rossman, 2004). These symptoms might influence activities of

daily living. For example, motor symptoms such as arm and leg weakness are inversely correlated with fine motor skills such as eating and walking (Motl, Snook, & Shapiro, 2008; NMSS, 2005). In addition to the physical symptoms, emotional symptoms such as depression and anxiety could affect normal daily activities (Minden et al., 2006). Collectively, MS symptoms are associated with reduced activities of daily living and eventually result in physical inactivity in persons with MS.

### Physical Activity in MS

This section first includes the definition of physical activity and example research to indicate the benefits of physical activity among healthy population and persons with disability, including MS. In the second part of this section, physical activity levels of MS are presented to demonstrate how much persons with MS are physically inactive. In the third part, physical activity measurement in MS was discussed by comparison of self-reports and objective measures in physical activity. The last part reviews supervised behavioral interventions in MS, and comparison of physical activity interventions and exercise interventions among persons with MS.

#### *Importance of Physical Activity and Exercise*

Although physical activity and exercise are overlapping, these two terms are not identical. Physical activity is defined as any body movement produced by the skeletal muscles that result in a substantial increase over the resting energy expenditure and it is categorized into household chores (i.e., vacuuming, sweeping floors, washing car and windows, raking leaves, etc.), occupational work (i.e., walking, lifting or packing boxes, etc.), and leisure-time activity (i.e., swimming, biking, running, exercise, and sports) (Bouchard & Shephard, 1994, p.77). Exercise, on the other hand, refers to prescribed, structured, and repetitive performance with purpose of improving or maintaining physical fitness (Center for Disease Control and Prevention [CDC],



2011, Glossary of Terms webpage; Chodzko-Zajko et al., 2009). Accumulating evidence supports positive relationships between physical activity/exercise and health outcomes. For example, regular participation in physical activity helps prevent cardiovascular diseases and weight gain (Knowler et al., 2002; Wing & Hill, 2001). One review study also reported that physical activity and exercise have beneficial aspects across several physical health outcomes related with obesity and cancer (Penedo & Dahn, 2005). Additional research demonstrated that regular and moderate physical activity is associated with decreases in the risk of coronary heart disease and type II diabetes by preventing obesity (Allen, 1996; Blair, 1994; Uusitupia et al., 2000). One final study indicated that physical activity and exercise are inversely associated with muscle weakness, fatigue, and sleep disturbance (Stewart & King, 1991; Sutherland & Andersen, 2001). Collectively, physical activity and exercise play an important role in providing good status of physical health.

Engaging in physical activity and exercise further produces positive effects on mental health and psychological well-being. There is evidence that higher levels of physical activity and exercise are associated with better mental health (i.e., depression) in both children and adults (Biddle & Mutrie, 2001; Craft, 2005; Giacobbi, Hausenblas, & Frye, 2005). Wijndaele et al. (2007) also reported that physical activity can be a preventive behavioral strategy for reducing psychological stress. Allgower, Wardle, and Steptoe (2001) further found that physical activity and exercise have a favorable influence on depressive symptoms among young adults. Despite of the well-documented benefits of physical activity and exercise, there is relatively little interest for examining a positive relationship between physical activity and health outcomes among persons with disability (Rimmer, Braddock, & Pitetti, 1996).

There is emerging evidence that engaging in regular physical activity is positively associated with physical function and psychological well-being among persons with disability (Heath & Fentem, 1997). It is reported that patients with cancer have a significant improvement in physical function (e.g., muscle strength and body composition) as well as psychological and emotional status (e.g., mood states and QOL) by engaging in physical exercise (Courneya & Friedenreich, 1999). Additional study found that resistance exercise trainings over an 18-month period for persons with chronic heart failure are effective for increasing muscle strength and physical function (Savage et al., 2011). There is another study to indicate that physical activity appears to be a means of rehabilitation in chronic disease, facilitating better physical function and QOL (Rimmer, Chen, McCubbin, Drun, & Peterson, 2010). To that end, engaging in physical activity and exercise could contribute to improvements in physical and mental health as well as psychological well-being among persons with MS.

Indeed, cumulative evidence supports that physical activity and exercise are promising behavioral strategies for managing MS-related symptoms (i.e., loss of function, feeling in limbs, fatigue, loss of balance, pain, and depression) (Motl, McAuley, & Snook, 2005; Simmons, Ponsonby, Van der Mei, & Sheridan, 2004; Stuifbergen, 1992). A meta-analysis indicated that exercise trainings are associated with a small, but clinically meaningful walking improvement among persons with MS (Snook & Motl, 2009). One recent study also reported that both physical activity and exercise training are associated with improvement in walking impairment among persons with MS (Motl, Goldman, & Benedict, 2010). Stroud and Minahan (2009) compared fatigue, depression, and QOL scores through self-reported survey between persons with MS who were regular exercisers and those who are non-exercisers in the absence of interventions. The results of this study indicated that persons with MS who engaged in exercise

regularly had more favorable fatigue, depression and QOL scores compared with those with MS who were not regular exercisers. This implicates that regular physical activity and exercise may help improve fatigue, depressive symptoms and QOL among persons with MS. Such collective evidence suggests that engaging in physical activity and exercise could be appropriate behavioral approaches for promoting physical functions as well as mental health among persons with MS.

#### *Physical Activity Levels in MS*

Regardless of the considerable benefits of physical activity and exercise in MS, physical activity and exercise have been discouraged in persons with MS because they tend to experience fatigue and overheat that may worsen MS-related neurological symptoms (Petajan & White, 1999). This eventually leads to lack of physical activity and causes worse fatigue and muscle weakness in MS.

Numerous studies have demonstrated that persons with MS have a remarkably less amount of physical activity than those without MS (Motl, 2008; Motl, McAuley, & Snook, 2005). Stuifbergen (1997) examined relationships between physical activity and social, mental, and physical health among persons with MS. A sample of 37 persons with MS completed the Human Activity Profile and the Medical Outcomes Study Short-Form Health Survey. The levels of physical activity among persons with MS in the study were lower than the normal levels of physical activity in healthy populations and adults with other chronic disease condition. This study further found that persons who engaged in regular exercise had significantly higher scores on the measure of physical functioning than those who did not engage in the exercise. These findings suggest that persons with MS have much lower average and maximal activity scores than the healthy populations.

Ng and Kent-Braun (1997) compared physical activity levels in 17 persons with MS who were not physically active, 15 healthy and sedentary persons with age- and sex-matched, and 8 healthy adults who participated in at least a 20-minute of the vigorous exercise more than 3 times per week during the previous 3 months. Participants in all of the groups completed the 7 Day Physical Activity Recall Questionnaire (7dPAR) and were asked to wear an accelerometer for the next seven days. Based on the results from the accelerometer, participants with MS in the experimental group were less physically active than the sedentary adults in the control group, and both persons with MS and sedentary controls were less physically active than the active controls. There was no significant difference in the 7dPAR scores between the MS and sedentary groups; however, the active controls were significantly more active than the MS and sedentary groups. The primary finding of this study supports that persons with MS had a low amount of physical activity measured by the accelerometer than both sedentary and active control groups.

Stuifbergen and Roberts (1997) further conducted research to explore health promoting behaviors, particularly focusing on exercise, among 629 women with MS. The participants were asked to complete the Health Promoting Lifestyle Profile II (HPLPII) and MS version of QOL Index. Women with MS in this study reported to rarely engage in physical activity, and 37% of the women with MS had stretching at 3 times per week, 35% of them had usual daily activities, 22% had light to moderate exercise, and 19% took part in leisure-time physical activity. They further had low scores on the physical activity subscale of HPLPII compared with the normative mean value from normative data with a larger sample of 712 adults ( $d = .67$ ). This study suggests that women with MS engage in significantly less amounts of physical activity than non-diseased populations.

Paul and Weinert (1999) conducted a study using the wellness profiles of women with MS (N = 227) who originally participated in the larger Family Health Study to compare their lifestyle indicators with the national health statistics. The indicators included physical activity levels, weight status, breakfast pattern, snacking, health perceptions, alcohol consumption, and tobacco use. Physical activity was assessed with two categories including the amount and type of activities completed during the past week. Among participants with MS in this study, 44% reported engaging in 'no activity', which reflected a higher level of inactivity than both the National Cohort of Midlife Women (28%) and the National Cohort with Chronic Illness (39%). Only 15% of the women with MS reported engaging in moderate and/or vigorous activity, which reflected a lower level of activity than both the National Cohort of Midlife Women (28.9%) and the National Cohort with Chronic Illness (28.4%). This implicates that women with MS engage in less total physical activity and less vigorous physical activity.

Busse, Pearson, Van Deursen, and Wiles (2004) further compared levels of physical activity among persons with chronic disease including MS, Parkinson's disease, and primary muscle disorders. Each disease group had 10 persons and matched controls of healthy individual. Physical activity was measured across a 7-day using the Step Watch activity monitor. Among the participants of the three diseases, the MS group had the lowest 7-day step count ( $M = 2,985$ ) with the primary muscle disorder group having higher counts ( $M = 3,003$ ) and persons with the Parkinson's disease accumulated the most step counts ( $M = 3,818$ ). There was a moderate correlation ( $r = .45$ ) between gait speed and daily step counts. Importantly, a difference in physical activity levels between the MS group and healthy controls was large in magnitude ( $d = 1.1$ ).

Romberg, Virtanen, Ruutiainen, Aunola, Karppi, and Ruutiainen (2004) also examined the duration, mode, and intensity of physical activity among 95 persons with mild to moderate MS. Physical activity was measured over a 4-week period using a self-report questionnaire adapted from the Mini-Finland Health Survey. The majority of the participants reported engaging in less than one hour of exercise training per week. The most common type of activity was walking engaging in between 1 and 2.9 hours per week. The participants further reported that they engaged in breathless activities (49%) among all physical activities. Overall, this study suggests that most persons with MS tend to engage in a low amount of physical activity at moderate intensity with breathlessness.

Collectively, persons with MS appear to be relatively inactive and less engage in regular physical activity and exercise compared to persons without MS. In this regards, developing behavioral interventions for increasing physical activity is imperative for providing guidance and support to help persons with MS engage in physical activity.

#### *Physical Activity Measurement*

Accurate assessment of physical activity is important to identify current levels and changes as well as to assess the efficacy of behavioral interventions designed to increase activity levels. Self-report measures of physical activity are easy to administer, cost-effective, provide normative values for comparability, and can provide information on the types of activities performed (Prince et al., 2008), but may not capture activity patterns throughout the day (Murphy, 2009). Some measures also include estimation of energy expenditure based on the duration and frequency of reported activity participation (i.e., Godin Leisure-Time Exercise Questionnaire). However, there are some limitations of using self-report measures such as recall bias and social desirability bias (Fisher, 1993) whereby people may respond in a way that will be

considered as favorable by others. Furthermore, the self-reported responses can be influenced by mood, depression, anxiety, or cognitive ability (Rikli, 2000), and it has possibility to over-estimate true physical activity and rates of activity (Prince et al., 2010).

By comparison, objective measures of physical activity have been increasingly used to overcome such limitations of self-report measures. Especially, accelerometers have been considered as notable measuring monitor for assessing the amount, frequency, and duration of physical activity (Plasqui & Westerterp, 2007). The accelerometer can further be used to obtain activity patterns and intensity occurred in daily lives (Murphy, 2009). An additional study supported that activity counts from accelerometers, but not scores from the self-reported surveys, were sensitive in detecting differences in physical activity among persons with MS compared with sedentary and active controls (Ng & Kent-Braun, 1997). However, accelerometers have some problematic issues of possible reactivity in behavioral interventions, whereby baseline assessment might prompt self-awareness of physical activity levels as well as excitement for receiving an intervention (Motl, McAuley, & Dlugonski, 2012). Another study further indicated that accelerometers may better reflect ambulatory capacity instead of physical activity (Weikert et al., 2010).

Approach has been made to examine the validity of measures in both self-reports and objective monitors of physical activity in healthy adults and persons with MS. Motl et al. (2005) evaluated the validity of scores from two self-report surveys, including GLTEQ and 7-day physical activity recall (7dPAR) as well as a pedometer (i.e., Yamax SW-200) and an accelerometer (i.e., model 7164) during 7 days of free-living conditions among persons with MS. The results indicated that there were weak, but moderate-to-strong correlations between GLTEQ and pedometers ( $r = .44, p = .56$ ) as well as accelerometers ( $r = .52, p = .56$ ). The findings

support that both self-reports measures and objective monitors can be validated measures for quantification of physical activity in persons with MS.

However, one study suggested opposite findings based on comparison self-reports with objective measures (i.e., accelerometers and pedometers) for assessing physical activity in observational and experimental studies among the general population. In this systematic review, the results demonstrate that correlations between self-reports measures and objective monitors were low-to-moderate with a mean correlation coefficient of 0.42 (SD = 0.25, range = -0.71 to 0.98). The findings provide supportive evidence that using both self-reports and objective measures can have an impact on assessing physical activity levels, and perhaps each measure may assess different aspects of physical activity (Prince et al., 2008).

Recently, the objective monitor (i.e., accelerometer) has been tested its validity for measuring physical activity among persons with MS by comparing with self-reported physical activity questionnaire (i.e., GLTEQ) and walking tests (i.e., Timed Up and Go, and 6 minute-Walk) (Weikert et al., 2010). The results indicated that accelerometer output was significantly correlated with only mobility measures in MS, whereas it correlated with both mobility and physical activity (GLTEQ) measures in controls without MS. Such findings suggest that accelerometers might better measure walking mobility than physical activity, in persons with MS. Additional evidence further demonstrates that use of objective monitors including pedometers may have disadvantages that pedometers might underestimate steps taken at slower gait speeds (i.e., with irregular and unsteady gait patterns). Furthermore, it may not capture upper-extremity activity or household chores such as pushing, lifting, or carrying objects (Berlin, Storti, & Brach, 2006).



Overall, selecting appropriate measures of physical activity is important to capture valid and reliable physical activity, and this will provide better indications of the actual physical activity levels that would be considered when it comes to designing physical activity interventions among both general population and people with chronic disease such as MS.

### *Supervised Behavioral Interventions in MS*

There is an existing body of literature about supervised physical activity/exercise interventions to support beneficial aspects of engaging in physical activity among persons with MS (Petajan & White, 1999; White & Dressendorfer, 2004). Research indicates that regular physical activity/exercise are potentially effective for improving body structure including cardiorespiratory endurance and walking speed as well as enhancing QOL among persons with MS (Garrett & Coote, 2009).

Mostert and Kesselring (2002) conducted research to examine the effectiveness of an aerobic exercise program among 26 persons with MS and 26 matched controls without MS. A total duration of the intervention program was 4 weeks, and an intervention group was asked to perform 5 times 30 minute bicycling per week at the individualized intensity. BAECKE Activity Questionnaire (Baecke, Burema, & Frijters, 1982) was used to measure daily physical activity, including work, sport and leisure time activity. Compared to the baseline, the MS exercise training group had a significant rightward placement of the aerobic threshold ( $VO_2+3\%$ ; work rate $+11\%$ ), an improvement of health perception (vitality $+46\%$ ; social interaction $+36\%$ ), an increase of activity level ( $+17\%$ ) and a reduction in fatigue ( $-14\%$ ) for the MS training group ( $p = 0.09$ ) has been found, which was more pronounced compared to MS group without the intervention ( $-4\%$ ). There was a 17% of increase in sport-related activity across the intervention period in the MS exercise group. The incidence of symptom exacerbation by physical activity

has been lowered than expected (6%). This study supports that the 4-week of the bicycling training may be helpful for promoting physical activity and exercise among persons with MS.

Schulz and colleagues (2004) also conducted a 8-week of the bicycle training intervention study to examine changes in immunological, endocrine, and neurotrophic factors as well as coordinative function and QOL among persons with MS. 28 persons with MS participated in the immune-endocrine measure, and 36 persons with MS were included in the coordinative function measure. All the participants completed a 30-minute of the bicycle ergometry training at 60% of  $VO_2$  max, and a wait-list control group was provided the exercise program after the 8 weeks. The training group also had a 30-minute endurance test, standardized tests of coordinative function (i.e., walking, figure eight, and posture coordination test), and completing a battery of questionnaires for measuring mental and psychological well-being before and after 8 weeks. Based on the immunological markers after the intervention, the most significant change was found in the lactate level that was lowered (pretest,  $2.5 \pm 1.8$ , posttest,  $2.1 \pm 2.3$ ;  $p = 0.04$ ) after the bicycle training although there was no significant training effects in changing endocrine and immune parameters or neurotrophins. Disease-specific QOL measured by the Hamburg Quality of Life Questionnaire for MS (Gold et al., 2001) was significantly improved in the training group. These findings suggest that the 8-week of bicycling training at the low intensity could benefit persons with MS for enhancing parameters of physical fitness and disease-related QOL.

Romberg, Virtanen, Ruutiainen, Aunola, and Karppi et al. (2004) examined the effectiveness of the exercise program developed for improving walking and physical function across a 6-month period of time among persons with MS. A sample of 95 persons with MS was randomly assigned into either an exercise group or a control group. The exercise intervention

included a 3-week of strength and aerobic training for inpatient rehabilitation, and continued for 23 weeks at home. Both groups were evaluated at baseline and at 6 month follow-up. The primary outcome measure included walking speed using the two different waling tests. Lower extremity strength, upper extremity endurance and dexterity, peak oxygen uptake, and static balance were measured as secondary outcomes. In the 7.62 minute walking time (MWT) and 500 MWT, the exercise group had a 12% decrease (95% confidence interval: 16% to 7%,  $p < 0.001$ ) and a 6% decrease (95% confidence interval: 10% to 2%,  $p < 0.001$ ) relative to baseline. The exercise group further had an improvement in the upper extremity endurance (mean change = 2.9 [95% confidence interval: 0.7 to 5.1]). This study suggests that exercise training could be a promising strategy for improving physical function among persons with MS who have mild to moderate level of disability in MS.

Another study done by Debolt and McCubbin (2004) examined the effectiveness of lower extremity resistance training on balance, power, and mobility for 8 weeks in persons with MS. A total of 19 persons with MS were assigned into an intervention group, and 17 persons with MS in a control group were asked to maintain current levels of physical activity. The intervention group had a total of 6 instructional sessions to learn the correct form of each exercise and record exercise procedures properly. After the 2-weeks of the instructional phase, the intervention group received all the equipment (i.e., vest, ankle weights, and data recording sheets) that required for home-based exercise training. Also, the exercise video was provided that was produced for this study. Primary outcome measures included balance measured by AccuSwayPLUS force platform; mobility assessed with the 'Timed Up and Go' (TUG); leg power taken by the Leg Extensor Power Rig. Overall, the results indicated that the leg extensor power was significantly improved in the exercise group (pretest,  $3.19 \pm 1.36 \text{W/kg}$ ; posttest,  $3.95 \pm 1.23 \text{W/kg}$ ;  $p = .004$ ). Such findings

support that resistance exercise training is presumably efficient for increasing leg strength in persons with MS.

The effect of resistance exercise training for physical activity promotion among persons with MS has been also proved in a study conducted by Bjarnadottir, Konradsdottir, Reynisdottir and Olafsson (2007). The study examined the effectiveness of a 5-week exercise intervention on physical function and QOL among persons with MS. 16 persons with MS were randomly assigned into either an exercise group or a control group. The exercise intervention contained 15 to 20 minutes of cycle ergometer and resistance training, such as muscle training. The exercise group participated in the training at 3 times per week during 5 weeks, whereas the control group was asked to maintain their normal exercise routines. The primary outcome measures included peak oxygen consumption, workload and anaerobic threshold, QOL score, and disability status. In the exercise group, the mean change in workload and the peak oxygen consumption was 0.34 W/kg (95% confidence interval: 0.09-0.58), and 4.54 mL/kg per minute (95% confidence interval: 1.65-7.44), respectively. Also, there was a mean change of 0.32L/min in an anaerobic threshold (95% confidence interval: 0.08-0.57). The QOL score was improved after the exercise intervention; however, there was no change in the disability level. Despite of the small sample size, this study provides preliminary evidence supporting that engaging in moderate exercise could contribute to an improvement in physical fitness among persons with mild MS.

Another study found that resistance training could be effective for improving both leg strength and walking speed in persons with MS (Pérez, Sánchez, Teixeira, & Fernández, 2007). A total of 36 persons with MS performed 3 times 60 minute of resistance training that involved a callisthenic or bodyweight exercise across a 6-week period of time. Strength tests involved clapping, back muscle, leg-lift, and abdominal work. The result of this study confirmed that

resistance training may be useful for improving strength (Back muscle,  $0.4 \pm 0.5$  m; Leg-lift,  $4.1 \pm 4.9$  rpts; Abdominal work,  $3.9 \pm 5.1$  rpts) as well as walking speed ( $3.7 \pm 2.3$  s) in participants with MS. The implication of this study is that a short bout of resistance training plays an effective role in MS rehabilitation for improving muscle strength and walking mobility.

Dalgas and colleagues (2009) had a 12-week of Progressive Resistance Training (PRT) to determine the efficacy of lower extremity among persons with MS. The exercise group ( $n = 19$ ) completed the PRT for 12 weeks and a wait-list control ( $n = 19$ ) joined the training afterwards. Both groups were tested before and after 12 weeks, and at 24 weeks as follow-up. The PRT intervention included an isometric muscle strength test of the knee extensors and functional capacity. Maximum voluntary contraction of knee extensors (15.7% [95% confidence interval: 4.3–27.0]) and functional capacity (21.5% [95% confidence interval: 17.0–26.1];  $p < 0.05$ ) were improved after 12 weeks of PRT in the exercise group compared to the control group ( $p < 0.05$ ). The improvement in the exercise group was maintained at the follow-up after 24 weeks. The findings of this study implicate that lower extremity PRT can be efficacious for improving muscle strength and functional capacity in persons with mild MS.

Finally, Freeman and colleagues (2010) conducted a small pilot study with 8 persons with mild MS to explore the effectiveness of core stability training on balance and mobility. An intervention for 8 weeks consisted of 16 core stability training and an individualized-home exercise program. Physical function measures were undertaken using a variety of testing (i.e., 10 meter-timed Walk, Timed Up and Go (TUG), Functional Reach forwards and lateral, MS walking scale, Activities Specific Balance Confidence Scale, Timed-single leg stance, and Visual Analogue scale). During the 8 weeks, 5 out of 8 participants in this study had an improvement in the timed walk ( $p = 0.019$ ), MSWS-12 Scale ( $p = 0.041$ ), forward ( $p = 0.015$ ) and lateral

functional reach ( $p = 0.012$ ). Regardless of the limited sample size, this study supports that stability exercise would be efficacious for increasing better balance and mobility among persons with MS.

In addition to the beneficial effects of the exercise intervention on physical fitness, there is a great body of literature to support the positive effects of the exercise intervention on fatigue, QOL, and psychological well-being among persons with MS. Petajan and his colleagues (1996) reported the effects of a 15-week of exercise training among 45 persons with MS. In this study, participants were randomly assigned to either an exercise group or a non-exercise group. Physical fitness (i.e., maximal aerobic capacity ( $VO_2$  max), isometric strength, body composition, and blood lipids) were measured at baseline and at follow-up. Profile of Mood States (POMS), Sickness Impact Profile (SIP) and Fatigue Severity Scale (FSS) were used for measuring psychological variables. The intervention involved 3 times 40 minute sessions per week, consisting of the arm and leg cycle ergometry. The exercise group had significant increases in  $VO_2$  max (22%) and physical work capacity (48%) compared to the non-exercise group over the 15-weeks training period. The exercise group further had a significant decrease in skinfold thickness (pre-training,  $70 \pm 51$  mm; post-training,  $64 \pm 4$  mm;  $p < 0.05$ ) and body fat ( $p = 0.068$ ) after 15 weeks of the aerobic training. Finally, depression and anger subscales were lowered in the exercise group at both 5 and 10 weeks of the intervention ( $p < 0.05$ ). Based on the results of this study, exercise training appears to improve typical MS-related symptoms, including depressive symptoms and low QOL along with improvements in aerobic capacity and muscle strength.

Another study of Oken and his colleagues (2004) determined the effectiveness of aerobic exercise training on mood, fatigue, and QOL among persons with MS. A sample of 69 persons

with MS were randomly assigned to three groups; a weekly Iyengar yoga class along with home practice, a weekly exercise class using a stationary bicycle along with home exercise, or a wait-list control group. All groups were administered to complete a battery of cognitive measures including attention, physiological measures of alertness, Profile of Mood States, State-Trait Anxiety Inventory, Multi-Dimensional Fatigue Inventory (MFI), and Short Form (SF)-36 of Health-related QOL. The primary findings of this study were that Energy and Fatigue (Vitality) on SF 36 Health-related QOL and the general fatigue on MFI were only improved after the 6-month period of time ( $p < .001$ ). There were no significant effects on cognitive function and mood. This suggests that aerobic exercise training is a potentially favorable method for improving health-related fatigue in persons with MS.

Motl and Gosney (2008) examined the effects of exercise training interventions on QOL among persons with MS. They searched MEDLINE, PSYCHINFO and CURRENT CONTENTS PLUS for the period of 1960 to November 2006 using the key words including exercise, physical activity and physical fitness in conjunction with QOL and MS. 13 studies with a total of 484 MS patients were reviewed and provides evidence supporting that exercise training is associated with a small, but statistically significant improvement in QOL among persons with MS (mean effect size;  $g = 0.23$  [95% CI: 0.15-0.31]).

Plow, Mathiowetz, and Resnik (2008) undertook research to determine the impact of physical activity intervention on psychosocial correlates of physical activity among persons with MS. A sample of 50 persons with MS was randomly assigned to either 7 weeks long group education session or an individualized physical rehabilitation. The individualized rehabilitation consisted of 4 preventive physical therapy sessions for promoting physical activity among participants with MS. The education sessions focused on energy conservation, time/stress

management, self-efficacy and social support for exercise. Both the education and rehabilitation group had a 16-week home practice that included 3 times per week of stationary bicycle training and twice a week of the Thera-Band strengthening exercise. Physical activity was measured using Health-Promoting Lifestyle Profile II (HPLP II), and other psychological variables, including barriers to exercise self-efficacy; social support; expectations, and self-identity were measured. The key findings of this study indicated that both the education and rehabilitation groups had increases in frequency of engaging in physical activity ( $p < 0.05$ ). Also, social support ( $\beta^2 = .34$ ) and self-identity ( $\beta^2 = .44$ ) at pretest were correlated with physical activity ( $p < 0.05$ ). After the intervention, self-efficacy ( $\beta^2 = 0.38$ ) and social support ( $\beta^2 = 0.31$ ) were associated with physical activity ( $p < 0.05$ ). This study further provides preliminary evidence to suggest that determining correlates of physical activity is of major importance when it comes to development of physical activity interventions among persons with MS.

Dalgas and colleagues (2010) expanded their previous study (Dalgas et al., 2009) of the progressive resistance training (PRT) to determine the efficacy of a 12-week PRT on fatigue, mood, and QOL among persons with MS. The intervention group had a 12-week PRT program completed whereas the control group was asked to maintain their normal activity. The intervention program involved endurance and resistance training that included warm-up, stationary bicycling, leg press, knee extension, hip flexion, hamstring curl and hip extension. After the 12 weeks, fatigue improved during exercise by -0.6 (95% confidence interval (CI): -1.4 to 0.4), mood improved by -2.4 (95% CI: -4.1 to 0.7) and QOL (Physical component of SF 36 Health Survey) improved by 3.5 (95% CI: 1.4 to 5.7). The intervention effects were maintained for at least 12 weeks after end of intervention. This implicates that the PRT is a possible useful behavioral strategy to improve fatigue, mood, and physical-related QOL among persons with MS.



Conclusively, prescribed and supervised exercise interventions have been known as efficient behavioral approaches to promotion in physical function, mental health, and QOL among persons with MS. The weakness of such interventions, however, needs to be replaced with the alternative behavioral interventions for emphasizing non-supervised lifestyle physical activity in persons with MS.

#### *Exercise versus Lifestyle Physical Activity*

As seen in the previous section, most of the behavioral interventions for improving active lifestyle among persons with MS have utilized a group of prescribed and structured exercise training under supervision. Such exercise training programs tend to limit a long-term use of interventions, and it further requires a great amount of time and cost to set up in-place testing (Van Roie et al., 2010). As alternative, lifestyle physical activity interventions could compensate for the limitations of the supervised exercise interventions. Lifestyle physical activity defines as self-selected, planned or unplanned activities, which is the daily accumulation of at least 30 minutes of moderate to vigorous daily activities (i.e., house chores, occupational activities) (Dietz, 1996; U.S. Department of Health and Human Services [Centers for Disease Control and Prevention], 1996). It can be facilitated and manipulated more voluntarily compared with structured/supervised exercise training (Dunn, Anderson, & Jakicic, 1998).

Indeed, evidence demonstrates that both lifestyle physical activity and structured exercise interventions have equal effects for improving physical fitness among middle-aged healthy adults (Dunn et al., 1999; King, Haskell, Taylor, Kraemer, & DeBusk, 1991). In addition, lifestyle physical activity interventions indicate positive effects on cardiovascular disease risk factors such as reducing body fat and elevated blood pressure when compared to programmed exercise (Dunn et al., 1997; Elmer et al., 1995).

There is increasing interest that lifestyle physical activity intervention can be beneficial when it is delivered through non-supervised mode, such as telephone or print material as reinforcement of integrating physical activity into daily routines (Dunn et al., 1998). To date, there is a lack of research to determine the effects of non-supervised behavioral interventions focusing on lifestyle physical activity among persons with MS. Motl, McAuley, Wynn and Vollmer (2011) recently conducted a panel study to indicate positive, longitudinal associations between changes in lifestyle physical activity and walking impairment in RRMS, addressing the potential importance of targeting free-living physical activity in developing behavioral interventions. This further implicates that lifestyle physical activity interventions can contribute to better effects on a large scale through non-supervised mode of delivery which is relatively cost-effective and time-saving compared with the structured and supervised exercise training program.

Such lifestyle activity interventions would be more effective when it has a theoretical base so that it can help identify correlates of physical activity and understand the behavior change over time (Dunn et al., 1998). In other words, identifying correlates of physical activity behavior should be preceded for implementing physical activity interventions to understand what would play a role in determining physical activity among persons with MS (Motl et al., 2006). The correlates of physical activity could be utilized for designing optimal intervention in promotion of physical activity, and this need to be explained in the context of a theoretical framework (Glanz & Bishop, 2010). The next chapter will present one of the most prominent health behavior theories, Social Cognitive Theory (SCT) and how the SCT can be utilized in understanding physical activity behavior and developing behavioral intervention in persons with MS.

## Social Cognitive Variables in Physical Activity Behavior

### *Social Cognitive Theory*

SCT proposes that there is a triadic, reciprocal relationship between personal factors, environment, and behavior (Bandura, 1986; 1997). Individuals alter or construct external environment to meet their purpose which is devised for themselves. Behavior can also influence the personal factors (i.e., cognitions, affective, and biological responses) and are influenced by the environment (Carron, Hausenblas, & Estabrooks, 2003).

Self-efficacy is a central component of the personal factors in the triadic reciprocal causation of the SCT. It is defined as a situation-specific belief that person can successfully perform a specific behavior. Efficacious people are ready to take advantage of opportunity and figure out solutions to overcome impediments or change them by collective action (Bandura, 1997). Efficacy beliefs come from four sources; mastery experiences, social modeling, social persuasion, and interpretations of physiological and affective responses. It is noted that self-efficacy influences certain activities, efforts expended on those activities, and the degree of persistence in the face of failures. To that end, those who with high levels of self-efficacy have a greater effort and persistence in the face of adversity and they are more willing to face challenges than persons with low levels of self-efficacy (Bandura, 1997).

There are additional influential agents that need to be considered in explaining social cognitive behavior. In a structural model offered by Bandura (2004), there are psychosocial agents, including outcome expectations (i.e., physical, social, and self-evaluative outcome expectations), sociocultural factors (i.e., facilitators and impediments), and self-regulation (i.e., goal setting).

The outcome expectations are a belief, addressing that performing certain task will result in certain consequences (Bandura, 1997). Physical outcome expectations have either favorable or aversive effects of the behavior followed by benefits and losses from the behavior. The second set of outcome expectations is social outcome expectations, which is influenced by the social approval and disapproval in the interpersonal relationships. One final outcome expectations is self-evaluative outcome expectations that include the positive and negative self-evaluative reactions to one's behavior. People adopt personal standards and regulate their behavior by their self-evaluative reactions (Bandura, 2004).

Sociostructural factors (i.e., facilitators and impediments) could explain the role of social support within the SCT (Bandura, 1997). At the level of the triadic reciprocal determinism, social support could be considered as an environmental factor and might have direct effects on behavior moderated by self-efficacy. In turn, social support can also influence self-efficacy by way of social persuasion, and self-efficacy would mediate the relationship between social support and behavior (Bandura, 1997). Self-regulation is another determinant of behavior change and provides motivation influenced by self-efficacy, outcome expectations, and sociostructural factors as well as guidelines for the desired behavior change. This operates through self-monitoring of their goals and the achievable goals lead people to attain the desired behavior by continuous efforts and guiding action (Bandura, 1991; 2004).

### *Social Cognitive Determinants of Physical Activity*

Theoretical constructs of the SCT have been utilized to understand how individuals come to adopt and maintain health behaviors such as physical activity (Bandura, 1997). The principle of SCT has been supported in health promotion research, and provides a comprehensive

conceptual framework for understanding correlates of health behaviors, including physical activity (Bandura, 2004).

Self-efficacy is one of the most powerful and consistent predictors of physical activity among healthy adults (Bandura, 1997; McAuley, 1993; McAuley & Blissmer, 2000; Sallis, Hovell, & Hofstetter, 1992; Sallis & Owen, 1999; Trost, Owen, Bauman, Sallis, & Brown, 2002). Roviniak, Anderson, Richard, and Stephens (2002) had a prospective study to determine the relationship between social cognitive variables (i.e., self-efficacy, outcome expectations, self-regulation, and social support) and physical activity among young adults. The findings of this study suggest that self-efficacy had the greatest effects on physical activity mediated by self-regulation (i.e., goal setting and planning) ( $\beta_{\text{indirect}} = .57, p < .05$ ). McAuley, Jerome, Elavsky, Marquez, and Ramsey (2003) further conducted prospective research to examine the relationship between self-efficacy and adherence in older adults. A total of 174 persons with low levels of physical activity were randomized either a walking group or a stretching/toning group, and the outcome measures were assessed at 6 and 18 months. The best fit model indicated that there were direct, significant associations of social support, affect, and exercise frequency with efficacy at the end of the program. Efficacy, in turn, was associated with physical activity at the 6 and 18 months follow-up ( $p < .05$ ). The model accounted for 40% of the variance in 18 months activity levels. This prospective study provides evidence that the positive association between self-efficacy and physical activity exists among older adults and this addresses the important role of self-efficacy in the long-term exercise behavior.

Outcome expectations are another factor that contributes to understanding physical activity behavior. This has been appeared to a significant predictor of physical activity in both diseased (e.g., cancer patient; Rogers et al., 2006) and non-diseased population (Clark, 1999;

Winters, Petosa, & Charlton, 2003). People can develop their expectations for the desired outcomes and this could help to increase motivation for engaging in the physical activity (Maibach & Cotton, 1995). Wojcicki, White, and McAuley (2009) examined the validity of theoretically consistent-three factors in outcome expectations (i.e., physical, social, and self-evaluative outcome expectations) exercise scale in middle-aged and older adults. Participants ( $N = 320$ ) were asked to complete a battery of questionnaires that measure outcome expectations, self-efficacy, physical activity, and health status. The result of this study indicated that higher self-efficacy were significantly associated with physical ( $r = .26, p < .001$ ), social ( $r = .26, p < .001$ ), and self-evaluative ( $r = .17, p < .001$ ) outcome expectations. This study further indicated that persons who met the physical activity guidelines had higher outcome expectations for exercise along all three dimensions. The findings support the positive associations between outcome expectations and physical activity in older adults.

Self-regulatory strategy (i.e., goal-setting) is an important component for understanding the underlying mechanism of physical activity behavior (Bandura, 1997; 2004). Success for changing physical activity behavior depends on a capability of self-monitoring (i.e., planning and tracking goals), goal-setting and evaluating behavior. Anderson-Bill, Winett, Wojcik, and Williams (2011) conducted a longitudinal study to determine the associations between social cognitive variables and physical activity among adults aged between 40 and 90. Physical activity-related social support, self-efficacy, outcome expectations, and self-regulatory strategy were measured. Physical activity levels were assessed by pedometer and self-reported log. The primary findings of this study are that self-efficacy, self-regulatory behaviors, and social support contributed to physical activity behavior among aging adults, and changes in physical activity across a 16-month period of time are attributed by earlier increases in self-efficacy ( $\beta_{\text{total}} = .41, p$

<.05), which significantly mediated the effects of treatment on physical activity. This suggests that utilizing two target variables, self-efficacy and self-regulatory behavior (e.g., goal setting, making plans), is a potentially helpful for guiding development of physical activity intervention among aging adults.

Social support in SCT has not been widely examined in the context of the association with physical activity. Bandura (1997) proposed that social support can indirectly influence on physical activity mediated by self-efficacy. Also, social support (i.e., family, friends and exercise partners) is considered as an environmental factor and associated with adherence to physical activity (Bandura, 1997). This might be explained in a structural model suggested by Bandura (2004) explaining that facilitators (i.e., social support) could be one of the predictors of physical activity change.

The components of SCT have been incorporated in physical activity research for better understanding of the associations between social cognitive variables and physical activity among persons with MS. For example, social cognitive variables (e.g., self-efficacy) have been appeared to be correlates of physical activity among persons with MS (Motl & Snook, 2008). Motl, Snook, McAuley, Scott, and Douglass (2006) adopted a social cognitive perspective to examine self-efficacy, enjoyment, social support, and disability as correlates of participation in physical activity among persons with MS. 196 persons with MS completed a battery of questionnaires measuring self-efficacy, enjoyment, social support, and disability. Participants were administered to wear an accelerometer for 7 days for assessing physical activity. The primary finding of this study is that those who reported higher levels of self-efficacy ( $\beta = .29, p < .001$ ) and enjoyment ( $\gamma = .28, p < .001$ ) engaged in a greater amount of physical activity. Motl, Snook, McAuley, and Gliottoni (2006) further examined the associations among symptoms, self-efficacy, and physical

activity in persons with MS in the context of SCT. Using structural equation modeling, the results indicated that symptoms had direct negative relationships with self-efficacy ( $\gamma = -.32$ ) and physical activity ( $\gamma = -.24$ ), and self-efficacy had a direct positive relationship with physical activity ( $\beta = .57$ ). Overall, this study provides preliminary evidence that self-efficacy may have a mediating role between symptoms and physical activity.

Morris et al. (2008) also adopted the social cognitive perspective to determine the roles of perceived environment, self-efficacy, and functional limitation in understanding physical activity behavior among older women without MS ( $n = 136$ ) and women diagnosed with MS ( $n = 173$ ). The major findings suggest that self-efficacy ( $\beta = 0.22, p < 0.01$ ) and functional limitation ( $\beta = -0.38, p < 0.01$ ) contribute to better explanation in physical activity levels among women with MS. Another study done by Motl and Snook (2008) tested a hypothesis that self-efficacy might play a role in mediating the associations between physical activity and QOL among persons with MS. This observational study was conducted with 133 persons with MS through a self-reported survey. The results of this study indicated that those with MS who were physically active had greater self-efficacy for function ( $\gamma = .30, p = .001$ ) and control ( $\gamma = .27, p = .002$ ), and such greater self-efficacy was associated with greater physical ( $\beta = -0.38, p = .001$ ) and psychological ( $\beta = -0.62, p = .001$ ) components of QOL. This supports that physical activity is a possibly modifiable behavior approach for improvement in QOL by way of increases in self-efficacy among persons with MS.

Ferrier, Dunlop, and Blanchard (2010) conducted a study to examine the effects of self-efficacy and outcome expectations on physical activity among persons with MS over 1 month. 76 participants with MS completed the baseline assessment to measure barrier and task self-efficacy, outcome expectations, and physical activity. Telephone interview was followed up after



one month later to discuss any changes in physical activity. Regression analyses indicated that self-efficacy ( $\beta = .41$ ) and outcome expectations ( $\beta = .27$ ) directly influenced physical activity, and self-efficacy is directly related to outcome expectations ( $\beta = .28$ ). This implicates that persons with MS who are highly self-efficacious in the face of barriers to physical activity may expect more positive benefit in physical activity, and this could result in more physical activity. Interventions are needed to target both self-efficacy and outcome expectations for promoting physical activity in this population.

There is one cross-sectional study that has been recently published to support that self-efficacy is indirectly associated with physical activity by way of goal-setting, self-evaluative outcome expectations, and impediments among persons with RRMS (Suh, Weikert, Dlugonski, Sandroff, & Motl, 2011). This observational study was conducted to examine the relationships among social cognitive variables and physical activity in 218 persons with RRMS, and this provides a consistent evidence with a model provided by Bandura (2004) that self-efficacy has an indirect role in explaining physical activity behavior. This cross-sectional study was further extended by examining a longitudinal relationship among changes in social cognitive variables and physical activity in persons with MS across an 18-month period of time (Suh, Weikert, Dlugonski, Balantrapu, & Motl, 2011). Consistent with the cross-sectional study (Suh, Weikert, Dlugonski, Balantrapu et al., 2011), self-efficacy and goal-setting were maintained the positive associations with physical activity among persons with MS. This suggests that both self-efficacy and goal setting are potentially effective target variables for guiding development of physical activity interventions among persons with MS.

Understanding the correlates of physical activity could allow for development of effective physical activity interventions among persons with MS. As physical activity has the

potential to manage MS-related symptom and improve overall QOL in persons with MS (Motl, McAuley et al., 2006; Motl, Snook, & Shapiro, 2008), it is of major importance to develop an effective intervention for promoting physical activity in this population. In the next section of this literature review, a body of example study of SCT-based behavioral interventions for increasing physical activity will be reviewed.

### *Physical Activity Interventions on SCT*

There is an existing body of evidence to present that behavioral interventions for promoting physical activity appear to be efficient when it is designed within a theoretical framework. As indicated in previous section, understanding determinants or mediators of physical activity is important and necessary for implementing effective physical activity interventions, and those determinants are identified in the theoretical frameworks (Baranowski, Anderson, & Carmack, 1998; Lewis et al., 2002). Interventions developed with an explicit theoretical concept are more effective than those lacking a theoretical base (Glanz & Bishop, 2010). Additional evidence exists that one of the successful intervention strategies for health promoting behavior is to incorporate theoretical constructs into the intervention (King, Stokols, Talen, Brassington, & Killingsworth, 2002; Ory, Jordan, & Bazzarre, 2002).

There is a group of health behavior theories based on a psychosocial perspective that have been used in the field of physical activity research (i.e., Theory of planned behavior and Health belief model). Most of these theories are overlapped in a way that behavior change is influenced and determined by self-efficacy, outcome expectations, goals, and impediments (Bandura, 2004). The theory of planned behavior (TPB) and health belief model focus on the possible predictors of behavior. SCT, however, allows for not only predicting determinants of behavior per se, but principles of behavior change, and this could make it possible to understand

the mechanism of behavior change that how individuals adopt and maintain the behavior (Bandura, 2004). Indeed, SCT explains a triadic reciprocal interaction among the psychosocial determinants, whereas the determinants of TPB are based on one-way direction (Rogers et al., 2011). Additional evidence further indicates that SCT has better predictors of physical activity than those of TPB, indicating that self-efficacy explains more variations in physical activity than perceived control and intentions from the TPB (Dzewaltowski, Noble, & Shaw, 1990). To that end, it is warranted that SCT can offer a strong conceptual constructs for understanding the underlying mechanisms of physical activity behavior and this can be well-adopted in designing behavior interventions for increasing physical activity.

There is a substantial amount of research to examine the effectiveness of physical activity interventions derived from the SCT among populations without disability. For example, Hallam and Petosa (2004) conducted research to examine the feasibility of a four-session work-site exercise intervention to promote physical activity by way of improvements in SCT variables related with exercise adherence among healthy adults. Two groups were assigned into either a treatment or a control condition. The treatment group was provided information for increasing exercise self-efficacy, outcome expectations, use of self-regulatory strategies, attaining short-term goals, and participating in exercise during four 60-minute sessions of the intervention. Evaluations were performed at 6 months and 12 months through a self-reported survey. The results of this study indicated that the treatment group had increases in self-regulation strategies, outcome expectations, and self-efficacy. 67 % of participants in the treatment group were able to maintain exercise behavior across a 12-month period of time whereas the comparison group declined in exercise participation from 68% to 25% over 12 months. This suggests that self-

regulatory skills (i.e., goal-setting), exercise self-efficacy and outcome expectations may be useful determinants for predicting long-term physical activity among persons without disability.

Additionally, Rovniak, Hovell, Wojcik, Winett, and Martinez-Donate (2005) conducted an intervention study to examine the extent to which SCT-based approach would influence the effectiveness of two walking programs. 61 sedentary women participated in either a high fidelity group or a low fidelity group across a 12-week period of time. Among those two email-based walking programs, the high fidelity group was administered to focus more on precise SCT-based recommendations for following mastery procedures than the low fidelity group, and the intervention was designed to simulate how mastery procedures were utilized in most existing SCT-based physical activity programs. Primary outcome assessments included 1-mile walking test of physical fitness and completing a self-reported survey measuring social cognitive variables at baseline and post-test. Self-reported walking quantity was further assessed at baseline, posttest, and 1-year follow-up. Based on the results, the 1-mile walking test time of the high fidelity group was improved more than twice as much as that of the low fidelity group (86 vs. 32 seconds, respectively,  $p < .05$ ). Other social cognitive variables such as goal setting and positive outcome expectations ( $p < .05$ ) were improved better in the high fidelity group compared with the low fidelity group. Regardless of the small effects of the interventions, this study provides meaningful evidence that SCT-based interventions are a possibly effective for increasing physical activity among sedentary women.

Cramp and Brawly (2006) also examined the social cognitive variables (i.e., barriers self-efficacy, outcome expectations, and physical activity) embedded in exercise interventions across a 4-week period of time among postpartum women. A total of 57 participants were randomized into either an intervention group that included a standard exercise program plus group counseling

with self-regulatory skill, or a comparison group that included the standard exercise program - only. The outcome measures were the 7-day Physical Activity Recall, proximal outcome expectations, and barriers self-efficacy. The findings of this study indicated that the standard exercise training combined with the group-mediated social cognitive behavioral counseling had higher exercise participation effects ( $p < 0.01$ ) compared to the standard exercise training alone over the course of the intervention. The intervention group had further sustained higher values of barrier self-efficacy and outcome expectations ( $p < 0.05$ ) compared to the standard exercise group. This implicates that behavioral interventions may be effective given the SCT-based counseling for promoting physical activity among post-natal women. Another study conducted by Anderson-Bill, Winett, Wojcik, and Winett (2011) was designed to examine how changes in psychosocial constructs (i.e., self-efficacy, outcome expectations, and self-regulation) at 6 months would contribute to improvements in nutrition, physical activity, and weight control at 16 months. A 52-week SCT-based Guide to Health intervention was developed, consisting of 15 to 20 web screens and required participants to log into the screens for at least 5 to 10 minutes each week. Early modules targeted self-efficacy through gradual behavior changes guided by self-regulation (i.e., goal-setting). The intervention web screens also presented a series of core-content modules that additionally addressed social support and outcome expectations related to physical activity. After 4 months, the target agent of the program shifted to maintenance with continued self-regulation. The intervention program further provided generic goals for adding steps and minutes of walking to daily routines, fitness walking after reaching 30 minutes of walking 5 days a week, fruits and vegetables (F&V), whole-grain foods and low-fat dairy foods, and reducing high-fat and high-sugar foods. After the 16 months of the intervention, participants had behavioral and weight changes and increases in daily step counts, MET hours/week

expended in walking, and intake of F&V. There were also decreases in their intake of fat, sugar-sweetened foods, and overall daily calories. Importantly, the longitudinal structural model that included social cognitive variables (i.e., self-efficacy, social support, self-regulation, and outcome expectations) indicated significant behavior changes at 6 months, and nutrition, physical activity and weight control had significant changes at 16 months. These findings suggest that the web-based behavioral interventions could be efficiently utilized based on SCT for promoting health behavior including physical activity among the general population.

There has been a growing effort to incorporate SCT into development of physical activity interventions among disease populations. Rogers et al. (2011) recently explored a randomized study to examine the efficacy of a 3-month intervention based on SCT among 41 breast cancer survivors. Intervention included 12 supervised exercise sessions, 6 group discussion sessions, and 3 face-to-face counseling sessions administered over 3 months. The exercise sessions involved walking on the treadmill and stretching. Time walked and walking intensity were individualized from the baseline fitness test and updated by a supervisor. Control group was provided a usual care that included American Cancer Society print pamphlets and downloaded website information related to physical activity. Physical activity was measured by 7-day wearing-accelerometer, and primary social cognitive variables outcome measures included barrier self-efficacy and barrier interference. Compared with the usual care group, the intervention group reported lower barriers interference and greater enjoyment of physical activity. Barriers interference mediated 39% ( $p = .004$ ) of the intervention effects at post intervention. However, barriers self-efficacy and enjoyment were not fully explained in the intervention effects. Regardless of the partial effects of the intervention, this study supports that SCT-based

physical activity intervention could influence variables associated with physical activity, and in turn, those variables can mediate physical activity behavior.

Another randomized controlled trial was conducted by Pinto, Papandonatos, Goldstein, Marcus, & Farrell (2011) to examine the efficacy of a home-based physical activity intervention for colorectal cancer (CRC) patients. The Transtheoretical model (TTM) and SCT have been incorporated into telephone counseling for improving physical activity among 20 patients with CRC in the intervention group. The intervention group was provided instructions about tips of moderate exercise. Pedometer and log were given for self-monitoring physical activity. They also received tip sheets about physical activity and CRC-related information over the 12 weeks. Weekly phone calls were followed up to each participant for activity counseling to increase self-efficacy and outcome expectations for physical activity participation, and reinforce goal-setting and exercise planning. Motivational interviewing was incorporated during the phone calls. There was a control group that received weekly phone calls with CRC survivorship tip sheets, but no attempt was made to provide physical activity-related information. Outcome measures were assessed at baseline and 3, 6, and 12 months, including 7-day Physical Activity Recall (7PAR), Community Healthy Activities Model Program for Seniors (CHAMPS), and stage of motivational readiness for physical activity. All participants were asked to wear an accelerometer for 3 consecutive days. Compared with the control group, the intervention group reported significant increases in minutes of physical activity at 3 months based on the 7PAR and CHAMPS. There were no significant group differences for fatigue, self-reported physical functioning, and QOL at all the time points. Motivational readiness was improved in the intervention group only at 3 months. The findings provide supportive evidence that SCT-based

physical activity intervention delivered by telephone calls may be effective for increasing physical activity participation among cancer survivors.

The social cognitive variables further appeared to be important determinants of physical activity among persons with chronic obstructive pulmonary disease (COPD). Donesky et al. (2011) explored a home-based waling intervention study for examining determinants of frequency, duration, and continuity of the intervention over 1 year among patients with COPD. All participants (N = 103) who were restricted to exercise participation due to dyspnea were randomly assigned to a dyspnea self-management program (DM) alone with 4 additional supervised exercise sessions for familiarity, and DM with 24 additional supervised exercise sessions. Both groups were instructed to walk 4 days for at least 20 minutes per walk. Home walking and symptoms were reported in a daily activity log and during telephone calls from supervisors. Social cognitive outcome measures included self-efficacy, social support, and depressive symptoms. The results of this study that persons who had higher self-efficacy level, greater social support, and fewer depressive symptoms were more engaged in the home walking. This implicates that determinants identified from SCT could play an important role in tailoring interventions for promoting physical activity among persons with COPD.

Collectively, SCT-based interventions for promoting physical activity have the potential for better predicting physical activity by way of identifying major target determinants of behavior change among disease population, and this could be also effective among persons with MS. There is, as of yet, few study of SCT-based physical activity interventions among persons with MS. McAuley and Motl et al. (2007) conducted a 3-month randomly-controlled trial to compare the effects of a self-efficacy enhancement exercise condition with a control on exercise adherence, well-being, and affective responses to exercise. 26 persons with MS were divided into



two groups, either an efficacy enhancement exercise or a standard exercise condition. The efficacy enhancement exercise focused on providing lecture plus discussion related with exercise self-efficacy, goal-setting, barriers, outcome expectations, and social support. The standard care condition addressed the general health-related topics (e.g., general health benefits of exercise, injuries, and nutrition). Both groups participated in the exercise program under supervision of trained exercise leaders. After the 3 months, persons in the efficacy enhancement exercise condition appeared to participate in more exercise sessions, and reported to have higher levels of well-being and exertion, and better follow-up exercise compared with persons in the standard care condition. Persons having stronger exercise self-efficacy who reported more enjoyment in the exercise sessions indicated significantly greater adherence with the exercise program across the 3 months ( $p < .05$ ). These findings suggest that theoretical concepts of the SCT would be considerable predictors of physical activity behavior among persons with MS.

Block, Vanner, Keys, Rimmer, and Skeels (2010) conducted a behavioral intervention study for increasing physical activity to examine the associations between social cognitive variables (i.e., self-efficacy, capability of achieving goals, social support, and overcoming barriers) and physical activity among persons with spinal cord injury and MS. The intervention included a 10-day meetings across 5 months with interactive workshops, regarding health promoting behavior, including physical activity and independent living topics, accessible physical and recreational activities, and peer mentoring. Group activities were also performed at the community-based setting to provide indoor and outdoor physical activities (i.e., aerobic and strength exercise, kayak, and sailing). Primary outcome measures were self-efficacy and goal achievement. Based on the results, there was a statistically significant difference in changes in self-efficacy scores for both persons with spinal cord and MS in the intervention group ( $p = 0.007$ ,

$d = 0.925$ ) compared with the wait-list group. Regardless of the small sample size, these findings suggest that self-efficacy and goal-setting are potential target variables of predicting changes in g perceptions of physical activity among persons with MS.

One recent study explored a randomized SCT-based intervention study delivered through Internet for physical activity promotion among persons with MS (Motl, Dlugonski, Wojcicki, McAuley, & Mohr, 2011). SCT variables were utilized as possible mediators in the intervention materials. A total of 54 persons with MS were assigned into either an Internet intervention condition or a waitlist control. The participants completed measures of physical activity, self-efficacy, outcome expectations, functional limitations, and goal setting before and after the 12 weeks. Based on the results, persons in the intervention group reported a statistically significant ( $p = .01$ ) increase in physical activity over time compared with the control group ( $d = .72$ ). Change in goal setting was further appeared to be a significant mediator over time. This pilot study provides preliminary evidence to support that SCT-based intervention might be potentially effective approach for promoting physical activity in persons with MS.

In summary, evidence exists that social cognitive variables play a key role in explaining and understanding the underlying mechanism among the variables and physical activity behavior among the general population and persons with MS. Such determinants of physical activity (i.e., self-efficacy, goal setting, and outcome expectations) can be identified within SCT, and this could help to develop behavioral interventions for promoting physical activity behavior among persons with MS. However, there is a lack of research that examines the efficacy of a theory-based behavioral intervention for increasing physical activity among persons with MS.

Particularly, SCT specifies the dynamic relationships among individual, environment, and

behavior and this can be adopted in understanding and predicting physical activity behavior among persons with MS.

#### Theory-based Behavioral Interventions delivered through Non-Supervised Technology

There has been increasing interest in non-supervised behavioral interventions for promoting physical activity. Non-face-to-face contact (e.g., telephone, internet, and print media) has been recognized as an alternative to traditional contact (i.e., face-to-face) in health promoting research (Napolitano & Marcus, 2002; Jenkins, Christensen, Walker, & Dear, 2009). The strengths of the distant delivery mode include reaching a large sample, cost-effectiveness, and maintenance in an improvement at follow-up (Marcus, Owen et al., 1998; Van den Berg, Schoones, & Vlieland, 2007). Non-face-to-face delivered-interventions have appeared to be effective for improving physical activity among sedentary persons without disease (Marshall, Owen, & Bauman, 2004). To date, there are few studies that examined the efficacy of non-face-to-face physical activity interventions among persons with chronic diseases, such as MS and type II diabetes (Bombardier et al., 2008; Dutton, Tan, Provost, & Smith, 2009).

In MS research, most behavioral interventions for promoting physical activity among persons with MS have been developed based on in-person activity under supervision to improve strength (Harvey, Smith, & Jones, 1999; Kraft, Alquist, & Lateur, 1996), endurance (Rodgers et al., 1999; Svensson, Gerdle, & Elert, 1994), fatigue (Patti et al., 2003), functional abilities (Petajan et al., 1996; Romberg et al., 2004; Solari et al., 1999), mental health (Petajan et al., 1999), and QOL (Solari et al., 1999). The activity-based/supervised intervention programs have been utilized in a variety of face-to-face conditions, including multidisciplinary inpatient rehabilitation in the hospital (Craig, Young, Ennis, Baker, & Bogglid, 2006; Solari et al., 1999, Storr, Sorensen, & Ravnborg, 2006), and community fitness center (Gehlson, Grigsby, & Winant,

1984). Given the situation in which the activity-based interventions obviously need supervision from a trained physiologist, clinicians, and exercise leaders, there are considerable limitations of the face-to-face, supervised interventions that includes limited reach, inflexibility of time management and high cost for operating testing (Haines et al., 2007; Marcus et al., 2007). Potentially, such limitations could be minimized by using non-supervised technologies that could provide more efficient and economical way of distributing physical activity interventions among persons with MS.

There is a growing body of research that use of the non-supervised behavioral interventions that includes a theoretical base outside of a clinic or laboratory environment has resulted in positive effects on improvements in physical activity among populations without a chronic disease condition (Castro, King, & Brassington, 2001; Marcus, Owen et al., 1998; Van Keulen et al., 2011). For example, designing health behavior messages based on a theoretical framework delivered by non-supervised technologies for behavior change appears to be effective for helping target populations change in the behavior (Maibach & Cotton, 1995). SCT play an important role in health-related behavior message design, and evidence supports the importance of social cognitive variables for designing messages across a variety of health behaviors, including diet, nutrition, drug use and physical activity (Maibach & Cotton, 1995). Collectively, behavioral interventions that target social cognitive variables could significantly influence on physical activity behavior change.

#### *Telephone-delivered Physical Activity Interventions*

Telephone-delivered behavioral interventions have been found to be effective to promote and adopt health promoting behaviors among the general population as well as persons with disability (Bennett, Young, Nail, Winters-Stone, & Hanson, 2008; Bombardier et al., 2008;

Castro & King, 2002; Eatkin, Lawler, Winker, & Hayes, 2011; King et al., 1991; Ligibel et al., 2011). Although interventions delivered through telephone can be time-consuming and dependent on staff resources, using telephone is typically more readily available, convenient, and less burdensome compared with the face-to-face contact in terms of delivering intervention programs (Castro & King, 2002).

Bennett et al. (2008) conducted research to evaluate the efficacy of telephone-delivered motivational interviewing (MI) intervention for increasing physical activity among physically-inactive adults living in rural area. Participants were randomly assigned into a MI intervention (n = 43) or a control (n = 43) group. The participants in the MI group were provided a pedometer and monthly telephone calls for MI over 6 months. The controls received equal number of telephone calls that included non-MI content. At the end of the intervention, a total of 72 participants completed the study (i.e., 35 in the intervention group and 37 in the control group), and participant in the telephone-only MI intervention group had increases in exercise self-efficacy, but did not increase levels of physical activity compared with the controls. Regardless of non-significant intervention effects, these findings implicate that telephone-delivered MI is a potentially practical and inexpensive approach for promoting physical activity among adults in rural area.

Lewis, Martinson, Sherwood, and Avery (2011) conducted a pilot study to evaluate a theory-based exercise intervention delivered by telephone counseling in pregnant and postpartum women. 37 women in either pregnant or postpartum were provided weekly telephone counseling from health educators across 3 months. The counseling was based on the SCT and TTM, focusing on self-efficacy, social support, goal-setting, and barriers to exercise participation. All participants were asked to complete daily activity logs for self-monitoring and mail it back to the

health educators and the log was used for data analysis with the 7 day Physical Activity Recall. Pregnant participants significantly increased their exercise from a mean of 60.47 minutes per week at baseline to 132.9 minutes at 3 months ( $p < .01$ ). Postpartum participants also had improvement in the exercise from a mean of 68.9 minutes per week at baseline to 123.8 minutes at 3 months ( $p < .05$ ). Despite of the small sample size for pilot data collection, these findings provide future direction of a telephone-based behavioral intervention study for increasing physical activity behavior among pregnant and postpartum women. Given the hypothesis that such non-face-to-face interventions may be ideal for populations who struggle with time management for exercise or transportation constraints, this non-supervise/distant mode of delivery could benefit persons with disability.

Another telephone-based intervention study conducted by Eakin, Lawler, Winkler, and Hayes (2011) examined the efficacy of the telephone-delivered intervention for increasing exercise among women with newly-diagnosed breast cancer living in rural area. The intervention was delivered through a total of 16 calls over 8 months plus a workbook and exercise tracker to the participants in the intervention group. The content of the intervention was designed based on the SCT and Chronic Disease Self-management Intervention Model for increasing self-efficacy for exercise, identifying barriers, and goal-setting. The goal for exercise in the intervention group was targeted to 45 minutes moderate level of aerobic and resistance exercise at least 2 or 4 days per week. The activity level was individualized based on the baseline functional and exercise history data. The control group had a usual care of breast cancer, including the workbook and exercise tracker only. Regardless of high retention rates at 12 months, participant in the intervention reported no adverse events in the exercise participation, and there was a statistically significant between-groups effects in the resistance training. Participant in the intervention group

further had significant improvements at 12 months after surgery in terms of all outcomes including QOL, fatigue and upper body function. These findings provide support for feasibility of non-face-to-face interventions among women with breast cancer in a rural area where it may have a limited availability of physical activity programs.

Similarly, Ligibel et al. (2011) tested the efficacy of a telephone-delivered physical activity intervention across a 16-week period of time among 121 cancer survivors (i.e., 100 for breast cancer and 21 for colorectal cancer). They were randomly assigned in either an intervention or a control group, and physical activity, function, fatigue, and exercise self-efficacy were measured at baseline and follow-up. The telephone-delivered intervention was based on SCT and motivational interviewing (MI) in order to encourage participants for engaging in physical activity. The intervention consisted of 30 to 45 minutes, 11 semi-structured phone calls over a 16-week period to discuss goal-setting for exercise and performance assessment. All participants were provided a pedometer to track their exercise routine targeted up to 180 minutes of moderate exercise participation per week. The result of this study indicated that participants in the intervention group had increases in physical activity (54.5 vs. 14.6 min in controls,  $p = 0.13$ ), and also had significant increases in fitness based on a 6-MIN Walk distance (186.9 vs. 81.9 feet in controls,  $p = 0.006$ ) and physical functioning (7.1 vs. 2.6,  $p = 0.04$ ) as compared with the control group. This study provides evidence to support the efficacy of a telephone-delivered physical activity intervention for cancer survivors, and this could be feasible for physical activity interventions.

In MS, Bombardier et al. (2008) conducted first randomized-controlled study of a telephone-based intervention to determine if motivational interviewing (MI) would increase health promoting behaviors among persons with MS. A total of 5 telephone calls were made to

deliver MI for discussing about SCT variables (i.e., exercise goal-setting, fatigue management, social support, stress management), and alcohol or drug use at 1, 2, 4, 6 and 12 months.

Participants were measured in strength, fitness, and cognition as objective measures as primary outcome assessments, and fatigue, self-reported health status, perceived social support, and QOL were measured as well. The primary findings of this study includes that the intervention group reported greater improvement in health promotion activities, including physical activity as well as better fatigue and mental health-related QOL. This suggests that telephone-delivered MI could be utilized for increasing physical activity among persons with MS, mediated by improvements in fatigue and mental health-related QOL among persons with MS.

#### *Print-based Physical Activity Interventions*

Another alternative method for delivering behavioral interventions is to use a print media (e.g., newsletters). Evidence indicates that using print materials can be effective for increasing health promoting behaviors, including physical activity among the general population and persons with disability (Noar, Benac, & Harris, 2007; Williams et al., 2011). The strengths of the print materials include encouraging self-help to change behavior, low cost and, capability to be kept for future reference (Napolitano & Marcus, 2002).

There is an existing body of evidence to demonstrate that print materials such as booklet, brochure, and pamphlet that deliver information about physical activity play a critical role in disseminating intervention program for addressing the importance of health promoting behavior in the public health among the general population (Marcus, Emmons et al., 1998; Short, James, Plotnikoff, & Girgis, 2011). Sevick and colleagues (2007) also found that a print-based intervention was more cost-effective than a telephone-based intervention. One review study indicated that print materials appear to be an influential means of delivering intervention



programs for improving physical activity (Marcus, Owen et al., 1998). A meta-analysis also reported that print materials based on SCT may have a key role in increasing the efficacy of interventions when the theoretical constructs are used for tailoring physical activity interventions (Noar, Benac, & Harris, 2007).

Marcus, Emmons et al. (1998) conducted a randomized-controlled trial to compare the efficacy of motivationally-tailored print materials with that of standard self-help print materials for enhancing physical activity among employees. A total of 1559 participants were recruited from 11 worksites and assigned into either an intervention or a control group. The intervention group received the tailored-intervention print materials at baseline and 1 month later. The interventions were designed based on SCT and TTM. Motivational readiness for physical activity and time-spent in physical activity participation were assessed at baseline and 3 months following baseline. The comparison group was provided the standard and generic self-help print materials from the American Heart Association. After the 1-month follow-up, the intervention group was more physically active after receiving the individualized feedback and tailored-print materials compared with the control group. These findings suggest that motivationally-tailored messages in a printed material based on a theoretical framework are potentially efficient in behavioral interventions for improving physical activity among the general population.

Print-based interventions have been also utilized for increasing health promoting behaviors among persons with chronic disease. Demark-Wahnefried and her colleagues (2007) conducted a research project called 'The FRESH START' to examine the effectiveness of a 10-month print-based interventions for increasing healthy diet and exercise behavior among patients with breast or prostate cancer. Participants in the FRESH START group received print material by mail whereas the control group received non-tailored print material about generic information

on diet and exercise. The intervention was developed with SCT and TTM for increasing self-efficacy of exercise and intake of F&V as well as motivational readiness of exercise. Outcome measures were assessed at baseline and 1 year follow-up, including body mass index (BMI), dietary consumption, physical activity, and other psychosocial variables (e.g., exercise self-efficacy, depression, quality of life, and social support). Compared with the control group, the FRESH START group had greater improvements in lifestyle activities based on a self-reported survey (e.g., practice of two or more goal behaviors; exercise minutes per week; intakes of F&V per day) and physiological markers (i.e., total fat; saturated fat; and BMI). These findings suggest that the FRESH START program is effective in improving lifestyle behaviors and the weekly exercise, daily intake of F&V as well as decreasing intakes of fat and saturated fat. This study implicates that print material could be an alternative to face-to-face counseling for increasing health promoting behaviors among persons with chronic diseases, including cancer.

Finally, Dutton et al. (2009) examined the efficacy of print-based interventions for increasing physical activity among persons with type II diabetes. 85 persons with type II diabetes were randomly assigned into either an intervention or a control group. The intervention was originally developed and used by Marcus, Bock et al. (1998) and Napolitano and Marcus (2002) that includes brief information for physical activity targeting social cognitive variables (i.e., self-efficacy, goal setting, knowledge, and social support) as well as motivational readiness for exercise. The results of this study indicated that the tailored print-based intervention was effective in physical activity promotion and enhancing self-efficacy for exercise. Such findings support that the effects of the intervention on physical activity was completely mediated by changes in self-efficacy. This implicates that the targeting self-efficacy can provide a greater effects of the intervention on promoting physical activity among persons with type II diabetes.

Taken together, print-based intervention may be another effective way of non-face-to-face contact through targeting theoretical constructs (i.e., SCT) in persons with disability for increasing physical activity behavior.

#### *Telephone- and Print-based Physical Activity Interventions*

Research demonstrates that integration of more than one delivery mode in distance intervention may have greater impact on physical activity behavior change (Marshall et al., 2004). Indeed, Castro et al. (2001) conducted a randomized-clinical research called ‘The Stanford Sunnyvale Health Improvement Project’, which was implemented for a 2-year-based intervention delivered by telephone and print. After one year of home-based counseling, participants were randomly assigned into either a continued-telephone and mail contact or a mail-only intervention for an additional year. They were asked to maintain their physical activity at the same intensity assessed at baseline in order to examine how much the activity was maintained with follow-up. 140 older men and women first received face-to-face, home-based counseling and moved on to the next stage, which was designed to assess the maintenance of physical activity behaviors across one year. The content of telephone calls at the second year were based on SCT that focused on active problem solving skills of barriers to physical activity, self-monitoring of goals, and social support. Mailing print included written messages to encourage maintaining physical activity. Interestingly, persons who were adapted to high intensity of exercise tend to maintain their exercise more when they received the mail-only intervention compared with those who received the intervention through both telephone and mail. This may be explained in the fact that persons who have higher efficacy of exercise may need moderate level of interventions that can change their behavior easily up to the desired level compared to persons who are low self-efficacious who have not adapted to regular exercise at

high intensity (Bandura, 2004). Nevertheless, using both telephone and mail appeared to be effective for maintaining the exercise in the group which is targeted to low intensity of exercise. This suggests that physical activity interventions delivered by telephone and mail could be ideal for those who need a moderate level of guidance to be physically active.

Ball, Salmon, Leslie, Owen, and King (2005) conducted a randomized-controlled trial to examine the effectiveness of a print-based intervention, and print- plus telephone-delivered intervention for increasing physical activity among inactive Australian adults. A total of 66 adults aged between 45 and 60 were participated in either a print-based intervention group or a group that received both print- and telephone-based intervention. Physical activity was assessed by Community Healthy Activity Models Program for Seniors (CHAMPS). The interventions were based on SCT and TTM to incorporate behavioral modifiable strategy, including goal setting and self-monitoring. Printed newsletters included physical activity information about overcoming barriers to physical activity and staying motivated. Participants in print- plus telephone-based intervention had a telephone interview to receive feedback from the past activities based on information assessed at baseline. There were increases in global physical activity, moderate-vigorous intensity activity and walking between baseline and 12 weeks for both intervention groups. Such improvements were maintained up to 16 weeks, but participants in the print plus telephone-based intervention stayed on slightly higher levels of the global physical activity and walking than those in the print-based group. These findings provide the potential for promoting initial increases in physical activity through both print materials and telephone among Australian adults.

Lewis et al. (2006) developed a physical activity intervention based on the TTM and SCT among persons without a chronic disease condition. The intervention group received a self-help

print material tailored to individual's motivational readiness of physical activity and designed to increase self-efficacy of exercise. The comparison group, on the other hand, was sent a booklet that includes generic information on physical activity and cardiovascular fitness designed by American Heart Association. Physical activity was measured at baseline, 1, 3, and 6 months through the 7-day Physical Activity Recall. Other psychosocial variables such as self-efficacy for physical activity and decision-making for physical activity were measured at each time point. There was greater treatment effect on increasing a total minutes of physical activity per week in the intervention group over the 6 months compared with the comparison group. Additionally, the intervention group indicated increases in self-efficacy relative to the comparison group ( $p = .061$ ). Increases in self-efficacy from baseline to 3 months were further significantly associated with increases in minutes of physical activity behavior at 6 months, controlling for baseline levels of physical activity. These findings support that a theory-based physical activity intervention delivered by print material is potentially effective for promoting physical activity behavior, and self-efficacy could be one of the major target variables influencing physical activity change and needs to be considered when developing interventions.

The efficacy of a mailed-print material and/or telephone-delivered intervention for improving health promoting behaviors among persons with chronic disease has been appeared in one study. Morey et al. (2009) examines the effectiveness of a telephone- and mail-delivered intervention for promoting healthy diet and physical activity behavior among older, overweight cancer survivors. 641 overweight (body mass index  $\geq 25$  and  $< 40$ ), long-term ( $\geq 5$  years) survivors (aged 65-91 years) of colorectal, breast, and prostate cancer were randomly assigned to an intervention group ( $n = 319$ ) or a wait-list control ( $n = 322$ ) in Canada, the United Kingdom, and 21 US states. The intervention was a 12-month, home-based program of telephone

counseling and mailed materials for promoting diet quality and exercise. The interventions were based using the TTM and SCT focusing on self-efficacy enhancement and goal setting for target behaviors. Main outcome assessment was measured by a self-reported physical function on the SF-36 physical function subscale at baseline and 12 months. Secondary outcome measures included changes in function on the basic and advanced lower extremity function subscales of the Late Life Function and Disability, physical activity, body mass index, and overall health-related QOL. The results of this study indicated that the mean function scores decreased in the intervention group ( $-2.15$ ;  $p = .03$ ) at 12-month follow-up compared with the control group ( $-4.84$ ;  $p = .03$ ). The mean changes in basic lower extremity function were  $0.34$  in the intervention group compared with  $-1.89$  in the control group ( $p = .005$ ). Finally, physical activity, dietary behaviors, and overall QOL increased significantly in the intervention group compared with the control group ( $p < .001$ ). The findings provide potential evidence that print material and telephone calls could be useful means of a theory-based physical activity intervention for promoting healthy diet and exercise behavior among cancer survivors.

Collectively, there has been increased interest regarding utilization of a print material and telephone in delivering behavioral interventions for health promoting behavior given recognizable benefits, including relatively low cost and flexibility of time management (Ball et al., 2005). Use of telephone and print media play a critical role in efficient dissemination of health information for promoting physical activity (Napolitano & Marcus, 2002).

SCT has been adopted in a great body of health behavior intervention research and indicated the positive effects on promoting physical activity behavior in the purpose of disease prevention (Dunn et al., 1998; Rogers et al., 2011). Self-efficacy is a core variable for explaining and predicting physical activity behavior (Bandura, 1997; McAuley & Blissmer, 2000). Evidence

indicates that individuals who have a moderate sense of self-efficacy are not fully efficacious about the desired behavior, but they are more likely to be ready for changing behavior compared with those who have high or low levels of self-efficacy (Bandura, 2004). For those with a moderate level of self-efficacy in the certain behavior, additional support and guidance by interactive means such as a tailored print or telephone counseling would provide tips of self-help to change behavior (Bandura, 2004).

To date, there is no published data to indicate the efficacy of physical activity interventions specifically among those who are moderately self-efficacious for physical activity with or without MS. SCT-based intervention delivered by non-supervised technologies for promotion of physical activity among persons with MS could be an efficient alternative to intensive, in-place interventions under supervision in adopting and maintaining physical activity.

## Summary of Literature Review

MS is an inflammatory neurological disease that is prevalent in approximately 250,000 to 350,000 people in the United States. It mostly occurs in young adults aged between 20 and 40, affecting physical fitness, mental health, and quality of life. MS-related symptoms are associated with reduced mobility, which eventually interferes with daily living activities and physical activity. Such physical inactivity may cause worse symptoms of MS. Indeed, physical activity levels in persons with MS are relatively low compared to populations without chronic disease conditions and other types of chronic diseases (Motl, 2008).

There is a growing body of evidence that physical activity is associated with an improvement in cardiovascular function, muscle strength, and mental-related quality of life among persons with MS (Motl, Fernhall, McAuley, & Cutter, 2011; Flachenecker, 2012). Given the benefits of physical activity in persons with MS, it is imperative for developing and delivering behavioral interventions for increasing physical activity among persons with MS, following by identifying determinants or predictors of physical activity behavior. Health behavior theories play a key role in understanding the underlying mechanisms of health behavior including physical activity, and this can help identify potential correlates of physical activity. Social cognitive theory (SCT; Bandura, 1986) is one of the primary health behavior theories, which has been utilized in physical activity research (Bandura, 1997; McAuley, 2003). SCT explains the reciprocal relationships between social cognitive variables (i.e., self-efficacy, outcome expectations, impediments/facilitators, and goals) and behavior, and self-efficacy is identified as a key correlates of physical activity in behavioral interventions study among the general population as well as persons with MS (Bandura, 2004). SCT further provides a hypothetical structural model to explain that self-efficacy, outcome expectations, goals, and



sociostructural factors (i.e., impediments and facilitators) are associated with physical activity. This model could be also used for implementation of physical activity interventions as a conceptual framework for better understanding of the underlying mechanism of behavior change among persons with a chronic disease condition such as MS. Collectively, behavioral interventions that are based on theoretical frameworks could be an appropriate approach for understanding physical activity behavior (Glanz & Bishop, 2010). Most behavioral interventions for increasing physical activity have been based on supervised and face-to-face-delivered interventions, and such mode of delivery includes some well-recognized limitations that limited sample size and high cost. Alternatively, use of non-face-to-face contact (i.e., Internet, telephone, print media) might be effective approaches to compensate for the limitations that the face-to-face contact has.

To date, there is lack of research to investigate the efficacy of theory-based behavioral interventions for increasing physical activity delivered by non-supervised contact among persons with MS. One study reported that telephone interview had positive effects on improvement in health promoting behaviors, including physical activity among persons with MS (Bombardier et al., 2008). Another study provides preliminary evidence to indicate that an internet-delivered physical activity intervention based on SCT is potentially practical and useful for motivating physical activity participation among persons with MS (Motl, Dlugonski, et al., 2011). Further research is needed to provide stronger support to indicate that the distant and non-face-to-face-delivered interventions would offer better explanation of changes in SCT variables and physical activity over time among persons with MS.

Overall, the current study would possibly provide further evidence to support the potential effects of print-and telephone-delivered intervention based on SCT for improving physical activity among persons with MS.

## CHAPTER III: METHODS

### Recruitment

Advertisement about the study was conducted by distributing a flyer through e-mail to those who have participated previously in a research study funded by NMSS (Motl, McAuley, & Sandroff, 2013). Briefly, the sample in that study consisted of 223 women and 46 men. The mean age was 45.9 years (SD = 9.6), and the duration of MS (time since diagnosis) was 8.8 years (SD = 7.0). The median Patient Determined Disease Scale (PDDS) score was 2 (range = 0 – 6) and corresponded with moderate disability (i.e., no limitations in walking, but significant problems that limit daily activities) (Hadjimichael, Kerns, Rizzo, Cutter, & Vollmer, 2007). This cohort has participated in a previous observational study for 2.5 years with experiences in wearing accelerometers, completing logs, and completing batteries of questionnaires.

Persons who were interested in this study contacted our laboratory for information and screening for inclusion. The inclusion criteria were definite diagnosis of RRMS; independently ambulatory or ambulatory with single point assistance (e.g., cane); relapse free in the past 30 days; being non-active defined as not engaging in regular physical activity (i.e., 30 minute-accumulated per day) on more than 2 days of the week during the previous 6 months; free of contra-indications for physical activity (e.g., no underlying cardiovascular disease) based on Physical Activity Readiness Questionnaire (Thomas, Reading, & Shephard, 1992); having the visual ability necessary to read 14 point font; meeting the age requirement (i.e., 18-64 years of age). The reason why this study only used RRMS was that it is the most common type of MS and persons are relatively ready and be able to engage in physical activity compared to other types of MS. One final screening criterion was to have middle levels of exercise self-efficacy. The criterion for middle levels of efficacy was determined based on previous longitudinal study

dataset among persons with MS ( $N = 269$ ; 83% of women) with the Exercise Self-Efficacy Scale (EXSE; Motl et al., 2013). Based on a frequency analysis, the middle category of scores for the EXSE ranged between 50 and 70 of a total score, and this was considered as middle levels of the exercise self-efficacy. The mean (SD) of the EXSE scores based on the telephone screening for inclusion was 56.6 (3.9). According to the threefold stepwise implementation model from the SCT, print- and telephone-based interventions for increasing physical activity could be more helpful and effective for those who have middle levels of self-efficacy to be physically active compared with those who have high or low levels of exercise self-efficacy (Bandura, 2004).

The proposed sample size was 50 (25 for an intervention group and 25 for a control group) persons with RRMS. This sample size was based on a priori analysis with self-reported physical activity mean scores (i.e., GLTEQ) for detecting a moderate effect size ( $d = 0.50$ ; Motl et al., 2011) with assumptions that one tail  $\alpha = .05$ ,  $\beta = .10$  for 90% power. This power analysis suggested 50 participants. Considering possible attrition rate of 20% based on the non-supervised technology intervention study (Marcus et al., 2007), the final sample for adequate power considering drop-out was 60. The flow of participants is presented using CONSORT diagram in Figure 1.

## Measures

### *Physical Activity*

Physical activity was measured by the Godin Leisure-Time Exercise Questionnaire (GLTEQ; Godin & Shephard, 1985). The GLTEQ is a self-administered 2-part measure of usual physical activity; we only included the first part in this study consistent with previous research. The first part has three items that measure the frequency of strenuous (e.g., jogging), moderate (e.g., fast walking), and mild (e.g., easy walking) exercise for periods of more than 15 minutes

during one's free time in a typical week. The weekly frequencies of strenuous, moderate, and mild activities are multiplied by 9, 5, and 3 metabolic equivalents, respectively, and summed to form a measure of total leisure activity. The scores range between 0 and 119 MET minutes per week. Researchers have provided evidence for the validity of scores from this measure in persons with MS (Gosney, Scott, Snook, & Motl, 2007; Motl, McAuley, Snook, & Scott, 2006; Weikert, Motl, Suh, McAuley, & Wynn, 2010).

### *Accelerometry*

This study used ActiGraph single-axis accelerometer [model 7164 version, Manufacturing Technology Incorporated (MTI), Fort Walton Beach, FL], a small ( $2.0 \times 1.6 \times 0.6$  inches) and light weight (1.5 ounces) device. The participants wore the accelerometers for 7 days during the waking hours, except while showering, bathing, and swimming. The accelerometer was kept on an elastic belt around the waist at the non-dominant hip from the moment upon getting out of bed in the morning through the moment of getting into bed in the evening. The participants were also asked to record the time that the accelerometer was worn on a log, and this was verified by inspection of the minute-by-minute accelerometer data. The data from accelerometer were processed, summing the minute-by-minute counts across each of the 7 days and then averaged the total daily movement counts across the 7 days to attain the accelerometer data in total activity counts per day across a 7-day period. Unfortunately, data processing problems (i.e., the data files were saved in a format that did not permit analyses beyond total activity counts) did not permit the analysis of the output of accelerometers for computing time spent in light, moderate and vigorous physical activity based on common metabolic equivalent unit categories.

### *Self-Efficacy*

Self-efficacy was assessed by the EXSE (McAuley, 1993). This scale has six items that assess individual's belief in their ability to engage in 20+ minutes of moderate physical activity 3 times per week, in one month increments, across the next 6 months. The items are rated on a scale from 0 (Not at all confident) to 100 (Completely confident) and averaged into a composite score that ranges between 0 and 100. Higher scores reflect greater confidence in one's ability to regularly engage in exercise. This scale is internally consistent and has evidence of score validity (McAuley, 1993) and has been included in previous research on physical activity in MS (Motl, McAuley, Doerksen, Hu, & Morris, 2009; Motl, Snook, Scott, et al., 2006).

### *Outcome Expectations*

Outcome expectations for exercise were measured by the Multidimensional Outcomes Expectations for Exercise Scale (MOEES; McAuley, Motl, White, & Wojcicki, 2009; Wojcicki et al., 2009). This scale contains 15 items that reflect three subdomains of outcome expectations. Six items reflect physical outcome expectations (e.g., "Exercise will increase my muscular strength," "Exercise will improve my overall functioning"), four items assess social outcome expectations ("Exercise will improve my companionship," "Exercise will increase my acceptability by others"), and five items measure self-evaluative outcome expectations (e.g., "Exercise will give me a sense of accomplishment," "Exercise will help me manage my stress"). The 15 items were rated on a 5-point scale from 1 (Strongly disagree) to 5 (Strongly agree) and summed to form the subscale measures of outcome expectations. Subscale scores range between 5 and 15 and higher scores reflect greater outcome expectations. This scale has good internal consistency and evidence of score validity in older adults (Wojcicki et al., 2009) and persons with MS (McAuley et al., 2009). Regarding validity, scores from the physical, social, and self-

evaluated outcome expectation scales were correlated with objectively measured physical activity ( $r = .22$ ,  $r = .19$ , &  $r = .20$ , respectively), self-reported physical activity ( $r = .17$ ,  $r = .20$ , &  $r = .19$ , respectively), and self-efficacy for exercise ( $r = .32$ ,  $r = .18$ , &  $r = .33$ , respectively) in persons with MS (McAuley et al., 2009).

### *Functional Limitations*

Functional limitations represented impediments for physical activity and was measured using the Functional Limitations component of the abbreviated Late-Life Function and Disability Instrument (LL-FDI; McAuley, Konopack, Motl, Rosengren, & Morris, 2005; Motl et al., 2010). The Functional Limitations component contains 15 items that correspond with advanced lower extremity function, basic lower extremity function, and upper extremity function. An example item for the advanced lower extremity function is “How much difficulty do you have with going up and down a flight of stairs outside, without using a handrail?” The 15-items are rated on a 5-point scale ranging from 1 (none) to 5 (cannot do) and are reverse-scored and then averaged to form composite measures of advanced lower extremity function, basic lower extremity function, and upper extremity function with higher scores representing better functioning; scores for each subscale range between 5 and 25. The subscale scores are summed into a composite measure of functional limitations that ranges between 15 and 75. Higher scores reflect fewer functional limitations. There is evidence for the factorial (i.e., strong fit of the measurement model for the 15-item scale) and construct validity (i.e., discrimination between clinical MS course and level of mobility disability; correlations with neurological impairment [ $r = -.71$ ], symptoms of fatigue [ $r = -.44$ ], depression [ $r = -.42$ ], and physical health status [ $r = .74$ ]), and responsiveness of the Functional Limitations component of the abbreviated LL-FDI in persons with MS (Motl et al., 2010).

### *Goal-Setting*

Exercise goals were measured by the Exercise Goal-setting Scale (EGS; Rovniak et al., 2002). This contains 10 items that reflect goal-setting for exercise behavior and the items are rated on a 5-point scale from 1 (Does not describe) to 5 (Describes completely). The item scores are summed into an overall score that ranges between 10 and 50. Higher scores reflect a stronger tendency for setting goals for exercise. There is evidence that supports the reliability ( $\alpha = .89$ ) and validity of Exercise Goal-setting Scale scores in young healthy adults (Roviniak et al., 2002), but not in persons with MS. For example, Exercise Goal-setting Scale scores have correlated with self-efficacy ( $r = .53$ ), enjoyment ( $r = .42$ ), social support ( $r = .34$ ), and physical activity ( $r = .38$ ) in young healthy adults (Roviniak et al., 2002).

### *Social Support*

Social support for physical activity was measured by the 12-item Social Support and Exercise Survey (SSES; Sallis, Grossman, Pinski, Patterson, & Nader, 1987). Examples of items from the SSES include “During the past 3 months, my family (or members of my household) or friends exercised with me; gave me encouragement to stick with my exercise program.” The items on the SSES are rated on a 5-point scale ranging from 1 (None) to 5 (Very often), and family and friends scales are scored by summing total of items 1-12. There is evidence that SSES scores provide a reliable and valid measure of social support for exercise in healthy adults (Sallis et al., 1987), but not in persons with MS. Additionally, perceptions of social support were measured by the 24-item Social Provisions Scale (SPS; Cutrona & Russell, 1987). The items on the SPS are rated on a four-point scale ranging from 1 (strongly disagree) to 4 (strongly agree), and item scores are summed to form an overall score that ranges between 24 and 96. There is evidence that supports the internal consistency, test–retest reliability, and construct validity of



scores from the SPS as a measure of social support (Cutrona & Russell, 1987), and this scale has been used in persons with MS (e.g. Motl, McAuley, Snook, & Gliottoni, 2009; Suh, Weikert, Dlugonski, Sandroff, & Motl, 2011).

### *Disability*

Disability was measured using the Patient Determined Disease Steps (PDDS) scale (Hadjimichael et al., 2007). The PDDS is a self-report questionnaire that contains a single item for measuring disability using an ordinal scale from 0 (Normal) through 8 (Bedridden). This scale was developed as an inexpensive surrogate for the Expanded Disability Status Scale (EDSS) and scores from the PDDS are linearly and strongly related with physician-administered EDSS scores ( $r = .93$ ; Hadjimichael et al., 2007).

## Intervention Materials

### *Printed Newsletters*

Each newsletter targeted a specific agent of SCT (e.g., self-efficacy) for increasing physical activity in persons with MS. The purpose of the newsletters was to offer information about key determinants of physical activity that motivates physical activity for persons with MS. Newsletters were delivered through USPS and e-mail. The first newsletter focused on the physical and psychological benefits of physical activity as well as self-monitoring among persons with MS. The second newsletter was then given for description of goal-setting for physical activity. The third newsletter contained how to improve exercise self-efficacy as well as description of four sources in enhancing exercise self-efficacy (i.e., mastery experiences, social modeling, social persuasion, and interpretations of physiological and affective responses). The fourth newsletter included information that developed appropriate outcome expectations of being physically active. The fifth and sixth newsletters targeted barriers to physical activity and social

support for physical activity, suggesting guidance of how to overcome the barriers and find out facilitators in physical activity (i.e., social support from family, friends, and community programs). Each newsletter had a front and back page, and consisted of a variety of sections (i.e., case study, tips of the week, and useful resources) related to physical activity in MS.

Table 1 *Topics covered by each SCT-targeted newsletter*

Week	Title of Newsletter	Intervention Content	Theoretical Concept
1	'Ready, Set, Go!'	<ul style="list-style-type: none"> <li>Increasing expectations of physical activity and starting self-monitoring physical activity with pedometer</li> </ul>	<ul style="list-style-type: none"> <li>Outcome expectations</li> <li>Behavior (i.e., physical activity)</li> </ul>
2	'Commit to change'	<ul style="list-style-type: none"> <li>Learning how to set up goals and use activity log</li> </ul>	<ul style="list-style-type: none"> <li>Goal-setting</li> </ul>
3	'You can do it'	<ul style="list-style-type: none"> <li>Learning how to increase self-efficacy of being physically active</li> </ul>	<ul style="list-style-type: none"> <li>Self-efficacy</li> </ul>
4	'Expectations'	<ul style="list-style-type: none"> <li>Increasing outcome expectations of engaging in physical activity</li> </ul>	<ul style="list-style-type: none"> <li>Outcome expectations</li> </ul>
5	'Overcoming barriers'	<ul style="list-style-type: none"> <li>Identifying possible barriers to physical activity</li> <li>Learning how to overcome it</li> </ul>	<ul style="list-style-type: none"> <li>Impediments</li> </ul>
6	'Social support'	<ul style="list-style-type: none"> <li>Find out social support for physical activity</li> </ul>	<ul style="list-style-type: none"> <li>Facilitator</li> </ul>

### *Pedometer*

Pedometer (Yamax SW-200, Yamasa Tokei Keiki Co., Ltd, Tokyo, Japan) and log book were delivered to the intervention group for the purpose of self-monitoring and tracking physical

activity. The pedometer and log book further assisted in setting-up goals as self-regulatory strategy for increasing physical activity.

### *Telephone Calls*

Telephone calls were made to all participants in this study for a 10 to 15-minute discussion after each newsletter was delivered. The main purpose of telephone calls was to reinforce information on the newsletter and help participants understand the content, and apply it to their daily routines. This occurred through a semi-scripted phone interview. The example questions in the script included ‘Have you tried any physical activity suggested in the newsletter?’, ‘What strategies or goals did you use to be active?’, and ‘Did the newsletter help you engage in more physical activity?’. Additionally, the phone calls included coaching how to set up goals with pedometer as well as checking average step counts from each participant.

### Control Materials

Participants in the control group received a total of 6 newsletters designed to provide information that was not related to physical activity (i.e., managing stress, nutrition, allergies, blood pressure, alcohol use, and cholesterol). Telephone calls were further followed up to check that the participants received the newsletters as well as that the content of the newsletters were easy to follow. The topic of physical activity was not discussed during phone calls. This condition served as a control for attention and social contact.

### Procedures

#### *Initial Screening, Baseline Assessment, and Random Assignment*

The researcher contacted potential participants who expressed interest in the study and conducted the screening procedure to see if they meet the inclusion criteria of this study. After

initial telephone contact and screening, all participants who volunteered provided a signed informed consent document. Upon receipt of informed consent, participants were given a battery of questionnaires along with an accelerometer through the USPS. They were further provided pre-stamped and pre-addressed envelopes for return postal service. Participants were asked to wear the accelerometer for a 7-day period along with completing the questionnaires as baseline assessment. Upon return, all questionnaires were checked for completeness, and if any has missing data, researcher made a phone call to collect the data.

After completion of the baseline assessment, participants were matched in pairs based on results from the measures including physical activity based on the self-reported questionnaire (i.e., GLTEQ) and disability levels. Participants were then randomly assigned into either the intervention or control condition using a random number table.

#### *Intervention Delivery*

The intervention materials were delivered in a single wave across a 6-week period and the participants in the intervention received a total of 6 newsletters developed on a basis of active agents (i.e., self-efficacy) from the SCT. The control group also received 6 newsletters that included useful information which was not related to physical activity in MS (i.e., nutrition, allergies, and alcohol use, etc.).

Print newsletters were mailed by the USPS on Thursday each week to ensure that the newsletters arrived at the beginning of the next week (i.e., Monday or Tuesday). Newsletters were further emailed to participants as well on the day matched upon the estimated delivery date in case of missing mail or delivery failure. After the newsletter was delivered, telephone calls were made on Monday and Tuesday for the intervention group, and the control group received calls on Wednesday and Thursday.

### *Post Assessment*

After the 6-week of the intervention treatment, post assessment for all the participants were preceded for follow-up.

### *Compensation*

Participants received US\$10 for completing the measures on each of the measurement periods including baseline assessment and follow-up.

### Statistical Analyses

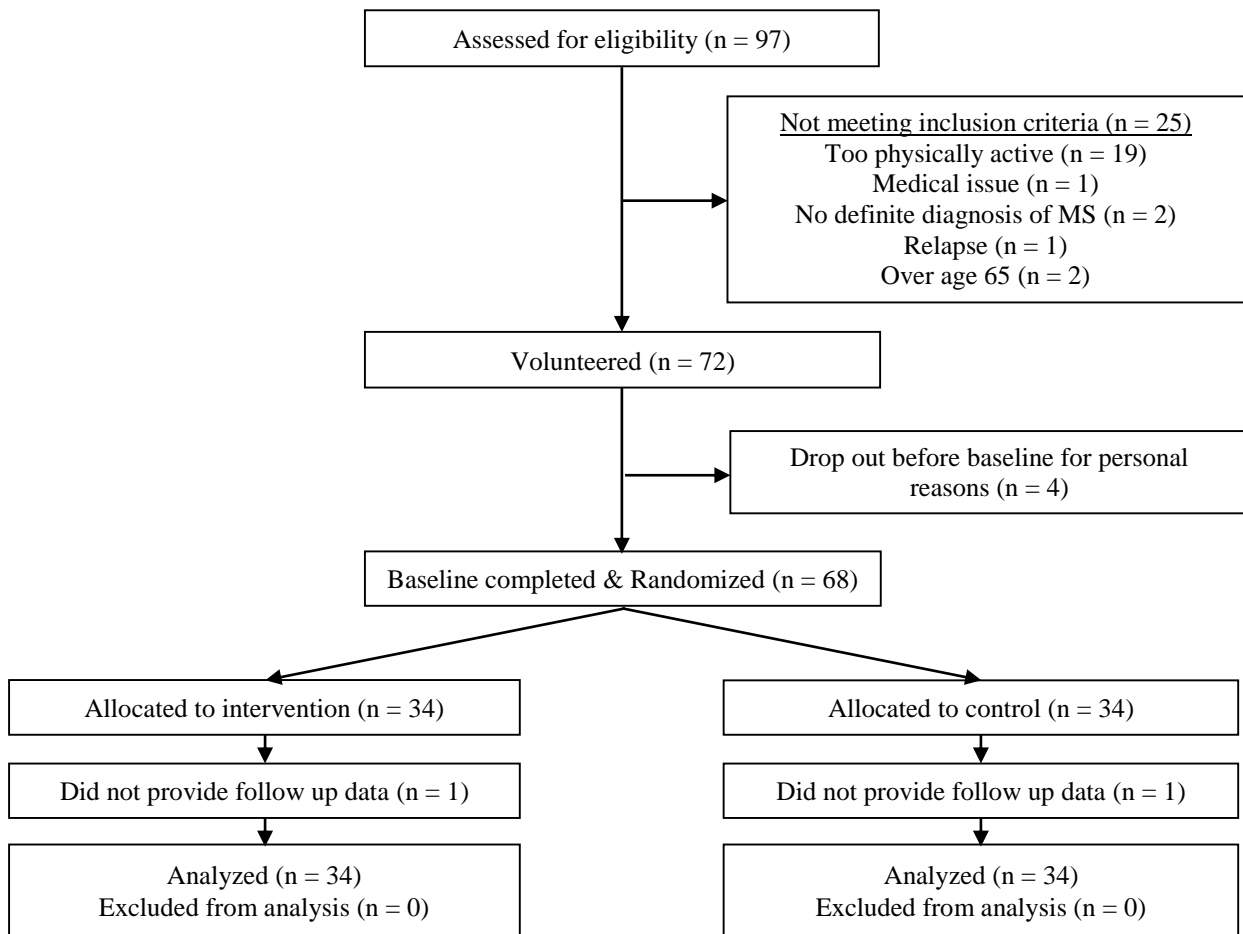
All analyses were conducted in PASW Statistics, version 18.0 for Windows. The missing data were replaced with the corresponding baseline value, thereby allowing for an intent-to-treat analysis. Initial descriptive statistics on demographics and MS-related variables (e.g., type of MS) were performed. Independent samples *t*-tests were used to compare groups for initial differences in study variables. Next, the effects of the intervention on the study variables was examined using 2 (Condition: Intervention & Control)  $\times$  2 (Time: Pre & Post) mixed model analysis of variance (ANOVA) based on univariate *F*-statistic. Condition was a between-subjects factor and time was a within-subjects factor. Interactions were decomposed using paired and independent samples *t*-tests. Effects sizes for *F*-statistic were expressed as partial eta-squared ( $\eta^2_p$ ). Effects sizes based on differences in mean scores were expressed as Cohen's *d* and interpreted as small, medium, and large based on values of 0.20, 0.50, and 0.80, respectively (Cohen, 1988). Multiple linear regression analyses were conducted to examine the mediator variables. This analysis involved regressing change in physical activity on condition in the first analysis and then regressing change in physical activity on condition plus change in putative mediators in the second analysis. Mediation was based on the effects of condition on physical activity becoming reduced in magnitude and non-significant after controlling for the mediator variable(s). The

proportion of explained variance in the outcome from the regression analysis was based on the adjusted  $R^2$ .

## CHAPTER IV: RESULTS

### *Participants*

97 participants were recruited and assessed for eligibility, and 72 participants satisfied the study inclusion criteria. Of those volunteered 72 participants, 68 participants completed the questionnaires and returned the study packet at baseline. The resulting 68 persons were randomly assigned into either intervention or control group. Two people did not provide follow-up data (n = 1 in the control group, n = 1 in the intervention group).



*Figure 1* Consort diagram

Independent samples *t*-tests and chi square statistics ( $\chi^2$ ) compared each group at baseline to determine whether there were any group differences in sex ( $\chi^2 = 1.62$ ,  $df = 1$ ,  $p = 0.20$ ), age ( $t = -.99$ ,  $df = 66$ ,  $p = 0.35$ ), weight ( $t = 0.52$ ,  $df = 66$ ,  $p = 0.61$ ), height ( $t = 1.77$ ,  $df = 66$ ,  $p = 0.09$ ), education ( $\chi^2 = .00$ ,  $df = 1$ ,  $p = 1.00$ ), race ( $\chi^2 = 3.14$ ,  $df = 1$ ,  $p = 0.08$ ), employment ( $\chi^2 = 0.24$ ,  $df = 1$ ,  $p = 0.63$ ), MS type ( $\chi^2 = .00$ ,  $df = 1$ ,  $p = 1.00$ ), disease severity ( $t = .47$ ,  $df = 66$ ,  $p = 0.64$ ) and disease duration ( $t = .53$ ,  $df = 66$ ,  $p = 0.60$ ) (See Table 2). There were no significant differences between the two groups in demographic, morphologic, and clinical variables at baseline.

The mean age of the total sample at baseline was 49 years (SD = 8.8; range 18-64). The majority of the sample was female (81%), Caucasian (96%), well-educated (47% > were college graduates), and were employed (47.1%). The sample consisted primarily of individuals with RRMS (n = 66), with the remaining individuals having SPMS (n = 1) or benign MS (n = 1). The mean time since MS diagnosis was 12.1 years (SD = 7.9, range 3 - 33 years) and the mean PDDS score was 2.0 (SD = 1.8, range 0 - 7). The overall PDDS score of ~ 2.0 indicated that the sample had moderate disability defined as no limitation walking ability, despite problems that limit daily activities.

Table 2 *Demographic and clinical data at baseline for the intervention and control groups*

Characteristic	Total (n=68)	Control (n=34)	Intervention (n=34)
Sex (male/female)	12/56	8/26	4/30
Age (years)	49.0 (8.8)	48.0 (9.4)	50.1 (8.1)
Education (college graduate/less than college graduate)	48/20	24/10	24/10
Race (Caucasian/non-Caucasian)	65/3	31/3	34/0
Employment (unemployed/employed)	36/32	17/17	19/15
MS type (RRMS/Other)	66/2	33/1	33/1
Weight (kg)	78.9 (22)	79.8 (20.3)	77.5 (23.7)
Height (cm)	167.1 (7.1)	167.4 (5.1)	165.2 (6.0)
Time since diagnosis (years)	12.1 (7.9)	12.7 (8.8)	11.6 (7.1)
Disease severity (arbitrary units)	2.0 (1.8)	2.2 (1.8)	2.0 (1.8)



Note. Values represent mean (standard deviation); Disease severity = Patient Determined Disease Steps Scale score (PDDS).

### Group Comparison of Pretrial Values for Physical Activity and Social Cognitive Variables

Independent samples *t*-tests were used to compare if there were any group differences in physical activity and social cognitive variables at baseline. Table 3 provides data on pretrial values for physical activity and the putative mediator variables for those who completed the study. There were no significant differences between the intervention and control groups on pretrial values for GLTEQ scores ( $t = .89, df = 66, p = .38$ ), activity counts ( $t = -1.26, df = 56, p = .21$ ), self-efficacy ( $t = -.42, df = 66, p = .68$ ), goal setting ( $t = 1.30, df = 66, p = .20$ ), social outcome expectations ( $t = -.72, df = 66, p = .48$ ), functional limitations ( $t = .31, df = 66, p = .76$ ), family support for exercise ( $t = 2.06, df = 66, p = .06$ ), friends support for exercise ( $t = 1.20, df = 66, p = .24$ ), and social provisions ( $t = -.33, df = 66, p = .74$ ). There were statistically significant differences between the two groups on physical outcome expectations ( $t = -3.40, df = 66, p = .00$ ), and self-evaluative outcome expectations ( $t = -2.40, df = 66, p = .02$ ) indicating that the control group reported higher values compared with the intervention group.

Table 3 *Physical activity and social cognitive mediator variables in pretrial and post-trial for intervention and control groups*

Variables	Control		Intervention	
	Pretrial	Post-trial	Pretrial	Post-trial
Physical activity (GLTEQ)	22.7 (19.4)	20.3(21.9)	19.1 (14.8)	27.4 (20.6)
Activity counts (Accelerometer)	174063.8 (67675.1)	143339 (73777)	205488.1 (115937.7)	198391.9 (120697.1)
Self-efficacy	47.3 (15.3)	41.9(18.1)	48.7 (11.9)	48.9 (14.1)
Goal setting	22.5 (9.7)	20.6 (8.9)	19.6 (8.7)	25.4 (9.2)
Physical outcome expectations	33.0 (3.7)	33.6 (4.1)	35.9 (3.2)	35.1 (4.3)
Social outcome expectations	23.3 (3.6)	24.2 (5.1)	24.0 (4.4)	24.2 (4.4)
Self-evaluative outcome expectations	16.0 (2.1)	16.2 (2.3)	17.3 (2.4)	17.3 (2.4)
Functional limitations	33.0 (13.4)	33.2(13.5)	32.0 (11.3)	32.7 (11.2)
Family support for exercise	30.7 (16.9)	24.2(16.5)	23.3 (14.2)	22.4 (13.0)
Friends support for exercise	27.7 (20.3)	23.9(19.2)	22.3 (17.1)	20.7 (14.0)
Social provisions	15.0 (2.7)	15.5 (1.8)	15.2 (2.3)	15.6 (1.6)

*Note. Values represent mean (standard deviation). Physical activity= Godin Leisure-Time Exercise Questionnaire; Self-efficacy= Exercise Self-efficacy Scale; Physical outcome expectations= Multidimensional Outcome Expectations for Exercise Scale, Physical subscale; Social outcome expectations= Multidimensional Outcome Expectations for Exercise Scale, Social subscale; Self-evaluative outcome expectations= Multidimensional Outcome Expectations for Exercise Scale, Self-evaluative subscale; Family support for exercise= Social support and Exercise Survey, Family subscale; Friends support for exercise= Social support and Exercise Survey, Friends subscale; Social support= Social Provisions Scale; Functional limitations= Late-Life Function and Disability Inventory; Goal setting= Exercise Goal setting Scale.; n = 34 per condition for all variables except activity counts for 29 participants per condition.*

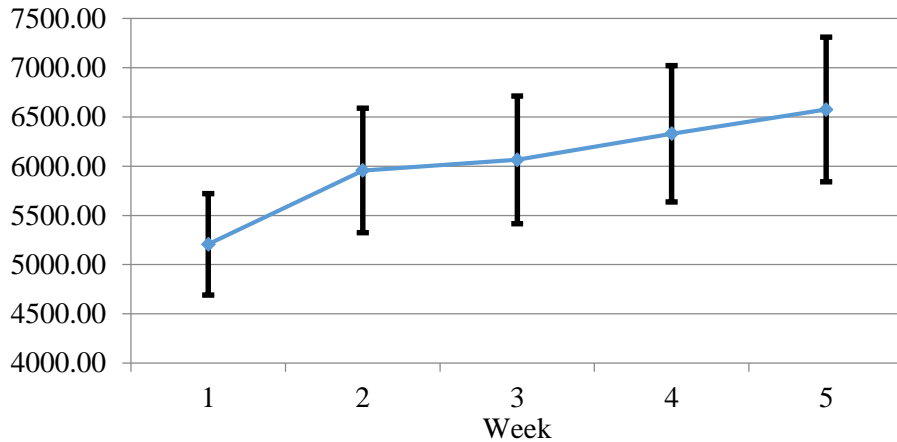
### *Effects of the Intervention on Physical Activity*

There was a statistically significant condition-by-time interaction on GLTEQ scores,  $F(1, 66) = 5.47, p = .02, \eta_p^2 = .08$ . The mean scores are in Table 3. The intervention group reported a statistically significant ( $p = .02$ ) and medium increase in physical activity over time ( $d = 0.56$ ), whereas the control group had a small ( $d = -0.13$ ) and non-significant ( $p = .45$ ) reduction in physical activity over time.

Activity counts per day from accelerometers were analyzed with a total number of 58 participants. There were 10 people ( $n = 4$  in the control,  $n = 6$  in the intervention) with missing baseline data who could not be included in the analysis, and 8 people ( $n = 4$  in the control,  $n = 4$  in the intervention) with missing follow up data who were included in the analysis based on the intent-to-treat approach. There was no condition-by-time interaction on activity counts per day,  $F(1, 56) = 1.29, p = .26, \eta_p^2 = .02$ . Although this overall  $F$ -statistic indicates that decomposing the interaction effects was not necessary, changes in activity counts per condition were examined given that this was one of the primary outcomes in this study. There was a non-significant change in activity counts in the intervention group ( $d = -.06, p = .65$ ), whereas a statistically significant reduction in activity counts was observed in the control group ( $d = -.45, p = .03$ ).

One additional analysis examined change in step counts per day from pedometers over the intervention period; the control group did not wear the pedometer and were not included in the analysis. The one way repeated measures ANOVA indicated a statistically significant time

main effects on step counts,  $F(1, 32) = 8.03, p \leq .01, \eta_p^2 = .20$ . Figure 2 provides average (standard error) step counts over the intervention period and indicates that steps per day increased by 1,368 per day over the 5 weeks of the intervention period ( $d = .46$ ).



*Figure 2 Step counts from pedometer over the 5 weeks for the intervention group*

*Note. n = 33 for the intervention group*

#### *Effects of the Intervention on Possible Social Cognitive Mediator Variables*

The same analytic model (mixed model ANOVA) was conducted to determine changes in social cognitive variables. There was a statistically significant condition-by-time interaction on goal setting,  $F(1, 66) = 16.88, p \leq .01, \eta_p^2 = .20$ . The intervention group reported a statistically significant and large increase in goal setting over time ( $d = 0.68, p \leq .01$ ), whereas the control group had a non-significant, small reduction in goal setting over time ( $d = -0.19, p = .14$ ).

The ANOVA did not indicate a statistically significant condition-by-time interaction between the two groups on exercise self-efficacy ( $F(1, 66) = 3.19, p = 0.08, \eta_p^2 = .05$ ), physical outcome expectations ( $F(1, 66) = 3.01, p = 0.09, \eta_p^2 = .04$ ), social outcome expectations ( $F(1, 66) = .83, p = 0.36, \eta_p^2 = .01$ ), self-evaluative outcome expectations ( $F(1, 66) = .59, p = 0.44, \eta_p^2 = .00$ ), functional limitations ( $F(1, 66) = .11, p = 0.73, \eta_p^2 = .00$ ), family support for exercise ( $F$

(1, 66) = 3.40,  $p = 0.07$ ,  $\eta_p^2 = .04$ ), friends support for exercise ( $F(1, 66) = .24$ ,  $p = 0.62$ ,  $\eta_p^2 = .00$ ), and social provisions scale ( $F(1, 66) = .01$ ,  $p = 0.91$ ,  $\eta_p^2 = .00$ ).

### *Mediator Analysis*

The mediator analysis involved three preconditions: 1) condition was related with physical activity; 2) condition was related with the presumed mediator; and 3) the presumed mediator was associated with physical activity. The aforementioned mixed model ANOVAs supported preconditions 1 and 2 for considering goal setting as a mediator of changing in GLTEQ. Bivariate correlation analysis in Table 4 indicated that there was a statistically significant relationship between changes in goal setting and GLTEQ scores supporting precondition 3. The initial analysis regressed change in GLTEQ on condition (0 = control, 1 = intervention) and the model was significant,  $F(1, 66) = 5.47$ ,  $p = 0.02$ , adjusted  $R^2 = .06$ . Condition was a significant predictor of change in GLTEQ ( $B = -10.85$ ,  $SE B = 4.63$ ,  $\beta = -.28$ ,  $p = .02$ ). The next analysis regressed change in GLTEQ scores on condition and change in goal setting. The model was significant,  $F(2, 65) = 6.84$ ,  $p = 0.002$ , adjusted  $R^2 = .15$ . Only change in goal setting was a significant predictor of change in GLTEQ ( $B = 0.80$ ,  $SE B = 0.29$ ,  $\beta = 0.35$ ,  $p = .007$ ). The effects of condition on GLTEQ was no longer statistically significant ( $p = .35$ ). This indicates that goal setting mediated the intervention effects on self-reported physical activity.

Table 4 *Bivariate correlations (r) between changes ( $\Delta$ ) in self-reported physical activity and mediator variables*

Variables	$\Delta$ GLTEQ
$\Delta$ Self-efficacy	.18
$\Delta$ Goal setting	.40*
$\Delta$ Physical outcomes expectations	-.05
$\Delta$ Social outcome expectations	-.04
$\Delta$ Self-evaluative outcome expectations	.06
$\Delta$ Functional limitations	.02
$\Delta$ Family support for exercise	.10
$\Delta$ Friends support for exercise	-.02
$\Delta$ Social provisions	-.08

*Note.* \* $p \leq .01$ ; Physical activity= *Godin Leisure-Time Exercise Questionnaire*; Self-efficacy= *Exercise Self-efficacy Scale*; Physical outcome expectations= *Multidimensional Outcome Expectations for Exercise Scale, Physical subscale*; Social outcome expectations= *Multidimensional Outcome Expectations for Exercise Scale, Social subscale*; Self-evaluative outcome expectations= *Multidimensional Outcome Expectations for Exercise Scale, Self-evaluative subscale*; Family support for exercise= *Social support and Exercise Survey, Family subscale*; Friends support for exercise= *Social support and Exercise Survey, Friends subscale*; Social support= *Social Provisions Scale*; Functional limitations= *Late-Life Function and Disability Inventory*; Goal setting= *Exercise Goal setting Scale*.

*Exploratory Analysis for Possible Causal Agents of Change in Self-Reported Physical Activity in the Intervention Group*

Bivariate correlation analysis was conducted to examine the relationships between changes in steps counts from pedometer and changes in self-reported physical activity/and goal setting. The results indicated that there was non-significant relationships between changes in step counts and changes in self-reported physical activity ( $r = -.23, p = .20$ ), and changes in goal setting ( $r = .05, p = .78$ ). An additional analysis was conducted to examine the relationships between number of phone calls for the intervention group and changes in self-reported physical activity/and goal setting. The results indicated that there were no statistically significant

relationships between number of phone calls and changes in self-reported physical activity ( $r = .16, p = .37$ ) and changes in goal setting ( $r = .15, p = .40$ ).

## CHAPTER V: DISCUSSION

### Summary of Current Study

The primary objective of the current study was to examine the efficacy of the SCT-based intervention delivered by newsletters and telephone calls for increasing physical activity in persons with MS who are physically inactive and have middle levels of self-efficacy. The results indicated that the intervention group who received SCT-based intervention materials appeared to be more physically active based on self-reported physical activity over the 6 weeks compared with the control group that received materials including non-physical activity. Additionally, only goal setting was changed by the intervention and identified as a significant mediator of changing in self-reported physical activity. To that end, the major accomplishment of the current study is the provision of supportive evidence for the efficacy of theory-based interventions delivered by newsletters and phone calls for promoting self-reported physical activity in persons with MS who have middle levels of self-efficacy.

### Hypothesis 1

*The intervention delivered by newsletters and telephone calls would increase physical activity in persons with MS who are physically inactive and had middle levels of self-efficacy compared with persons in a control group.*

The results of this study indicated that the intervention was efficacious for increasing self-reported physical activity (i.e., GLTEQ), but not for changing objectively measured activity counts (i.e., accelerometers). This differential pattern of change was also observed in a behavioral intervention for promoting physical activity among the general population that self-reported physical activity increased over the intervention whereas activity counts from

accelerometer decreased over time (Bourdeaudhuij et al., 2011; Sloane, Snyder, Demark-Wahnefried, Loback, & Kraus, 2010).

Possible explanations for the different effect of the intervention on physical activity outcomes might be that GLTEQ and activity counts were not strongly correlated ( $r = .40$ ) in this study. This makes some sense considering that each measure assesses different aspects of physical activity, whereby the GLTEQ assesses frequency and intensity of brief bouts of physical activity over a 7 day-period to calculate energy expenditure whereas accelerometers measure total body movements over the entire waking hours of the day. Additional explanation is that self-reported measures (i.e., GLTEQ) may be over-reported, but not based on social desirability bias, considering evidence of no associations between GLTEQ scores and measures of social desirability in non-diseased adults (Motl, McAuley, & Distefano, 2005). Moreover, the current study was powered based on change in self-reported physical activity (i.e., GLTEQ), not based on changes in accelerometer and social cognitive variables, so this may be underpowered to detect changes in activity counts from accelerometer and changes in social cognitive variables in the current study. Additionally, the pedometer for the intervention group was not worn during the last week of the intervention. The pedometer in the current study played a role in self-monitoring for participants to track physical activity over the intervention period. However, participants were unable to wear the pedometer in the last week of the intervention because the follow-up assessment was made at that time, whereby the accelerometer was worn instead of pedometer. Perhaps the removal of the self-monitor might have negated actual changes in physical activity at the last week of the intervention, but participants are still reporting physical activity based on new patterns over the 6 weeks. One final explanation is that participants in this study may have worn the device in a wrong way, which can interfere with capturing correct body movement. The accelerometer



further is not water proof, and does not capture water-based activities (e.g., swimming) that might have been performed during the intervention period.

In terms of determining specific causal agent of change in self-reported physical activity (i.e., what about the intervention caused change in GLTEQ scores), the findings of this study indicated that changes in pedometer step counts and number of phone calls delivered to the intervention group were not significantly correlated with changes in self-reported physical activity in the intervention group. This suggests that there could be overall effects of the intervention materials (i.e., newsletters, phone calls, and pedometer) on changes in self-reported physical activity in the intervention group.

Overall, this study provides evidence that behavioral interventions delivered by newsletters and phone calls may be appropriate approaches to increase self-reported physical activity among persons with MS.

## Hypothesis 2

*The intervention in this study would work by possible mediators of physical activity behavior, including self-efficacy, outcome expectations, goal setting, and facilitators/impediments in persons with MS.*

The efficacy of the intervention on social cognitive variables (i.e., self-efficacy, goal setting, physical outcome expectations, social outcome expectations, self-evaluative outcome expectations, functional limitations, family support for exercise, friends support for exercise, and social provisions) was also examined in the current study. Of those variables, only goal setting was significantly changed over the 6 weeks in the intervention group and identified as a significant mediator of changing in self-reported physical activity. This is consistent with

previous Internet-delivered behavioral intervention study in persons with MS that only goal setting was significantly changed by the intervention (Motl, Dlugonski, et al., 2011).

This might be also explained in a goal setting theory (Locke & Latham, 2002) that goal setting is associated with performance (i.e., physical activity), and this might be especially true in those who have middle levels of self-efficacy and yet ready to commit to behavior change because they tend to give up quickly in the face of barriers. They can achieve desired changes by learning self-regulatory strategies (i.e., goal setting) through interactive guidance (i.e., print materials or telephone counseling) (Bandura, 2004). Another possible explanation for the findings of considering goal setting as a significant mediator of self-reported physical activity might be the emphasis that was placed on goal setting, instead of other social cognitive variables throughout the intervention period. Especially, phone calls for the intervention group played a role in not only reinforcing the intervention materials, but also tracking weekly step counts from pedometer and discussing setting up/changing goals based on the step counts for increasing physical activity. To that end, goal setting may represent an important target variable that should be considered in developing behavioral interventions for increasing physical activity in persons with MS who are physically inactive.

The current study did not indicate significant changes in exercise self-efficacy over time in the intervention group, whereas the control group had a significant reduction in exercise self-efficacy over the 6 weeks. This indicates that levels of exercise self-efficacy were maintained throughout the intervention for the intervention group. This is inconsistent with findings in previous study that self-efficacy was overestimated at baseline and it was finally corrected at the end of the intervention which the efficacy levels decreased in persons with MS and healthy adults (Klamm et al., 2009; Motl, Dlugonski, et al., 2011). Furthermore, the efficacy levels at

baseline in the current study ( $M = 47.3$ , range from 0 to 100) were even lower than the levels from previous study in persons with MS ( $M = 77.7$ , range from 0 to 100) (Motl, Dlugonski, et al., 2011). Because the current study recruited persons who had middle levels of self-efficacy with a mean of 56.6 at recruitment, their recalibrated baseline efficacy levels with a mean of 47.3 indicate that the efficacy may be reported in a more realistic way at baseline and it can be maintained over the 6 weeks.

### Novel Aspect of Study

There are novel features and findings of the current study. One of the notable features in this study is that there was a control group that received different substitutes of intervention material over the intervention period. The control group was not supposed to receive any physical activity-related information through newsletters and phone calls over the intervention period. Instead, the newsletters contained information (i.e., managing stress, nutrition) from the MS-related website such as National MS Society so that this condition served as control for attention and social contact. This highlights that the current study had a credible control condition as opposed to the condition receiving standardized, generic information or being a wait-list (Bombardier et al., 2008; Motl, Dlugonski, et al., 2011).

Another notable feature in this study is that the current study focused on middle levels of exercise self-efficacy in persons with MS based on Bandura's threefold stepwise implementation model, and this provides the initial evidence that newsletters and phone calls can benefit physical activity promotion, especially for those with middle levels of self-efficacy of physical activity. Finally, the current study was developed with only SCT along with sociocognitive model as well as threefold stepwise model. By comparison, other theory-based physical activity intervention studies used two or more theoretical frameworks to develop the intervention such as using TTM

and SCT, or only considering self-efficacy from SCT (Ball et al., 2005; Lewis et al., 2006; Marcus et al., 2007).

There are some notable findings in this study. One of the novel findings in this study is that changing in self-reported physical activity was observed at 6 weeks, and this is consistent with previous intervention study that changing in self-reported physical activity appeared at 6 weeks over a 12 week period of time (Motl, Dlugonski, et al., 2011). Evidence further supports that a 6-week of intervention delivered by print materials (i.e., self-manuals) for promoting physical activity was efficacious for increasing physical activity among the general population (Marcus et al., 1992). Another study further reported that changing in step counts from pedometer was observed at 6 weeks among inactive patients (Trinh et al., 2011). Additional novel finding in this study is that average step counts from pedometer per day increased by 26.2% over the intervention period. This was also observed in a systematic review of pedometer-based physical activity intervention in the general population that pedometer users who had step goals significantly increased their physical activity by 26.9% (Bravata et al., 2007). One final notable finding in this study is that objective monitors used in this study (i.e., accelerometer and pedometer) brought about different results, indicating that pedometer step counts increased over the intervention period whereas activity counts from accelerometers had non-significant changes over time. One possible explanation of the discrepancy of the results between pedometer and accelerometer is that pedometers provided direct numbers of step counts on the device, and this may have motivated participants to change physical activity behavior by allowing for looking at the step counts.

## Study Limitations and Future Directions

There are some limitations of the current study. First, the time-spent in light, moderate, and vigorous physical activity was not included in the analysis because of data processing problems that the data files from the accelerometers were saved in a format that did not permit analyses beyond total activity counts. Another limitation is that the sample of this study had minimal disability and the results should not be generalized amongst those with RRMS who have more severe mobility impairments as well as other severe types of MS (i.e., secondary-progressive MS or primary-progressive MS). An additional limitation is the representativeness of the sample based on the demographic characteristics of the participants. The sample of the current study primarily consisted of women with RRMS, and furthermore, this sample was recruited from pool of participating in previous physical activity study in MS. This may affect participants' expectations that may have primed the current intervention study. Furthermore, the measures were not originally developed for persons with MS and some of the measures included both physical activity and exercise behavior (e.g., social support for exercise scale). It is previously noted that most of the measures have some evidence to support the correlation with measures of lifestyle physical activity in previous research (Motl et al., 2009). Regrettably, there were no data available regarding the long-term efficacy of this intervention.

One of the directions for future study is that longer term follow-up may be helpful for identifying the most efficacious approach for achieving sustained increases in physical activity among persons with MS. Additionally, further study is needed to develop material of physical activity interventions that put a strong emphasis on other social cognitive variables (e.g., self-efficacy, outcome expectations, and social support) because goal setting was relatively highlighted through the phone calls and using pedometer in the current study. Furthermore,

measuring quality of life and other MS-related symptoms (i.e., fatigue and depressive symptoms) would further assist in better understanding of changes in physical activity behavior beyond the social cognitive variables among persons with MS.

### Conclusions

The current study indicated that the newsletter- and telephone call-delivered intervention based on SCT resulted in a statistically significant and large increase in self-reported physical activity over the 6 weeks in persons with MS who had middle levels of self-efficacy. Additionally, the effects of the intervention was mediated by only changing in goal setting, and this provides successful evidence to support that only goal setting was identified as a significant mediator of physical activity in persons with MS (Motl, Dlugonski, et al., 2011). Overall, non-supervised technology (i.e., newsletters and telephone calls) could have the potential for altering traditional approaches (i.e., face-to-face contact) in physical activity promotion in persons with MS because of reduced cost, easiness of time management, and large sample reach. This further provides initial evidence that behavioral interventions developed with SCT delivered through non-face-to-face approaches (i.e., newsletters and telephone calls) might successfully increase physical activity in persons with MS.

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